Healing the Healer: Exploring UK-based doctors' and nurses' nutrition and dietary behaviours within the workplace

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https://doi.org/10.34737/wq300

HEALING THE HEALER: EXPLORING UK-BASED DOCTORS' AND NURSES' NUTRITION AND DIETARY BEHAVIOURS WITHIN THE WORKPLACE

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A thesis submitted in partial fulfilment of the requirements of the University of Westminster for the degree of Doctor of Philosophy

May 2024

UNIVERSITY OF WESTMINSTER

Abstract

Medical doctors and nurses (DNs) play a crucial role in the National Health Service (NHS), but their occupational demands can negatively affect their health. Shift work, common in the medical field, has been linked to various health issues for DNs, including sleep disturbances, weight gain, cognitive performance decline, and cardiovascular health concerns. Nutrition has been identified as a key factor in managing these risks. However, limited research has been conducted on the dietary intake and nutritional behaviour of DNs during shift work. This thesis aims to address this gap by exploring the current diet and nutritional practices and the impact of shift work on DNs' food consumption and dietary behaviours using a mixed-method approach.

The qualitative study, conducted between 2020 – 2021, involved online semi-structured interviews with practising DNs undertaking shift work (n=16) from various occupational grades and specialities across the UK. Thematic analysis was performed on the collected data. The findings demonstrate the detrimental impacts of shift work on DNs' poor nutrition and health and wellbeing. Factors influencing DNs' diet during shifts are complex, with clinical responsibilities often being prioritised and at the forefront, thus often missing eating opportunities. Consequently, DNs frequently eat on the go. Hence, food accessibility and availability are significant in DNs' dietary decisions. Caffeine consumption is common among DNs to sustain energy during shifts due to its easy accessibility and availability. Night shifts pose challenges for maintaining a healthy diet and often lead to DNs making unhealthy food choices. Despite these challenges, DNs highly value their meals after their shifts as their main meal of the day. Workplace culture, staff shortages, and limited access to food facilities outside standard hours are additional barriers to good workplace nutrition.

Building on the qualitative findings, a quantitative analysis using the UK Biobank dataset (n=5,777) was conducted to compare the differences in dietary intake among UK DNs with different shift work patterns. The results indicate limited consumption of fruits, vegetables, fish, and dietary fibre, while all DN shift workers have a high intake of meat, tea, coffee, and alcohol. The data reported a significant difference between doctors and nurses, with doctors consuming more than nurses in unprocessed red

meat portions per week (2.176 ± 1.429 vs 2.053 ± 1.443) ($p<0.001$), cups of coffee per day (1.57 ± 3.859 vs 1.30 ± 3.60) ($p<0.001$), and overall alcohol intake per week (63.146g ± 48.570 vs 40.261g ± 48.242) ($p<0.001$). Meanwhile, nurses had a higher average consumption than doctors in portions of fruit (2.840 ± 2.489 vs 2.657 ± 2.796) and vegetables (2.415 ± 2.036 vs 2.349 ± 2.104) ($p<0.001$), cups of tea (3.14 ± 3.560 vs 2.18 ± 3.972) and water (2.60 ± 3.568 vs 1.40 ± 4.229) ($p=0.000$). Various shift work factors influence dietary intake, such as working hours, night shift length and frequency, and consecutive night shifts. Longer working hours and more night shifts were associated with poorer dietary behaviour, including reduced vegetable and meat intake but increased tea and coffee consumption. Between doctors and nurses, doctors consumed less fruit when working over 30 hours per week ($p=0.037$) and on consecutive ($p=0.020$) and night shifts ($p=0.048$). In other types of food, doctors consumed more than nurses in vegetables, meat, fish, milk, and coffee across different shift patterns. Whereas nurses consumed more water than doctors ($p<0.001$) and when measured against the average length of night and consecutive night shifts ($p=0.002$)

This thesis provides novel and valuable insights into the dietary intake and nutritional behaviours of DNs during shift work. Findings underscore the need for DNs to prioritise good nutrition, particularly highlighting the importance of considering workplace factors, such as regulations and cultures, in improving workplace nutrition during shifts. Further research is warranted to explore effective strategies for supporting and promoting DNs' workplace nutrition through changes in the healthcare setting. But also explore how other confounding factors, such as sociodemographic factors and other health behaviours, may influence DNs’ dietary habits at work.

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Sum, K., Cheshire, A., Ridge, D., Sengupta, D., Deb, S (2023). Doctors' and nurses' eating practices during shift work: findings from a qualitative study. The Nutrition Society's Winter Conference, The Royal Society London, 5-6 December 2023

Sum, K., Cheshire, A., Ridge, D., Deb, S (2022) Supporting doctors' nutrition in the workplace: findings from a qualitative study. The Nutrition Society's Summer Conference, 12-15 July 2022

> *selected and presented as one of the four Nutrition Society's theme highlights in the main conference programme, represented the "Nutrition and optimum life course" theme

Journal Publication

Sum, K., Cheshire, A., Ridge, D., & Deb, S. (2022). Supporting doctors' nutrition in the workplace: Findings from a qualitative study. Proceedings of the Nutrition Society, 81(OCE5), E161. doi:10.1017/S002966512200194X

Acknowledgements

"Education never ends...It is a series of lessons with the greatest for the last."
~Sir Arthur Conon Doyle. Sherlock Holmes: The Adventure of the Red Circle

This PhD has undoubtedly taken me on an expedition filled with valuable lessons and growth. I am immensely grateful for the endless support and guidance I have received throughout this journey.

First and foremost, I am deeply grateful to my team of supervisors, Dr Sanjoy Deb, Dr Dipankar Sengupta, Dr Anna Cheshire and Professor Damien Ridge, for their unwavering support, invaluable advice and expertise in the success of this thesis. They have not only taught me the importance of being part of a multidisciplinary team but have also kept me disciplined when my ideas often run wild!

I am grateful to the School of Life Sciences at the University of Westminster for providing me with a PhD Studentship, the opportunity to conduct my research and bring my research aspiration to fruition.

I greatly appreciate the support my participants, doctors and nurses received for their willingness to share their personal stories during the challenging time of the COVID-19 pandemic. Their insights have been invaluable to my research – thank you for your time and contribution.

I would also like to thank my family for their love, patience and support during this process, especially when it feels endless. Without them, this journey would not be possible.

Finally, doing a PhD does take a village. However, it is impossible to name everyone here. To the different communities and networks I have been fortunate to be a part of alongside this PhD, thank you in countless ways for your continuous encouragement, motivation, and support. I treasure those endless and often spontaneous conversations that have inspired and motivated me. Thank you.

Author’s Declaration

I, Kiu Sum, declare that all the material contained in this thesis is my own work.

Glossary of Abbreviations

A&E	Accidents and Emergencies
Asso	Association/ associated
BMI	Body Mass Index
BW	Body Weight
CHO	Carbohydrate
CVD	Cardiovascular Disease
Diff	Difference
DNs	Doctors and Nurses
EB	Eating Behaviour
EWTD	European Working Time Directive
FFFS	Frequency of fast food and snacks
FFQ	Food Frequency Questionnaire
g	Gram
GPs	General Practitioners
IPAQ	International Physical Activity Questionnaire
kcals	kilocalories
kg	Kilogram
kg/m^2	Kilogram per metre squared
m	Meter
n	Number
NHS	National Health Service
NoS	Number of servings of fruits and vegetables
OBS	Open Broadcaster Software
PA	Physical Activity
PIS	Participant Information Sheet
PSS	Perceived Stress Scale
SACN	Scientific Advisory Committee on Nutrition
Sat	Saturated
SD	Standard Deviation
Sig	Significant
SRI	Sleep-related Impairment Assessment

UK	United Kingdom
WHO	World Health Organisation
↑	Increase (of)
↓	Decrease (of)

CHAPTER 1: LITERATURE REVIEW

1.1 Introduction

1.1.1 Need for health professionals

The National Health Service (NHS) employed 1.2 million health professionals in 2023[1] and is one of the largest employers worldwide, with 24% of all NHS staff and 42% of doctors consisting from ethnic minority backgrounds (Woolf *et al.*, 2023) from a pool of 200-plus non-white nationalities (Baker, 2019). The NHS is a multicultural and multidisciplinary group of health professionals with over 350 professionals, including allied health professionals (e.g., dietitians, osteopaths, prosthetists and operating department practitioners), psychological professionals (forensic psychologists, counsellors, clinical neuropsychologists), healthcare science (e.g., clinical bioinformatics, cardiographers, geneticists) to the frontline professionals such as doctors, nurses and the ambulance services. Given the significant number of employees serving the national population, it is important to understand this workforce's challenges[2].

The UK population reached 67 million in mid-2021, according to Census 2021 (Office for National Statistics, 2022), with further statistics demonstrating its ageing population due to decreased fertility and mortality rates over time. However, this puts pressure on the NHS, with 70% of health and social care spending in England attributed to chronic health conditions (Lacobucci, 2017). Furthermore, combinations of multimorbidities continue to increase hospital costs and primary care provisions, demonstrating the high hospitalisation associated with multimorbidity (Soley-Bori *et al.*, 2021; Stokes *et al.*, 2021). A report, 'Health Profile for England: 2018' (Public Health England, 2018), provides an overview of the population's health, emphasising the top 10 issues impacting health determinants. While life expectancy has increased, mortality rates for conditions such as dementia, Alzheimer's disease and other long-term health conditions like diabetes continue to rise despite reduced morbidity rates

[1] NHS Workforce Statistics, February 2023 England and Organisation Available at: https://digital.nhs.uk/data-and-information/publications/statistical/nhs-workforce-statistics/february-2023
[2] NHS Constitution. Available at: https://eput.nhs.uk/about-us/nhs-constitution/

across all population groups. The Health Foundation in 2023 (Dunn, Eqbank and Alderwick, 2023) further emphasised the major challenges faced within the health and care sector, primarily focusing on the NHS, social care and public health services in England. As a result, factors such as employment and affordable access to healthy food play significant roles in health inequalities as society progresses. Nevertheless, many health barriers still hinder the adoption of healthier lifestyles. For example, obesity continues to burden health services despite increasing public health awareness, whereas mental health issues are more prevalent in females than males (20.7% and 13.2% respectively) (Public Health England, 2018). Therefore, it is important to consider and address the numerous health complications to ensure a standard of care that meets the needs of individuals and the population's health (Public Health England, 2018; Dunn, Eqbank and Alderwick, 2023).

Healthcare services provide safe and accessible medical care to those in need. The NHS is a key pillar supporting the health and wellbeing of the UK population, offering free access to healthcare services. However, this system constantly faces scrutiny, as healthcare professionals such as doctors and nurses (DNs) often work unpaid overtime shifts to meet patient demands (Moberly, 2017; Anderson *et al.*, 2021). For example, targets are set to ensure timely treatment, such as referral-to-treatment within 18 weeks and A&E waiting time within the four-hour target (Nuffield Trust, 2019). Perhaps it is due to the financial pressures on the system, with high service demand and limited resources contributing to these challenges. In the 2022/23 financial year, the Department of Health and Social Care in England dedicated £182 billion (Rocks and Boccarini, 2023) to healthcare, with further plans to increase 2.7% to £187 billion for 2023/24. Furthermore, the majority of revenue funding (86% in 2023/34) will contribute to the daily health services and the remainder on longer-term investments such as equipment, innovations and infrastructures. In 2018, the NHS received a five-year funding deal (Prime Minister's Office, 2018), with a 3.4% increase from 2019/20 to 2023/24 to meet the growing service demand and burden. Considering ongoing public health strategies and the aim to reduce health inequalities, the NHS continues to strive to ensure the population's long and productive working life, supporting a strong economy (Public Health England, 2019a).

1.1.2 Reasons to retain health professionals

The healthcare workforce (to note in this thesis, the term "healthcare workers" covers all healthcare professions in the healthcare system) is facing a shortage due to the complex nature of the wider health challenges (Anderson *et al.*, 2021). For example, newly qualified Foundation or Junior Doctors (or physicians known in some countries) encounter occupational difficulties and struggle to adapt to demanding new work schedules, resulting in low morale and high demands (Chandler *et al.,* 2019). Factors such as poor training opportunities, inadequate salaries, adverse working environments, and increasingly antisocial working hours that are unfavourable across the board in a challenging profession contribute to the challenges (Degen *et al.*, 2014; Chandler *et al.,* 2019). Therefore, this has resulted in a high dropout rate among Junior Doctors, with a decline in the percentage of those continuing training from 83% in Foundation Year Two in 2010 to 38% in 2018 (Degen *et al.*, 2014; Chandler *et al.,* 2019). Thus, this trend has also reflected the decreased number of qualified European Union (EU) doctors, with an increased reliance on non-EU registered doctors in recent years. Thus, this resonated with other health professional colleagues, such as nurses, where since the early 2000s, more temporary staff have filled vacancies in British hospitals (NHS Improvement, 2019; The Health Foundation, 2019). With limited health professionals available and relying on international recruitment to meet the safe staffing guidelines, this highlights the failure to adequately train grassroots healthcare professionals to meet the needs of the growing population (The Health Foundation, 2019).

Ensuring the wellbeing and retention of skilled professionals is critical, but it also goes beyond addressing the financial issues (Edwards, 2016). However, simply increasing funding is insufficient to guarantee a sustainable and healthy workforce readily available for the healthcare system. For example, the NHS workforce in 2022 had over six million days of sickness recorded due to health and wellbeing-related reasons (Jones, 2020). Furthermore, in the last 12 months, the NHS staff, ranging from consultants, junior doctors, nurses, radiographers and others, have been part of some national strike action, where a key facet of their dissent is linked to workforce conditions affecting wellbeing. Thus, the combination of growing occupation burdens, such as shift work, and rising expectations on the existing workforce puts additional strain on the NHS. It is also concerning that healthcare professionals, who dedicate long working hours to care for others, often face health risks themselves. The constant structural reorganisation, blame culture, and fear of learning (Wise, 2018) contribute to the stress, burnout, and exhaustion experienced by health workers during challenging times (McManus, Keeling and Paice, 2004; Doran *et al.*, 2016; Imo, 2017; Iliffe and Manthorpe, 2019). Consequently, while trying to cope with the pressure, staff struggles to provide the best quality of patient care. Therefore, it is evident that the health and wellbeing of healthcare professionals are not adequately addressed when patient safety and quality care are continuously measured as the sole focus (The Point of Care Foundation, 2017).

1.1.3 Overall health and wellbeing of health professionals

Health and wellbeing encompass all biopsychosocial aspects (i.e., physical, social, intellectual, and emotional factors), providing a holistic perspective on overall health. While health is often associated with physical fitness and mental stability, it is defined by the World Health Organisation as ‘a state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity (World Health Organisation, 1948). On the other hand, wellbeing does not have a single definition. However, it is associated with living well and addressing this by having a positive attitude in society with ‘the ability to adapt and self-manage (Diener, 2000; Frey and Stutzer, 2010; Huber *et al.*, 2011). Wellbeing involves positive emotions, life satisfaction, the absence of negative emotions and a sense of fulfilment, incorporating physical, social, economic, development, emotional, psychological, and engaging in activities (Eid and Larsen, 2008). Therefore, when evaluating outcomes, it is important to consider the comprehensive perceptions of health and wellbeing, acknowledging objective and subjective health elements that may change over time and vary according to individual needs and life stages.

The current global ageing population has demonstrated an increase in public health policies aimed at ensuring accessible healthcare services and minimising mortality and morbidity rates (Williams *et al.,* 2019; Rudnicka *et al.*, 2020). However, this demographic shift also raises healthcare expenditures as the population grows and other health and social care demands on the system, challenging its sustainability

(OECD, 2011; de Meijer *et al.*, 2013; Anderson *et al.*, 2021). Therefore, there is a hypothetical need to intensify healthcare services to provide for the longevity of the population's health with the necessary and effective medical needs. Thus, this necessitates healthcare professionals to work extended and unconventional hours to meet the healthcare demands of the population.

Health professionals often exhibit poor health patterns, with occupational and workplace factors contributing to increased stress and weight gain resulting from unhealthy food choices (Nicholls *et al.*, 2016; Kyle *et al.*, 2017). For example, the Health Survey for England assessed the prevalence of health and obesity among healthcare professionals on obesity, gender, age and occupation outcomes (Kyle *et al.*, 2017), involving over 20,000 participants via a five-year cross-sectional survey. The result indicated that nurses had the highest obesity prevalence compared to other healthcare professionals and non-health-related jobs (25.1% vs 14.4% vs 23.5%, respectively), although lower than unregistered caseworkers (31.88%). Likewise, a systematic review and meta-analysis further confirm the causal link between unhealthy lifestyle and increased risk of poor health outcomes in epidemiological studies, particularly among health professionals with irregular shift work, which correlated with obesity, sleeping disruptions, vitamin deficiency and digestive problems (Saulle *et al.*, 2018). While it is plausible to assume that the negative implications on doctors could influence the wider public health consequences, there is a scope to elucidate further the relationship between occupational and workplace factors with poor diet, health, and nutrition.

Efforts have been made to secure a better NHS workforce across the sector. Key policies such as the NHS Long Term Workforce plan in 2023 (NHS England, 2023b) considered prioritising staff health and wellbeing in promoting workforce retention, reducing absenteeism, and improving capacity. Similarly, the NHS Health and Wellbeing Framework (NHS England, 2021) aimed to increase patient safety and care quality, putting NHS healthcare professionals through a holistic approach to support the employees' health and wellbeing and building transparency across the sector. Considering this, A Covenant for Health, led by Lord Filkin with support from The King's Fund in 2023 (Filkin *et al.*, 2023), looked to build a healthier nation with a cross-party commitment in five to ten years for any government to act quickly, strengthening the partnership for health and bringing together businesses, the NHS, communities and individuals to make a sustainable and healthy change in the nation. Complementing this, the Workplace Health and Safety Standards were also developed in 2023 (NHS Employers, 2023) to address issues such as patient safety and experience, the quality of care and the health and wellbeing of the workforce. However, healthcare research has shown a correlation between the implications of negative staff wellbeing and patient experience (Hall *et al.*, 2016; Janes *et al.*, 2021; Prudenzi *et al.*, 2022).

Workplace nutrition and dietary behaviour significantly affect the population's overall health and the NHS Long-Term Plan (NHS England, 2023b). Evidence suggests that "one-third of a working adult's daily intake is consumed whilst at work" (Vasiljevic *et al.*, 2019). Therefore, the value in viewing 'food as medicine' emboldened NHS England to create the Healthcare Food Standards and Strategy Group in 2014 (NHS England, 2023a), which lays out the priorities of ensuring nutritional quality and sustainability of food/ drink provision for patients, visitors and the workforce within the workplace. Adherence to these standards nevertheless varied across the country, resulting in NHS England's publication of the national standards for healthcare food and drinks in 2023 (NHS England, 2023a). Undoubtedly, this framework highlights that implementing workplace interventions targeted at healthcare professionals can offer an opportunity to improve their dietary health and wellbeing (Drewnowski, 2020). Studies show that effective workplace interventions enhance employees' health and wellbeing, increase work efficacy, and promote general nutrition knowledge (Meyer *et al.*, 2019). One example is the Workplace Health Work Ready programme curated by the British Dietetic Association (British Dietetic Association, no date) to maintain a healthy workforce by improving employees' resilience, wellbeing and productivity through working with dedicated dietitians from the programme to assess the nutritional needs to delivery a tailored programme for the workplace. This highlights that not only doctors and nurses need to improve their workplace health, but rather for any workplace looking to improve their workforce. Thus, there is a knowledge gap among healthcare professions on their workplace nutrition, with health risks that must be further addressed.

1.1.4 Aims

This chapter aims to explore and understand the current literature for doctors and nurses (DNs) with health and wellbeing at work (i.e., shift work), particularly emphasising workplace nutrition. This section will synthesise and discuss the current scientific evidence relating to nutrition in managing health and wellbeing and assessing DNs' nutritional behaviour at work. Therefore, this review will summarise: 1) the challenges of being a DN and its impacts on health and wellbeing, 2) the impact of shift work on health and wellbeing, 3) shift work and its impact on nutrition consumption and dietary behaviour, and 4) the limitations and further research expanding the knowledge gap.

1.2 Being a doctor

1.2.1 Overview

Doctors are an important profession in society. The journey to becoming a qualified specialist doctor is lengthy and costly, with an estimated cost of training a junior doctor of up to £250,000, excluding additional postgraduate training (Curtis and Burns, 2015; Department of Health and Social Care, 2017). This extensive timeline, spanning up to 16 years or more, can often lead to demotivation and reduced energy over the years (Doran *et al.*, 2016). Starting from medical school, progressing through junior doctor roles, undertaking speciality training, continuing professional development, and assuming senior medical roles, doctors encounter significant challenges at each milestone.

Through various stages of a doctor's career, there are consistent challenges that impact their health and wellbeing (Figure 1) (Finlay and Fawzy, 2001; Kligler *et al.,* 2013; Zwack and Schweitzer, 2013; Kötter *et al.,* 2015; Mazurek Melnyk *et al.*, 2016; Van Der Wal *et al.*, 2016; Hatem and Halpin, 2019; Tharenos *et al.,* 2019). Figure 1 depicts the four main career milestones, i.e., medical school, junior doctor, developing medical specialism, and senior (consultant) roles), with the corresponding key challenges and possible health and wellbeing impacts based on previous literature. These challenges persist across different career stages. For example, doctors face difficulties in developing and maintaining doctor-patient relationships, establishing a professional identity, navigating uncertainties, and developing resilience to manage their occupational stress (Finlay and Fawzy, 2001; Kligler, Linde and Katz, 2013; Zwack and Schweitzer, 2013; Kötter, Pohontsch and Voltmer, 2015; Van Der Wal *et al.*, 2016; Hatem and Halpin, 2019). Similarly, doctors experienced common health and wellbeing impacts such as their occupational stress, the ineffectiveness of having a meaningful coping strategy to manage and maintain their wellbeing, and their ability to have self-awareness of looking after themselves healthily (Zwack and Schweitzer, 2013; Kötter *et al.,* 2015; Mazurek Melnyk *et al.*, 2016; Van Der Wal *et al.*, 2016; Tharenos *et al.,* 2019). These common challenges and factors influencing doctors' health and wellbeing will be further explored concerning their roles as shift workers, as well as their nutrition consumption and dietary behaviour.

1) **Medical School**	2) **Junior Doctor**	3) **Developing Medical Specialism**	4) **Senior Roles**
<u>Key Challenges</u>			
• Learning self-identity • Doctor 'image' • Shift from 'Safe bubble' environment • Perceived stress • Behaviour change • Limited health & wellbeing support • Developing doctor-patient relationship	• Personal & professional identity formation • Occupation expectations • Expanding &demonstrating ability to synthesis knowledge • Limited health & wellbeing support • Developing doctor-patient relationship • Integrating personal & professional values	• Establishing status & identity within workplace culture • Maintaining & exceeding occupation expectations • Increased job responsibilities • Sense of belonging • Developing resilience • Eradicating clinical practice knowledge & skills gaps	• [As previous career stages] • Abilities to adapt, managing uncertainties.
<u>Possible Health & Wellbeing Impacts Experienced</u>			
• Stress & emotional distress • Biopsychosocial impacts • Ineffective coping strategies • Self-awareness	• Maintaining health & wellbeing • Occupational stress • Self-awareness • Self-critical reflection • Change in actions & behaviours	• Shaping psychological wellbeing for their behaviours & actions • Occupational stress & burnout • Self-awareness • Sense of belonging • Work-life balance • Attitudes against perceived challenges	• [As previous career stages] • Abilities to control self-health and wellbeing factors • Self-awareness

Figure 1: Challenges and possible health and wellbeing impacts on doctors (Finlay and Fawzy, 2001; Kligler et al., 2013; Zwack and Schweitzer, 2013; Kötter et al., 2015; Mazurek Melnyk et al., 2016; Van Der Wal et al., 2016; Hatem and Halpin, 2019; Tharenos et al., 2019)

1.2.2 Key challenges faced by doctors at work

Identity

A doctor's identity is defined as *"a representation of self, achieved in stages over time during which the characteristics, values, and norms of the medical profession are internalised, resulting in individual thinking, acting, and feeling like a physician"* (Cooke *et al.*, 2010; Hatem and Halpin, 2019). However, doctors often encounter challenges in developing their personal and professional identities (Figure 1). A key challenge evidenced has been the struggle to build confidence and self-belief in their roles, which can be influenced by the different stages of medical careers (McNamara, 2012; Forsythe and Suttie, 2020). The transition from the sheltered environment of medical school to becoming a qualified doctor can be particularly daunting as doctors fear being judged and feel pressured to conform to the stereotypical physician image of a confident, tough, often self-sacrifice, and resilient physician (Kligler, Linde and Katz, 2013; Kamilova *et al.*, 2021). Developing their identities is a slow learning process and arduous journey, leading to their experience of anxiety, pain, difficulties and loss of autonomy (Kligler, Linde and Katz, 2013; Kamilova *et al.*, 2021). Evidence has suggested that doctors with lower empathy are more burnout due to increased responsibilities and poorer job satisfaction (Ferreira *et al.*, 2019; Yue *et al.*, 2022), emphasising the significance of recognising and prioritising physical and mental health to prevent overwhelming burdens and maintain a healthy workforce. Simultaneously, this demonstrates the complex and multi-layered behaviours that doctors must acquire over time, encompassing the necessary characteristics and attitudes to become successful medical personnel.

Developing abilities

The transition from being a "learner" to a "practitioner" in doctors' careers involves expanding their knowledge and skills while demonstrating their abilities to synthesise information (Hatem and Halpin, 2019). Furthermore, developing resilience enables doctors to self-reflect, self-challenge against worries, and find their maturity to adapt to the added pressure in clinical settings. An example is working in dissecting rooms with cadavers, an experience that should not be underestimated, as they test doctors' empathetic and emotional pressure and responsibilities within the medical field (Finlay and Fawzy, 2001; Arráez-Aybar *et al.*, 2021). This highlights the importance for doctors to demonstrate compassion beyond their assigned roles and be prepared for unforeseen situations that may arise in clinical practice.

Establishing successful doctor-patient relationships is important for ensuring continuous and effective patient care, building doctors' confidence in clinical decisions and taking ownership of their responsibilities (Martin *et al.*, 2017; Driever, Stiggelbout and Brand, 2020). These relationships are fostered through ongoing learning community support, helping doctors shape their professional identity and gain valuable experiences (Hatem and Halpin, 2019; Kamilova *et al.*, 2021). Therefore, the "feeling of being a doctor" encourages active contributions when delivering patient care despite complex and inexperienced tasks. An example of enhancing doctor-patient relationships is direct interaction with patients at their bedside, demonstrating their proactive capabilities. Research has shown that doctors who provide a higher level of continuity of care are associated with a lower mortality rate (Gillespie *et al.*, 2018; Gray *et al.*, 2018), highlighting the positive impact of fostering doctor-patient connections. Furthermore, these connections strengthen colleague relationships and foster a sense of belonging (Gillespie *et al.*, 2018). This indicates the importance of doctors going beyond their expected duties to develop professional values, demonstrate sincerity, and gain a deeper understanding of patients as unique individuals who provide the necessary individualised health support. Consequently, by maintaining positive attitudes and making meaningful contributions despite constant challenges, doctors can enrich the doctor-patient relationship and deliver enhanced care.

Health and wellbeing – the bigger picture of the health care system

Doctors face numerous occupational challenges and uncertainties within the healthcare system, significantly impacting their health and wellbeing (Figure 1). The demanding nature of their work necessitates support in a fast-paced work environment. Unfortunately, however, inadequate medical training exacerbates the stressful experiences they already encounter (Brennan *et al.*, 2010).

One prominent example is the chronic strain on the health system, particularly during global crises like COVID-19. Such events further complicate doctors' experiences and add to the complexity of maintaining their health and wellbeing. For example, in March 2022, the NHS faced immense pressure in hospitals, particularly during winter, as COVID-19 patients and regular winter admissions were admitted. Simultaneously, efforts were made to protect staff and patients from COVID-19 exposure. Statistics from this period reported that hospital beds were almost at *"1.5 times the capacity of the same time last year"* (Appleby and Davies, 2021). This demonstrates the impact of public health challenges on the healthcare system, directly impacting the workforce's capabilities to deliver care. Thus, healthcare professionals like doctors often sacrifice their health and wellbeing management to care for others. The subsequent sections of this review further delve into the health determinants of doctors' health and wellbeing, focusing on nutrition.

Reports from Royal Colleges highlight that health and wellbeing, career speciality, and working environment are the 'most common reasons doctors take a break from training' (British Medical Association, 2018, 2019; General Medical Council, 2018; Moberly, 2018). Statistics from the General Medical Council demonstrate that nearly one in four UK doctors and one in five trainees experience burnout due to their work (General Medical Council, 2018, 2019). The irregular working patterns also impact their sleep quality, health, and wellbeing. These concerning statistics have shown little improvement over the years, with the 2020 survey indicating that the unprecedented public health challenges caused by the coronavirus pandemic further intensify the situation. Therefore, doctors experience challenges managing their workplace health and wellbeing while striving to foster positive teamwork experiences, connectivity, and a sense of belonging in the working environment.

In 2019, the British Medical Association's report examined doctors' perceptions and their impacts on their role and their (mental) health and wellbeing (British Medical Association, 2019). This study utilised a cross-sectional survey and qualitative research with findings in Table 1, revealing five overarching themes and key factors associated with each theme. For example, doctors identified several practical perceptual barriers hindering their behaviour from reaching support when faced with the five stressors (Table 1). These barriers included a lack of awareness regarding available services within their Trusts, limited time to seek support for themselves, fear of breaching confidentiality and encountering patients or colleagues, hesitation in confiding in their line manager due to sigma affecting their future career, and limited access to support for those in rural areas. Conversely, perceptual barriers encompassed the ‘superhero syndrome’ where seeking help is seen as a sign of weakness and carries a cultural stigma, professional pride that expects resilience under pressure, the guilt associated with taking time off and burdening colleagues with the additional workload, and incompetency with a fear of jeopardising professional relationships and career prospects due to concerns about fitness to practice. The presence of practical and perceptual barriers highlights doctors' complex challenges concerning their health and wellbeing. Thus, these findings emphasise the need for sustainable changes to improve doctors’ health and wellbeing, which can also positively impact their perception of their role and ability to fulfil their responsibilities effectively.

Table 1: Research summary findings of doctors’ mental health and wellbeing (British Medical Association, 2019) *[Table created by the researcher]*

Overarching Themes	Brief Overview	Factors impacting doctors’ mental health
Systemic Factors	Issues resulted from problems with systems and processes within primary and secondary care	• Understaffing and rota gaps • Lack of flexibility and a poor work-life balance • Increased pressure on primary care • 10-minute consultations • Increased accountability and regulatory fears • Less time available to spend on their ‘main role’ of patient care
Endemic factors	Issues considered necessary realities of the job and the profession	• The rapidly evolving medical field • Traumatic events • Negative outcomes

Interpersonal factors	Issues resulted from doctors' relationships with their peers	• Stigma • Tendency to identify as so-called 'A-type' personalities • Hierarchy and bullying • Erosion of peer networks and peer support
Environmental factors	More practical issues, often linked to the workplace environment	• Lack of basic amenities • Training rotations • Lack of breaks
Sociocultural factors	Wider contextual factors outside of but impacting the medical profession	• Patient self-diagnosis • Increasing patient expectations • Doctors can feel undervalued by the public

Although doctors themselves could control these barriers directly and indirectly, as highlighted in the British Medical Association report (British Medical Association, 2019), there are also possible initiatives to promote good health and wellbeing. These initiatives can range from self-preventative approaches to the availability of supportive services. Therefore, there is an indication that improvements in the workplace environment, along with sociocultural shifts, can foster a sense of camaraderie and provide doctors with the ability to choose facilities and services that cater to their specific needs. Although the report addresses key perceptions regarding doctors' health and wellbeing, further explanation is needed to fully comprehend their challenges. Moreover, the role of nutrition, an important aspect of health and wellbeing, was not extensively examined, highlighting its potential significance in this context. This review will further interrogate this topic to highlight its relevance.

> "Health and wellbeing of NHS staff should no longer be a secondary consideration but needs to be at the heart of the NHS mission and operational approach."

Dr Steve Boorman
The Boorman Review 2009

The Department of Health's report 'Working for a Healthier Tomorrow' (2008), an independent review of staff's health and wellbeing – 'Improving Health and Work: Changing Lives' (2008) and 'NHS Constitution' (2009) – and The Boorman Review (2009) emphasised the importance of staff health and wellbeing, irrespective of their occupational position. Unsurprisingly, doctors are particularly vulnerable to burnout, stress and reduced wellbeing from occupational-related risk factors, surpassing the general population and other healthcare professionals. For example, a survey conducted on over 4,000 senior UK-trained doctors examined the impact of their occupation on their health, wellbeing, and career (Smith, Goldacre and Lambert, 2017). Results revealed that 75% of doctors recognised adverse effects on their health and wellbeing, such as stress, work-life balance issues, and heavy workloads. Chronic stress and illness emerged as the primary health and wellbeing implications, with the study identifying several main themes (Figure 2) that could explain the key drivers of poor health or wellbeing (Smith, Goldacre and Lambert, 2017). More recent systematic reviews further confirm similar findings, with stress and anxiety more prominent among those newly qualified doctors in the UK with better working conditions highlighting the importance of supporting doctors' wellbeing regardless of their specialities and grades (Balendran *et al.*, 2021; Teoh, Hassard and Cox, 2021; Krishnan *et al.*, 2022) When presented with the statement 'The NHS of today is a good employer when doctors become ill themselves', a majority of participants (43%) disagreed or strongly disagreed with this, with a significant difference observed between different medical specialities and hospital or non-hospital based environment – 49.1% GPs, 36.3% hospital medical specialities, 36.2% surgery and 37.3% other hospitals. Despite the negative impact of their job on their health and wellbeing, this study, with a high response rate of 84.6%, highlighted that doctors continue to ensure the effective functioning of the healthcare system for the broader population despite how their job contributes to their poor health and wellbeing (Smith, Goldacre and Lambert, 2017).

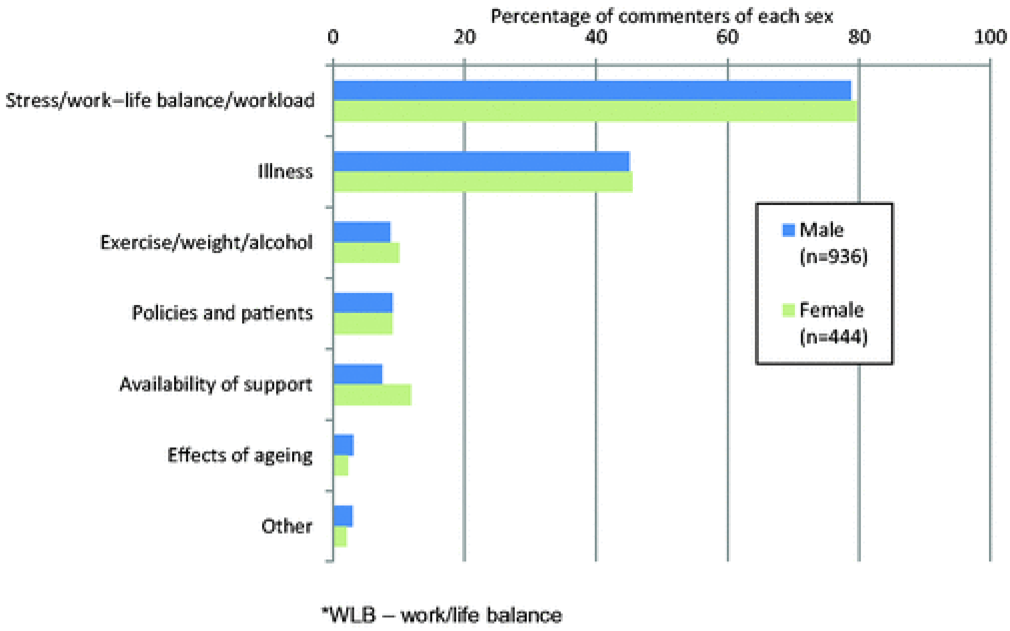

Figure 2: Cross-sectional survey results from Smith, Goldacre and Lambert (2017) on the adverse effects on senior UK-trained doctors' health and wellbeing. Copyright 2017, with permission from SAGE Publications.

To our understanding, no single guideline is solely dedicated to supporting doctors' health and wellbeing. However, 'All Our Health' (Public Health England, 2019b) is an available resource for England's health and care professionals. Its purpose is to empower professionals to use their "knowledge, skills and relationships to prevent illness, protect health and promote wellbeing", aiming to improve health outcomes and reduce health inequalities. Thus, this resource offers topic-specific information that assists in managing risk factors, including access to NHS toolkits and key local contacts for support. It also emphasises the importance of measuring the impact of interventions. Nevertheless, it calls upon professionals to take action by leveraging their expertise and relationships to maximise health protection and promotion. Although this resource encourages everyone to maintain a healthy lifestyle and equips professionals with the necessary knowledge to care for others, it also fosters doctors' self-awareness regarding their health and wellbeing.

1.3 Being a nurse

Nurses, similarly, play a vital role in the healthcare system, working alongside doctors in the same environment. They are responsible for providing comprehensive patient care and addressing their complex healthcare needs, and they are often seen as caregivers (Jinks and Hope, 2000; Drennan and Ross, 2019). However, nursing, like other healthcare professions, is demanding, and nurses often engage in shift work that covers around-the-clock shifts (Kim *et al.*, 2013; Bae and Fabry, 2014; Beebe *et al.*, 2017; Min *et al.*, 2019; Savic *et al.*, 2019; Zhao *et al.*, 2019), yet suffers from poor occupational wellbeing. As a result, nurses, like doctors, are not immune to the detrimental impact of occupational demands on health and wellbeing and, as such, also experience the challenges of shift work. Previous studies have highlighted the health risks associated with nurses, including the physical, psychological and emotional challenges leading to unhealthy work-life balance (Griffiths *et al.*, 2014; Ball *et al.*, 2017; Rosa *et al.*, 2019; Books *et al.*, 2020; Dall'Ora *et al.*, 2023). Furthermore, evidence has shown the challenges of retaining nurses in their occupation where job satisfaction and career identity were highlighted to be associated with a high turnover intention within their profession (Marufu *et al.*, 2021; Hu *et al.*, 2022) Thus, such health risks could be stemmed from poor working conditions and organisational environments (Lu *et al.*, 2012; Rosa *et al.*, 2019).

Shift work, in particular, has been identified as a significant contributor to poorer psychological and physiological health and wellbeing among nurses, as highlighted in a systematic review (Rosa *et al.*, 2019). The consequences of shift work include increased stress levels, compromised sleep quality, and increased risks of cardiovascular diseases. Furthermore, nurses share common challenges with doctors, such as being overworked, experiencing stress and occupational burnout, feeling isolated and encountering difficulties during the transition to the workforce after qualification (Barbiani, Nora and Schaefer, 2016; Singh *et al.*, 2022). For example, nurses also face challenges of occupational burnout. Prolonged shifts in unfavourable working conditions and limited break opportunities for rest during their shifts contribute to predictors of exhaustion and subsequently lead to job dissatisfaction (Dall'Ora *et al.*, 2023). This, too, was evidenced in night shifts, where nurses were ignored when complaining about fatigue due to sleep deprivation (Books *et al.*, 2020).

Nurses, too, share the experience of feeling alone and isolated, leading to poor mental health and wellbeing, similar to doctors. Evidence has indicated the association between nurses and shift work, especially in women, with an increased risk of poor mental health across seven longitudinal studies (Torquati *et al.*, 2019). Among nurses, anxiety and depression are particularly significant, especially when shifts are rapidly rotated, causing anxiety due to the time needed to adjust to the changing patterns (Booker *et al.*, 2019). These changes in sleep patterns and disruptions to circadian rhythms, along with managing cognitive consequences and coping strategies, contribute to anxiety related to shift patterns.

The mental health and wellbeing consequences of nurses' experiences require further understanding. Shift workers, including nurses, face a higher risk of substance use, such as alcohol and suicidal ideation, commonly affecting mental health (Brown *et al.*, 2020). These findings highlight the similarities in the challenges employees face in overworked environments and the inherent characteristics of professions involving shift work. As a result, regardless of the profession, the literature has demonstrated the shared experiences that employees deal with in their demands of shift work. The subsequent sections of this chapter will continue to explore shift work and its health implications more broadly applicable to doctors and nurses.

1.4 Shift work and health implications

Shift work – definitions

Shift work has become increasingly prevalent in 21st-century society, with irregular working patterns gaining prominence (Brown *et al.*, 2020). In Europe, approximately one-fifth of workers are engaged in shift work (Rivera *et al.*, 2020; Wolska *et al.*, 2022), and 36.1% of the global workforce clocking excessive hours (more than 48 hours) per week (Rivera *et al.*, 2020). In the UK, 13.7% of the public sector have shift work in their employment (Office for National Statistics, 2021), with 8.7 million people in the country with night shifts ranging from healthcare workers to construction and warehouse staff (Office for National Statistics, 2023). Elsewhere, in the United States, a survey revealed that 27% of the population is involved in shift work (Yong, Li and Calvert, 2017), while in Australia, 16% of employees opted to take shift work as their main job (Zhao *et al.*, 2019). These statistics highlight the widespread adoption of shift work across various countries, reflecting its significant presence in modern workplaces.

Under the ‘European Working Time Directive’ or ‘Working Time Regulations’ (2003/88/EC), ‘working hours’ can be defined as no more than 48 hours a week on average, over 17 weeks. However, this is exempt from those working in emergency services, such as doctors, who may wish to work additional hours (UK Government, 2020). The definition of shift work lacks clarity, as noted by the Health and Safety Executive (HSE, 2006). Shift work schedules are complex and encompass a variety of complex schedules and combinations (Box 1 summarises the common working patterns). For example, a study in a Canadian province identified 400 different shift work schedules across 88 organisations (Hall *et al.*, 2016). As a result, it can alternatively be defined as working more than eight hours within 24 hours (Stevens *et al.*, 2010; Brown *et al.*, 2020; Rivera *et al.*, 2020; Khosravipour *et al.*, 2021). Nevertheless, based on the definition of ‘working hours’, shift work is the ‘*working activity scheduled outside standard daytime hours, where there may be a handover of duty from one individual or workgroup to another’*. Here, ‘standard daytime hours’ in the UK can be defined as *‘commonly for eight hours between 7:00am and 7:00pm. There are usually two periods of work, one in the morning, the other in the afternoon, separated by a lunchtime break.’* (HSE, 2006). Night workers also fall under this category, working at least three hours between 11pm and 6am (UK Government, 2020). This highlights the difficulties in providing a fixed definition for working hours and shift work, emphasising the need to consider all work patterns when examining their impacts and effects.

Box 1: Examples of shift work (HSE, 2006)

- work during the afternoon, night or weekend, typically with periods of the work schdeule outside standard daytime hours
- extended work periods of 12 hours or more, often asociated with compressing the working week
- rotating hours of work
- split shifts, where work periods are divided into two distinct parts with several hours break in between
- overtime
- standby with on-call duties

Shift work in healthcare is becoming the norm to address service needs, but it is also associated with higher rates of sickness and stress than in other sectors (Brown *et al.*, 2020; da Silva *et al.*, 2021a; Wolff *et al.*, 2021; Sooriyaarachchi *et al.*, 2022). For example, occupational hazards have been found more prevalent among hospital staff, such as physical, chemical, radiation, psychiatric disorders and violence. As a result, healthcare workers experience less leisure time of physical activity as one coping mechanism to manage stress and burnout effect, thus contributing to higher perceptions of job stress and exhaustion as presented consistently with prior epidemiological studies and systematic and meta-analyses (Ganesan *et al.*, 2019; Hulsegge *et al.*, 2021; Wolff *et al.*, 2021; Sooriyaarachchi *et al.*, 2022; Bakirhan, Bakirhan and Yaşar, 2023). Doctors and nurses working in similar working environments as other healthcare workers also experience stress and burnout (Imo, 2017; Richter *et al.*, 2020a; Krishnan *et al.*, 2022; Delgado *et al.*, 2023). However, as mentioned in Section 1.2, the existing guidelines supporting the health and wellbeing of doctors and nurses are limited, with UK-based medical regulators and professional organisations appearing to only focus on the mental health aspects such as stress and resilience (British Medical Association, 2018, 2019; General Medical Council, 2018). Therefore, there is the opportunity to explore how shift work and its associated factors contribute to doctors' and nurses' health and wellbeing. First, this section will address the impact of shift work on the key health implications and identify its relationship with psychological, cardiovascular disease, obesity, type 2 diabetes, and other confounding risk factors. Additionally, we will explore how shift work impacts nutrition consumption and dietary behaviours amongst healthcare professionals, specifically medical doctors and nurses.

1.4.1 Impacts of shift work on overall health and wellbeing

1.4.1.1 Shift work and impacts on psychological factors

Sleep, cognitive function and performance

Environmental and psychosocial factors influence our bodies, giving rise to both acute and chronic stress responses to regulate our peripheral and central nervous systems (Chrousos, 2009; Kazakou, Nicolaides and Chrousos, 2023). These factors encompass a range of effects, including stress and burnout (Alexandrova-Karamanova *et al.*, 2016; Cannizzaro *et al.*, 2020), fatigue (Wright *et al.,* 2013), cognition function (Gavelin *et al.*, 2022), and performance (Kecklund and Axelsson, 2016; Collewet and Sauermann, 2017). Occupational stress is defined as a 'sense of fatigue' where the body is at constant weakness or depleted energy (Andel *et al.*, 2011; Cannizzaro *et al.*, 2020). Factors contributing to occupational stress include increasing work demand, low work morale and satisfaction, tensions in social relationships, and inability to manage their self-being effectively (Ramaci *et al.*, 2017).

Shift work, characterised by atypical working hours, has been strongly associated with negative implications on physical and mental health (Piasna, 2018; Virtanen and Kivimäki, 2018; Torquati, *et al.*, 2019; Brown *et al.*, 2020). Beyond occupational stress, the literature identified several consequences of shift work (Barnes-Farrell *et al.*, 2008; da Silva *et al.*, 2021a; Sooriyaarachchi *et al.*, 2022). One area affected is the work-life balance, as shift workers often face challenges in reconciling their family responsibilities with the demands of their working conditions and the socioeconomic factors they must consider when considering employment, thus leading to shift workers' intention to remain in their role. Ng *et al.* (2017) noted that the psychological impacts of nurses' roles outweighed the physical demands, indicating the difficulties in maintaining control over both sets of responsibilities while maintaining autonomy.

Similarly, studies on British nurses examined the association between shift patterns with shift preference and work commitment (Brooks and Swailes, 2002; Bell and Sheridan, 2020). Night nurses reported lower levels of professional commitments than those working other shift patterns. Although shift patterns did predict work commitment to some extent, long-term work commitments were influenced by career development opportunities. However, evidence remained unchanged despite being published across different years, suggesting that the more atypical the shift hours, the less or limited social support they might receive, resulting in isolation from their friends and family and other hobbies and activities due to a lack of shared free time (Wilson, 2002; Savic *et al.*, 2019; Bell and Sheridan, 2020; Senek *et al.*, 2020).

Shift work also carries other consequences, such as exhaustion and sleep deprivation, resulting in CVD risks (Christian and Ellis, 2011; Manohar *et al.*, 2017; Brito *et al.*, 2021; Reynolds *et al.*, 2023). Insomnia is a global health problem and further exacerbates these effects (Jehan *et al.*, 2017; Brito *et al.*, 2021; Reynolds *et al.*, 2023). Sleep quality is influenced by homeostatic and circadian regulations (Borbély *et al.*, 2016; Riegel *et al.*, 2019), with nutrition intake highlights to promote sleeping effects (Binks *et al.*, 2020). Female executives, in particular, are at a higher risk of sleep disturbance due to their high job demands than their male counterparts, who often occupy higher positions with more job control and social support (Gadinger *et al.*, 2009). The influence of gender on circadian rhythms could be argued as a contributing factor; however, it is clear that the adverse health consequences resulting from occupational stress are closely associated with sleep disturbances, leading to circadian rhythm sleeping disorder (Wickwire *et al.*, 2017; Brown *et al.*, 2020). Similarly, healthcare professionals in hospital and community settings commonly experience exhaustion and sleep deprivation. For example, female nurses exhibit a highly impaired sleep quality compared to their male counterparts (8.4% vs 38.6%). Those working longer shift hours tend to have higher burnout rates than those working shorter shifts (35.8% vs 24.8%, $p = 0.040$) (Giorgi *et al.*, 2018). Furthermore, the prevalence of burnout was also dependent on their specialist departments, where the psychiatric area had a higher burnout (50%) compared to surgical work (37.4%), critical work (29.8%) or medical work (24.1%). As a result, the adverse health consequences resulting from occupational stress and sleep disturbances are significant concerns for shift workers and highlights the need to address these challenges to improve their overall health outcomes.

Whereas for doctors, previous studies have indicated that they often work extended hours, resulting in minimal sleep, such as only three hours after a 14-hour shift and two and a half hours during 24-hour shifts (Persico *et al.*, 2018). This study reported that after a 24-hour shift, the lack of sleep impacted processing speed, working memory capacity, and perceptual reasoning due to the constant need for patient care, especially on nights with fewer shift workers. Nevertheless, this study's limitation was that it did not report any significant difference between the length of shift hours compared to a 14-hour shift. Therefore, this could indicate that the length of shifts influences physiological impacts, where fatigue (92.5%) and memory (68.7%) were significantly impaired, with a prevalence of increased risk of irritable bowel syndrome (13%) (Jaradat *et al.,* 2020). Likewise, another study evaluated perceived sleepiness and strategies to cope with fatigue symptoms among doctors. It was found that 91% of doctors experienced the highest level of fatigue after a night shift, with 34% admitting to falling asleep while driving and 84% self-reported having used medication, including caffeine, to sustain alertness during shifts (Ferguson *et al.*, 2018). Irrespective of the professions with shift work or the (ir)regular working environment, frontline professions constantly experience insufficient sleep. Therefore, this indicates that shift work has a causal effect on poor health and significant physical and mental implications.

Shift work, particularly in the healthcare sector, raises concerns about safety and cognitive impairments (Wagstaff and Sigstad Lie, 2011; de Cordova *et al.,*2016). High work morale and job satisfaction are needed for shift workers to be efficient and productive. Sleep aids cognitive functions (Lim and Dinges, 2010; Henry *et al.*, 2019). However, irregular working patterns, specifically night shifts, cause the body's natural circadian disruption, leading to decreased work performance, increased occupational stress and potential accidents. As a result, implementing regular breaks and reducing work hours has been shown to enhance productivity by 5 – 12% (Harrington, 2001). Prolonged and demanding work hours and heavy workloads often contribute to burnout, a common complaint among shift workers (Collewet and Sauermann, 2017). For example, a study involving workers from a meat-processing plant demonstrated a positive effect on production when they were given an extra four nine-minute breaks during their shift (Dababneh *et al.,*2010). Although healthcare settings may face challenges incorporating extra break time due to high clinical demands, the benefits of taking regular breaks for individuals to recalibrate before the next occupational demand should not be overlooked. Thus, regular breaks not only improve physical and mental health but also enhance cognitive engagement and attention span.

Similarly, night shifts have a significant impact on psychological factors. For example, research has shown that individuals working night shifts, such as security guards, experience increased cortisol levels before and after their shifts, which can be attributed to the biological stress (i.e. flight-or-fight) responses triggered by the sympathetic nervous system to stressful stimuli (Nader *et al.*, 2010; Cannizzaro *et al.*, 2020). Previous reviews have also indicated the association between low sleep quality from night shifts and a 17% increase in mortality (Li *et al.*, 2014; Kecklund and Axelsson, 2016). These indicate that night shift workers such as healthcare professionals are at a high prevalence of occupation stress, with cortisol as a predicable marker of non-communicable disease risks. Given these implications, it is therefore crucial that any shift requires regular breaks for work efficiency, productivity and improving health outcomes. As a result, supporting the psychological wellbeing of workers becomes paramount, emphasising the need to implement effective and relevant workplace strategies to minimise the risks of chronic health diseases.

Emotional behaviour

Prolonged shift work, especially in healthcare, can have an impact on emotional wellbeing due to the demands of emotional labour (Alexandrova-Karamanova *et al.*, 2016; Milenović *et al.*, 2016; Imo, 2017; Ibrahim *et al.*, 2023; Kirk, 2023). A study on nurses indicated that different shift types and individual experiences contribute to psychological wellbeing (Vermaak *et al.,* 2017). Nurses play a crucial role in providing individual regular patient care, which involves close personal contact with patients to address their physical and psychological wellbeing. This can be emotionally demanding and could suggest why nurses have a negative shift experience (Vermaak *et al.,* 2017). Research indicates that shift workers in various occupations often turn to alcohol consumption to regulate their negative emotions and aid sleep following stressful shifts (Dorrian *et al.*, 2017; Sayre *et al.,* 2019). Specifically, longer shifts (12 hours vs eight hours) have been associated with increased alcohol consumption (Dorrian *et al.*, 2017). A possible suggestion is that they must maintain their professionalism despite finishing work, without worrying about the consequences of drinking (i.e. agitation, depression, change in their normal behaviour). However, limited evidence exists specifically for healthcare employees in this context. Nevertheless, addressing the emotional wellbeing of healthcare workers and providing support in managing the emotional demands of their roles is crucial to ensure their overall wellbeing and minimise negative impacts.

Promoting positive emotions and self-motivation is associated with reduced alcohol consumption (Sayre *et al.*, 2019). A study by Barnes-Farrell *et al.* (2008) examined the association between working patterns with 'off-shift wellbeing', focusing on mental and physical wellbeing and work-to-family conflicts among healthcare workers across four countries. The findings revealed that the 'on-work' health and wellbeing reported interfering with 'off-work' life, where shift work is associated with multiple characteristics (i.e. physical wellbeing and mental wellbeing) (Geiger-brown *et al.*, 2004; Barnes-Farrell *et al.*, 2008). These studies highlight the interference from shift work on mental and physical health and wellbeing, possibly as a precursor to help shift workers overcome the occupational challenges faced. Thus, it is essential to identify effective and relevant coping mechanisms to achieve a healthy work-life balance. By recognising and implementing supportive measures within organisations, there is an opportunity to reconsider shift work arrangements and prevent the development of chronic health diseases.

Mental health

Irregular and prolonged working hours have been shown to have implications for mental health (Harrington, 2001; Ganster, Rosen and Fisher, 2018; Piasna, 2018). While the impact of shift work on physical health is well-established, the evidence regarding its effects on mental health is still evolving, with less conclusive results amongst different working patterns. However, several primary research studies highlight the association between shift work and mental health. For example, a cross-sectional study conducted on electronic manufacturing workers investigated the prevalence of depression and suicidal ideation among both male and female day and night shift workers while controlling confounding variables (Kang *et al.*, 2017). The results indicated a prevalence of insomnia thrice in the shift workers who followed a forward rotation schedule (i.e. six days each of morning, evening, and night shifts, with each six-day block separated by one to two days off) compared to non-shift workers. Moreover, there were significant differences in depression and suicidal ideation. This study demonstrated a strong correlation between insomnia and increased rates of depression and suicidal ideation (with ORs of 4.899 and 7.934, respectively), regardless of gender. The study controlled dependent variables; however, different working patterns were not independently evaluated across the different working sites to determine which shift pattern was more associated with depression and suicidal ideation. Nevertheless, evidence suggests that irregular and long working hours harm mental health. While the research on this topic is still developing, it highlights the need for further investigation and attention to the mental wellbeing of individuals engaged in shift work.

Healthcare shift workers constantly experience traumatic and stressful situations impacting their mental health. Female health workers, in particular, often face additional burdens such as household chores, childcare responsibilities, and social commitments, limiting their availability for certain shift patterns (Riley and Weiss, 2015), thus further straining their abilities to cope with multiple tasks. Considering the possible traumatic clinical experiences during shift work and other responsibilities, previous studies have suggested this as a plausible reason for shift work to be associated with mental health. For example, an Australian hospital-based nurse sample indicated that the severity of depression and anxiety were significant when measured against alcohol consumption on non-workdays due to clinical workload (Booker *et al.*, 2019). Similarly, in Japanese nurses, shift work was significantly associated with medical accidents (i.e. drug-administration errors, patient identification errors, needlestick injuries, faulty operation medication equipment), particularly among those categorised as “mentally in poor health” category (Suzuki *et al.*, 2004). These studies emphasised the profound impact and pressure imposed by irregular working patterns on mental health, regardless of whichever healthcare system. The healthcare sector is a personal yet emotionally invested occupation where working overtime with limited recovery time is a predictor of chronic disease risk. While the effects of shift work on mental health are evident, it is essential to consider other confounding factors related to health and occupation to enhance the overall wellbeing of shift workers.

1.4.1.2 Shift work and impacts on cardiovascular diseases

Metabolic syndrome encompasses CVD risk factors such as insulin resistance, hypertension, central obesity, and hypercholesterolemia (Psaltopoulou *et al.*, 2017; Yusuf *et al.*, 2020). Previous reviews have shown that the workplace environment contributes to CVD aetiology, increasing mortality and morbidity rates within the population (Bøggild and Knutsson, 1999; Torquati, *et al.*, 2018). As such, with its inherent circadian stress, shift work has been implicated in the induction of CVD risks through various physiological, psychosocial and behavioural implications (Figure 3) (Puttonen, Härmä and Hublin, 2010). However, the causal link between shift work and CVD has not been definitively established. For example, a meta-analysis of 17 studies published in 1999 concluded that shift workers have a 40% higher CVD risk than day workers (Bøggild and Knutsson, 1999). More recently, previous evidence suggests that prolonged and irregular work patterns cause circadian stress, leading to physiological and psychosocial consequences associated with CVD (Puttonen, Härmä and Hublin, 2010; Torquati, Mielke, *et al.*, 2018; Wang *et al.*, 2018; Boivin, Boudreau and Kosmadopoulos, 2022; Ansu Baidoo and Knutson, 2023).

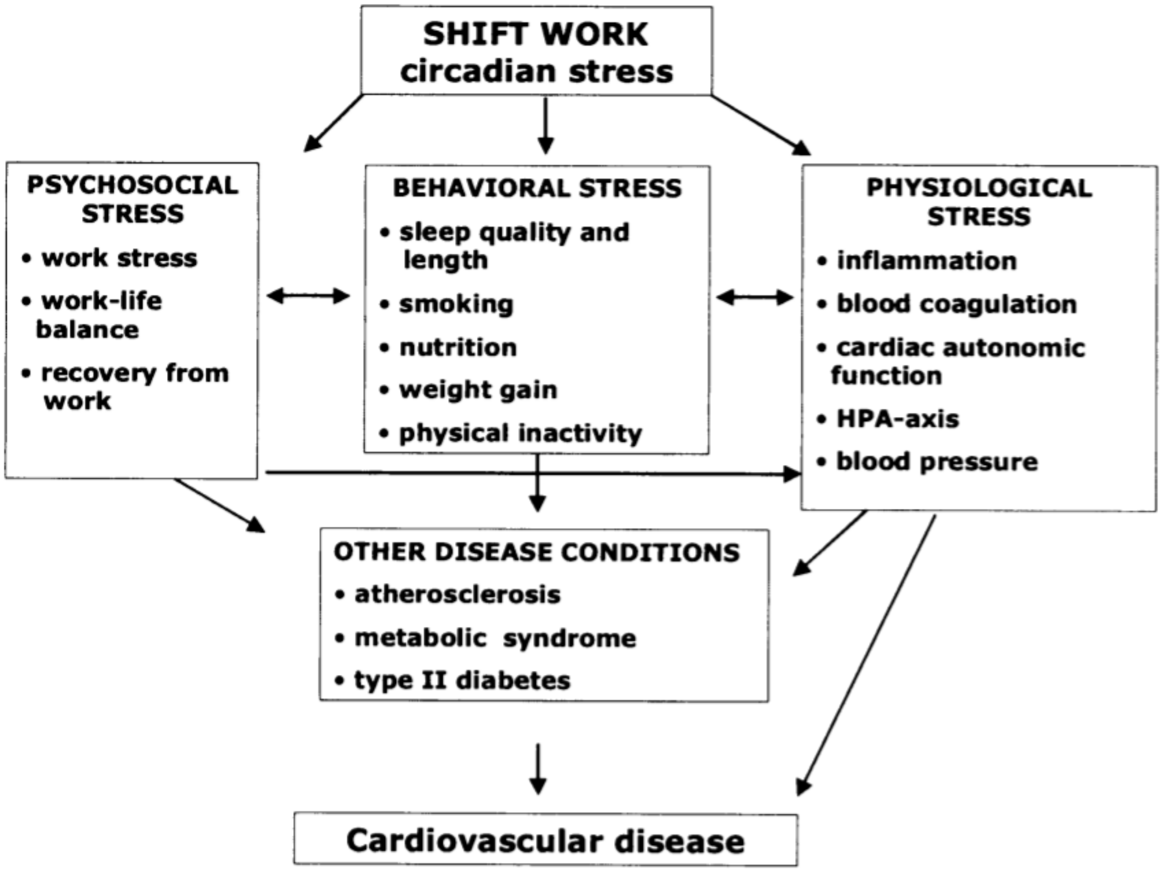

Figure 3: Pathways from shift work to cardiovascular disease (Puttonen, Härmä and Hublin, 2010). Copyright 2010, with permission from the Scandinavian Journal of Work, Environment & Health.

In contrast, a subsequent review of 16 studies conducted ten years later in 2009 presented a different perspective, with an overall negative association between shift work and heart disease. However, the reliability of the findings can be questioned due to the inadequate measurable outcomes and potential biases in participant selection and information gathering, which could hinder drawing definitive conclusions about the relationship between dietary and lifestyle habits and changes (Frost *et al.,* 2009). Similarly, a Finnish twin study with a follow-up period of 22 years found no association between the number of working hours and cardiac mortality risk despite 'potential confounding or effect-modifying factors' being considered and noted between the twin participants (Hublin *et al.*, 2010). Torquati *et al.* (2018) further updated the evidence, examining the association between shift work years and CVD mortality risk via a systematic review and meta-analysis of 21 studies. The authors considered the risk of biases and heterogeneity across the studies via a rigorous assessment (previous systematic reviews and meta-analyses lack in this area). However, contrary to the Finnish twin study, they observed a 26% increased risk of coronary heart disease in shift workers, as well as a 20% for coronary heart disease and overall CVD mortality, concurrent with a *'7.1% incremental risk for every five years of shift work exposure after the first five years'* (Torquati *et al.,* 2018). These contrasting findings highlight the complexity of examining the relationship between shift work and CVD. While some studies suggest a negative association or no significant impact, the updated review (Ansu Baidoo and Knutson, 2023) provides evidence of an increased risk of CHD and CVD mortality associated with long-term shift work.

Previous findings have contributed to new knowledge and confirm a more relative suggestion of shift work and the CVD impacts. However, it is important to acknowledge that the variations in the definitions and descriptions of CVD outcomes can introduce limitations in interpreting the research findings. Perhaps this could explain the uncontrolled confounding factors and selection biases that the authors did not explicitly address. In addition, it is worth noting that the literature in this area has grown considerably in recent years. However, the complexity of interpreting the causal association between shift work and CVD remains due to challenges such as heterogeneity in study designs, differences in defining shift work, and potential confounding factors, including underlying pathologies and physiological factors (including lifestyle behaviours). Therefore, considering these factors, it becomes evident that multiple pathways contribute to the association between shift work and CVD (Figure 3). As a result, future research is necessary to address these complexities and consider various confounding factors to gain a more comprehensive understanding of the mechanisms underlying the relationship and identify potential interventions to mitigate the adverse effects on cardiovascular health.

Shift work and diabetes mellitus

Diabetes is increasing its prevalence globally, with many incidences of Type 2 Diabetes Mellitus (T2DM) contributing to increased mortality and morbidity rates and impacting CVD risks (Matheus *et al.*, 2013; Kivimäki *et al.*, 2015; Leon and Maddox, 2015; Cai *et al.*, 2020). In 2014, the number of adults (over 18 years) worldwide with diabetes exceeded (World Health Organisation, 2020a), and within just five years, this figure rose to approximately 463 million (International Diabetes Federation, 2020). These escalating numbers primarily originate from low and middle-income countries. Furthermore, projections estimate that the global diabetes population will reach 700 million individuals by 2045 (International Diabetes Federation, 2020). As a result, this data emphasises the multifactorial nature of occupational-related diseases associated with shift work, linking CVD and diabetes risks.

Regular working hours can disrupt a range of biological processes regulating the body. For instance, circadian rhythms, hormone secretions and energy metabolism could result in cardiac consequences. The development of T2D is characterised by insulin resistance (inability to take glucose up from the blood) and pancreatic beta-cell failures (pancreas failed to secrete sufficient insulin) (Gale *et al.*, 2011; Roden, Petersen and Shulman, 2024). As such, shift work, especially during the night shifts, disrupts the normal circadian rhythm, leading to disturbances in glucose levels due to altered meal times and consumption patterns. Typically, insulin secretion increases during the daytime when individuals are awake, while glucose levels are elevated during the fasting state during sleep (Kalsbeek, la Fleur and Fliers, 2014; Roden, Petersen and Shulman, 2024). As a result, the disruption of this balance, including elevated post-meal blood glucose levels and reduced resting metabolic rate from the lack of nighttime resting (i.e. during nighttime working), contributes to an increased risk of developing diabetes and obesity (Buxton *et al.*, 2012; Antza *et al.*, 2022).

Lifestyle behaviours such as dietary consumption are an aetiology for CVD and imperative to T2DM management and prevention (Gibson, 2018). Previous evidence highlights that controlling diabetes through a healthier diet and physical activity improves cardiac-metabolic health (Sleiman *et al.,* 2015; Bae *et al.*, 2019; Mohd Azmi *et al.*, 2020). However, modifying dietary habits to accommodate irregular meal times and shift work, particularly during night shifts, can contribute to obesity (Saulle *et al.*, 2018). Studies found that shift workers have insufficient physical activity levels and are likelier to consume low-nutritional snacks to stay awake (Heath *et al.*, 2012; Nea *et al.*, 2015). This includes consuming high-energy dense food, disrupting glucose metabolism due to the timing of dietary intake and promoting an increase in body fat deposition, leading to overweight (Baron *et al.*, 2011; Xiao *et al.,* 2019).

Elsewhere, Shan *et al.* (2018) examined the association between night shift work, lifestyle factors and T2D risks in a 20-year cohort study as part of the Nurses' Health Study in the US. The results demonstrate that individuals working night shifts exhibited unhealthy lifestyle factors, including smoking and high BMI. A positive correlation was also observed between the number of years working night shifts and T2D risks. Nurses with more than ten years of night shift service were likelier to have three or more unhealthy lifestyle factors, such as poor diet, lack of physical activity, smoking and high BMI (Shan *et al.*, 2018). Building upon the Nurses' Health Study findings, Pan *et al.* (2011) further confirmed this association between night shift work and adverse health outcomes. Their study revealed that night shift work was positively associated with BMI (an increase of 0.17 units in BMI) and weight gain (0.45kg) every five years. Moreover, it increased the risk of developing T2D by 11% and 18% in Nurses' Study I and II, respectively (Pan *et al.*, 2011).

Likewise, a Danish Nurse Cohort conducted over a 13-year follow-up period yielded comparable results using a similar study design despite the different geographic locations (Hansen *et al.*, 2016). The findings indicated a statistical significance between night shift work and diabetes risk compared to other working patterns (HR=1.84; 95% CI 1.46 to 2.31). Participants who worked more night shifts exhibited lower physical activity levels, higher smoking rates, and increased hypertension than nurses without diabetes. However, unlike the Nurses' Health Study (Pan *et al.*, 2011; Shan *et al.*, 2018), Hansen *et al*. (2016) could not establish an association between shift work and BMI. A plausible rationale for this could be attributed to different shift work definitions, including variations in the timing of day, evening and night shifts, amongst different cohort studies. Additionally, differences in participants' characteristics should be considered, as the Nurses' Health Study primarily consisted of US female nurses, whereas the Danish study took place in a different geographical location. Study limitations in both cohorts, such as the different and unknown dietary habits, could have influenced the participants' diet and nutrition during working hours. Nevertheless, the evidence supports the challenges posed by night shift work in disrupting the circadian rhythm, which in turn affects normal glucose regulation and contributes to the development of T2D. Although these studies did not focus on diet composition, it is inevitable to disregard shift work schedules entirely due to other confounding factors (e.g. family, occupation type). Strategies such as reducing shift work frequency and addressing occupation-related stress factors an contribute to improved diet and lifestyle choices while increasing workers' knowledge to modify and prevent risks associated with T2DM.

Shift work and obesity

Common with diabetes, obesity is defined by the BMI with excess body weight (Leon and Maddox, 2015; Donini *et al.*, 2020). Amongst the general UK population, obesity is prevalent (Keaver *et al.*, 2020; Caleyachetty *et al.*, 2021; Zhou *et al.*, 2021), with epidemiological studies highlighting its association with metabolic dysfunctions such as hypertension, dyslipidaemia and increased in blood glucose contributing to a prediction of approximately one billion obese people worldwide by 2030 (Keaver *et al.*, 2020; Zhou *et al.*, 2021). On the other hand, individuals with shift work disrupt the circadian rhythm, implicating weight gain and leading to CVD risks due to the low levels of leptin and the behavioural stress response associated with starvation (Figure 3). As discussed, good dietary and lifestyle habits are critical contributors to managing CVD risks and minimising total mortality and morbidity rates (Kivimäki *et al.*, 2006; Ezzati and Riboli, 2013; Saulle *et al.*, 2018; Torquati *et al.*, 2018). However, shift workers often alter their eating patterns to compensate for their rotating and irregular working hours, which disrupts their appetite-regulatory hormones, energy levels, and glucose metabolism due to regular circadian misalignment (Puttonen *et al.,* 2010; Rahman *et al.*, 2010; Kosmadopoulos *et al.*, 2020).

Therefore, the timing of circadian food intake and prolonged eating duration could explain shift workers' increased body adipose tissues (Lin *et al.*, 2020). This altered timing of food intake may contribute to reduced energy expenditure during fasting periods, potentially promoting relative insulin resistance and the release of stored glucose (Kalsbeek, la Fleur and Fliers, 2014; Morris *et al.*, 2015; Qian and Scheer, 2016). For example, large UK cohort studies in the general adult population examined the association between insulin resistance and obesity, suggesting that food and dietary intake could contribute to the obesity epidemic (Brady *et al.*, 2018; Perry *et al.*, 2020). Results highlighted that sleep disruptions were associated with higher BMI and were further evidenced impacted by poor sociodemographic and lifestyle factors.

However, there is currently no robust evidence to firmly establish a direct link between reduced energy expenditure and weight gain for shift workers. Shift workers possess different food habits that are influenced by their working hours and disruptions to their daily routines, particularly during the night shift, thus affecting their behaviours towards food choices. For example, these disruptions of irregular working hours, especially at night, are associated with interrupted daily routine (i.e. changes in eating and sleeping habits due to an impairment of biological rhythms) (Bonnell *et al.*, 2017; Langenberg *et al.*, 2019). Consequently, the food consumption of shift workers, such as healthcare workers, can impact their physiological and psychological states, including cognitive function, sleepiness and emotions (Gibson, 2018; Saulle *et al.*, 2018; Mohd Azmi *et al.*, 2020). For instance, occupational-related stress could promote weight gain, influence dietary choices, and prevent people from maintaining a balanced diet. Therefore, the concept of chrononutrition, the 'food consumption in consideration of the meal timing' acknowledging the inconsistency, frequency and clock time (Pot *et al.,* 2014; Mohd Azmi *et al.*, 2020) in shift work contributes a significant role in comprehending the interaction between nutrition consumption and impacts on health implications.

Shift workers are more likely to be overweight, with primary epidemiological evidence noting a positive association between BMI and the duration of long working hours (Liu *et al.*, 2018; Rivera *et al.*, 2020; Berent *et al.*, 2022). A cross-sectional Australian study examined the relationship between shift work, BMI, workload, and work hours (Ostry *et al.*, 2006). This study revealed that those men working longer hours than females resulted in higher calorific food consumption with less exercise time, leading to a higher BMI over time. Similarly, a cross-sectional study of female nurses and midwives assessed the association of different working patterns, such as night shift work, with BMI and abdominal adipose tissues (Peplonska *et al.,* 2015). The findings demonstrated a weak positive association between cumulative night shifts and BMI, with an increase of 0.477 kg/m^2 per 1000 night shifts and 0.432 kg/m^2 per 1000 night shift hours with a slight increase in waist-to-hip ratio by 0.007 ($p = 0.075$ and $p = 0.073$, respectively). Additionally, the Nurses' Health Study II addresses the relationship between shift work and BMI and identifies job strain as a moderator to changes in BMI (Fujishiro *et al.*, 2017). The results reported that those individuals with a higher job strain exhibited greater BMI change, e.g. 0.117 greater (95% CI 0.042 to 0.192), with a higher prevalence when working over four years of night shifts. Considering the wider literature and the epidemiological studies, meta-analyses have further confirmed the impact of long working shift work hours and changes in BMI across Europe, US and Australia (Virtanen *et al.*, 2020; Zhang *et al.*, 2020), with similar results presented in the UK population undertaking shift work (Ho *et al.*, 2022). Despite the growing body of evidence suggesting a link between shift work and obesity, there are limitations to consider, including the self-reported and cross-sectional data that could constrain the validity of those results and the inability to fully understand the exposure of shift work on body composition over time. Furthermore, the current literature presents a similar ambiguity of the causal interaction of shift work on obesity and health and wellbeing, with the impact of other confounding factors, such as past exposures, stress, work-life balance, and medical histories, on obesity in the context of shift work remains unknown. Therefore, it is crucial to examine the dietary behaviours associated with shift work that may contribute to increased weight, waist-to-hip ratio, and ultimately obesity while also considering the influence of various confounding factors such as sociodemographic and individual factors (e.g. habits and motivation for change).

Similar evidence also suggests a comparable result indicating an obesity prevalence among resident doctors (Mota *et al.*, 2013; O' Keeffe, Hayes and Prihodova, 2019; Kunyahamu, Daud and Jusoh, 2021). Through a cross-sectional study, Mota et al. (2013) assessed doctors' health-related behaviours, perception of shift work, and their impact on food intake and anthropometric measures. Out of the 72 participating doctors, the results indicated that increased occupational stress was associated with higher rates of overweight and obesity (n = 24, 33.4% of participants were overweight and obese). Interestingly, the prevalence of overweight and obesity was significantly higher in men than in women (65% and 21% overweight and obese. This gender disparity in health outcome could be attributed to the significant differences in energy intake during shift work, with men consuming an average of 2227.4 ± 727.5 kcal/day and women consuming 1845.7 ± 713.2 kcal/day. In an Irish cross-sectional study, similar results were presented in doctors when compared against the general population, where doctors had a higher poor prevalence of lifestyle behaviours, including physical inactiveness and high alcohol consumption that could suggest its contribution to risks of obesity (O' Keeffe, Hayes and Prihodova, 2019). Nevertheless, it is important to note that doctors' lifestyles can be improved by enhancing hospital management, implementing policies for break opportunities, and promoting healthier dietary choices within the working environment. Thus, this highlights the need to understand the behaviour underpinning this interaction. Conversely, this study has limitations such as the lack of exploration of nutrition and eating habits, perceptions of health status, and the amount of clinical workload across different shift patterns among the surveyed population. These limitations may raise questions about the study's validity compared to other studies. As a result, further research is needed to investigate how various confounding factors can influence dietary behaviours and their association with other health problems.

Other meta-analyses indicate a positive association between shift work and overweight and obesity, with relative risks ranging between 1.17 – 1.66 during shift work (Wang *et al.*, 2014; Sun *et al.*, 2017; Liu *et al.*, 2018). Permanent night shift workers, in particular, were found to have a 29% higher risk of obesity compared to rotating shift workers (Sun *et al.*, 2017). However, despite this evidence highlighting the positive association between shift work and obesity, accepting such results with certainty is implausible without acknowledging those studies' potential limitations. Wang *et al.* (2014) consisted of six eligible studies, unlike Sun *et al.* (2017) and Liu *et al.* (2018), with 28 and 27 studies, respectively. This variation in the number of studies may introduce heterogeneity and impact the reliability of the estimated ratio. Secondly, the interpretation of 'shift work' and the frequency of shifts per week varied across studies. This could lead to over and/or underestimation of the exposure to obesity – for example, the duration of a short day vs a long day. Thirdly, the cumulative nature of shift work types also presented challenges in assessing the specific impact of different shift patterns on health. It is unclear and cannot be assumed if 'healthier' shift workers working in a particular shift pattern would have a higher or lower health implication risk. For example, there is a possibility of underestimation if individuals modify their shift schedules to primarily work day shifts to fit around their work and personal commitments, thus minimising the impact on their health. Despite these considerations, the overall consensus among studies indicates that permanent night shift work with prolonged exposure is significantly associated with abdominal obesity. Therefore, it is important for shift work patterns to mitigate any negative influences on health outcomes and minimise the increase in anthropometric parameters.

1.4.2 Shift work and impacts on nutrition consumption and dietary behaviours

1.4.2.1 Defining dietary behaviour and health food

The field of dietary choice is complex, with non-communicable diseases and malnutrition remaining ongoing public health challenges (Tapsell, 2017; Marijn Stok *et al.*, 2018; Budreviciute *et al.*, 2020). Unhealthy diets and practices continue to hinder efforts to improve nutrition and health outcomes among individuals. However, in today's media-saturated environment, health professionals face the difficult task of capturing the public's attention and influencing long-term health behaviours and outcomes amidst competition from uncredited sources (Randolph and Viswanath, 2004; Swire-Thompson and Lazer, 2020; Bryanov and Vziatysheva, 2021).

Dietary behaviour is often unclear across different disciplines, encompassing different measurable outcomes ranging from consuming food nutrients to eating habits, food preferences, eating patterns and personal health influences. However, researchers often refer to different terms interchangeably, perceiving the same meaning even within a single discipline like nutritional science. For example, some refer to "dietary intake" as the complex process of consuming meals, foods, and nutrients, including breakfast consumption, junk/ fast food, fruit and vegetables, micronutrients, and diet quality (Burrows *et al.*, 2017). On the other hand, others have referred to the same meaning using 'nutritional composition' to specifically refer to the macronutrients and micronutrients in the diet (Durazzo *et al.*, 2019). Therefore, the absence of a clear definition of dietary behaviour hinders the identification of its determinants and the comprehensive understanding of the related challenges. As such, clarifying this issue is essential to effectively address the complexities surrounding diets and their impact on behaviour and health outcomes.

Drawing from existing definitions of 'dietary behaviour' and amalgamating the various terminologies, 'dietary behaviour' can be defined for our present research as:

> "cover all aspects related to dietary behaviour from foraging to ingestion and range from the intake of single nutrients to patterns of entire diets, from

disordered eating to eating habits, from food preferences to food preparation" (Marijn Stok *et al.*, 2018)

Considering that dietary behaviour can be the cause or outcome of specific determinants (Tapsell, 2017; Marijn Stok et al., 2018), 'dietary behaviour' encompasses the whole holistic journey that involves multiple dimensions (Figures 4 and 5). For example, factors such as food choice (i.e. the behaviour in selecting food), eating behaviour (i.e. the act of food consumption) and dietary intake/ nutrition (i.e. exploring the molecular level when food breaks down into its content) are to be considered (Tapsell, 2017). To better understand the intricacies of dietary behaviour, Figure 4 provides a visual representation of the interplay between different factors, such as shaping an individual's dietary choices and behaviours. Figure 5 further illustrates the inter-relationship between nutrients, foods, diet, and food supply, indicating that nutrients in a diet are influenced by various dietary variables, which can positively and negatively affect health outcomes. Thus, understanding these interrelationships is important to comprehend the complexities of dietary behaviour and its implications for health and wellbeing.

Marijn Stok *et al.* (2018) employed a collaborative multi-method approach involving international scholars from interdisciplinary to develop a taxonomy of human dietary behaviour across the life course. Harmonising the complexity of multiple definitions from the literature, the authors aggregated the various terminologies available to create a unified framework. Through facilitated interdisciplinary collaboration, the importance of knowledge exchange emerged when mapping the comprehensive and structured concept applicable across multiple disciplines. Marijn Stok *et al.* (2018) present their definition of dietary behaviour, as mentioned above, in an impartial way, capturing the nutrition journey's complexity and addressing all the biological, physical and psychological aspects. Whilst the proposed definition used for this present research is not a finite 'end-product', the taxonomy (Figure 4) and its determinants can facilitate a dynamic approach to exploring the impact of shift work on nutrition and dietary behaviour in the workplace.

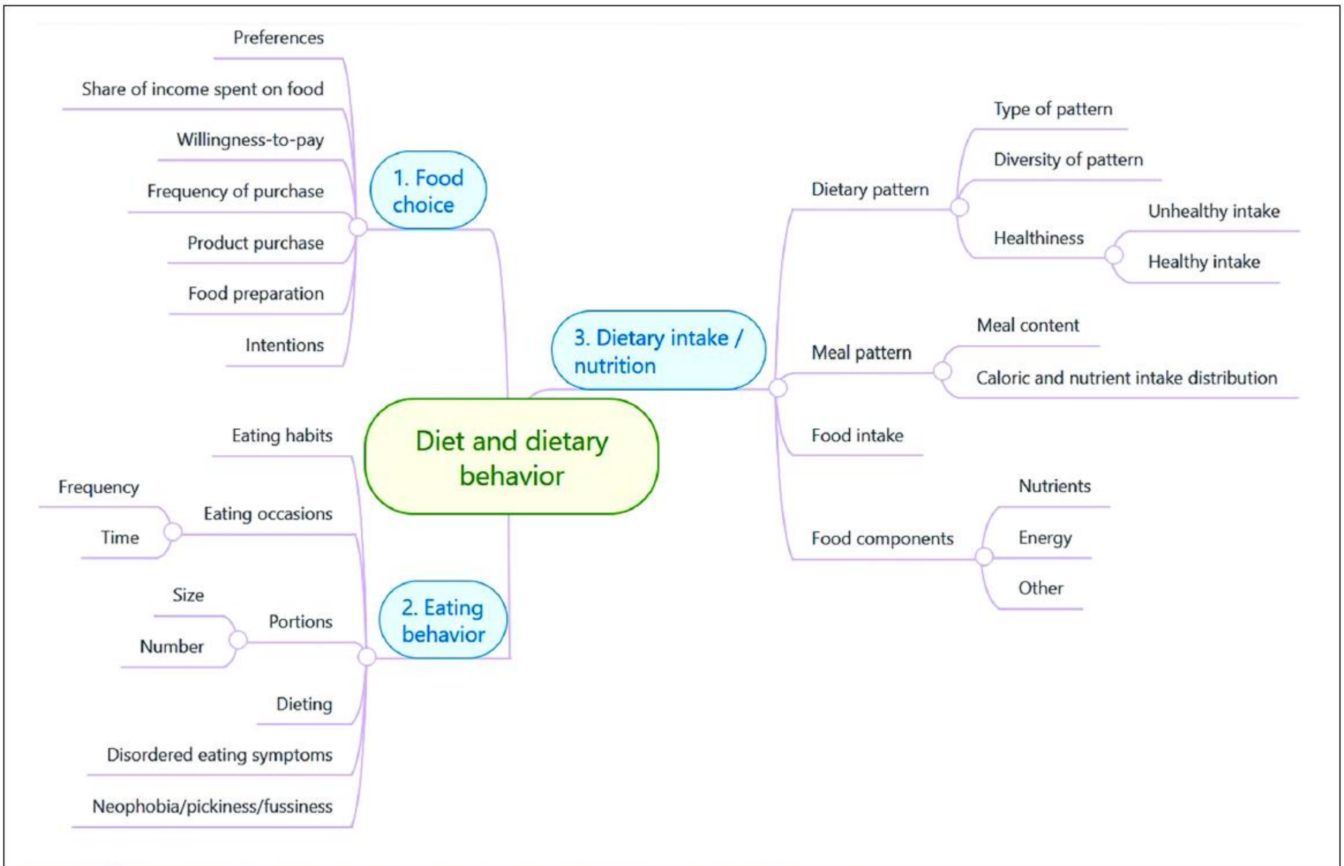

FIGURE 2 | The taxonomy of outcomes related to dietary behavior; figure prepared using MindMeister.com.

Figure 4: Conceptual analysis and taxonomy of 'dietary behaviour' (Marijn Stok et al., 2018). Copyright 2018, with permission from Frontiers Journals.

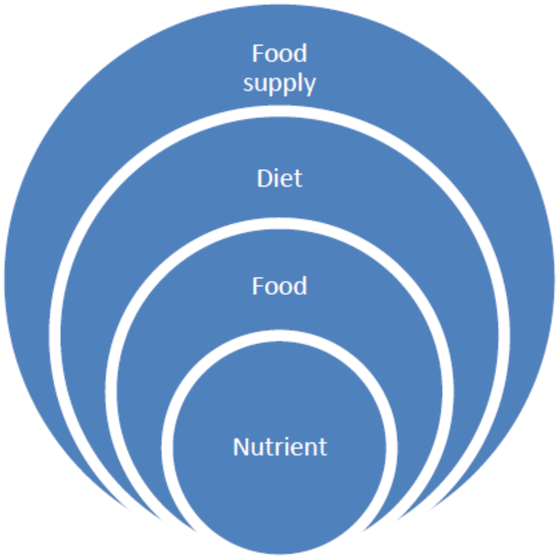

Figure 5: Inter-relationship on dietary variables (Tapsell, 2017). Copyright 2017, with permission from Chronic Diseases and Translational Medicine.

Defining 'healthy food'

Healthy eating consists of a balanced diet, as outlined in the recommended dietary guidelines such as the UK's 'Eatwell Guide' (Public Health England, 2016). Developed through a rigorous review of evidence-based literature, the Eatwell Guide acts as an 'optimised diet' (Buttriss, 2017). It provides specific nutritional recommendations to improve the UK population's dietary habits and promote a nutritional quality diet and good health (Scarborough *et al.*, 2012, 2016). The UK's eating guideline consists of five food groups, namely, 1) fruit and vegetables, 2) potatoes, bread, rice, pasta and other starchy carbohydrates, 3) beans, pulses, fish, eggs, meat and other proteins, 4) dairy and alternatives, and 5) oil and spreads. Additionally, the guidelines emphasise the importance of hydration. The goal of the Eatwell Guide overall is to bring quantifiable health benefits that are appropriate and acceptable for most populations.

As a result of the 'Eatwell Guide' and conceptualise the meaning of a balanced diet, 'healthy food' is defined in our present research as:

> "Healthier food was defined as more nutrient-dense, lower calorie, lower salt, lower sugar, lower cholesterol, or lower fat" (Mozaffarian *et al.*, 2011; Arno and Thomas, 2016)

This overall definition embraces the impacts of the whole diet on the individual as outlined by Public Health England rather than focusing solely on individual nutrients or food groups. Therefore, addressing dietary behaviour and promoting healthy eating habits is imperative in overcoming the limited successes observed in previous health promotions aimed at behavioural changes such as increasing fruit and vegetable consumption and decreasing fats and sugar intake. These challenges highlight the necessity for robust and systematic government strategies and support to address public health challenges (Traill *et al.*, 2010; Capacci *et al.*, 2012; Scheelbeek *et al.*, 2020). Furthermore, gaining a deeper understanding of an individual's health outcomes and behaviours towards their dietary choices encourages a mutual understanding of key health determinants. Thus, this understanding opens possibilities for implementing targeted strategies to address epidemiological challenges.

1.4.2.2 Dietary behaviour in hospital health care workers during shift work

Addressing the dietary challenges in the workplace requires comprehensive measures, including facilities for food preparation and the availability of palatable and healthy food options throughout the day. However, explicitly understanding and categorising the food intake to address those underlying problems to dietary behaviour during the shift, particularly in specific professions such as doctors, remain unclear despite numerous literature focused on nurses working in a similar working environment (Waterhouse *et al.*, 2003; Wong *et al.*, 2010; Sahu and Dey, 2011; Han *et al.,* 2016; Varli and Bilici, 2016; Leedo *et al.*, 2017; Monaghan *et al.*, 2017; Roskoden *et al.*, 2017; Langenberg *et al.*, 2019; Peplonska *et al.,* 2019; Terada *et al.*, 2019; Dias and Dawson, 2020; Lauren *et al.*, 2020). As such, many factors contribute to food choices during shift work, encompassing individual, interpersonal, organisational and policy-level influences (Figures 6 and 7) (Booth *et al.*, 2001; Monaghan *et al.*, 2018). Thus, it is evident that these interconnected factors play a crucial role in nutrition, dietary behaviours and their impact on shift work.

The findings of our scoping search are summarised in Tables 2 and 3 and provide an overview of existing studies that have investigated the dietary patterns of healthcare professionals using primary quantitative data. Table 4 highlights the similarities and differences between day and night shift workers. While most of these studies were predominantly on nurses who share a similar workplace environment with doctors, a wealth of research addresses dietary behaviours during shift work. This scoping search presents the foundation knowledge with the opportunity to identify the association between the impacts of shift work on health outcomes and acknowledge what and how workplace factors influence dietary behaviours.

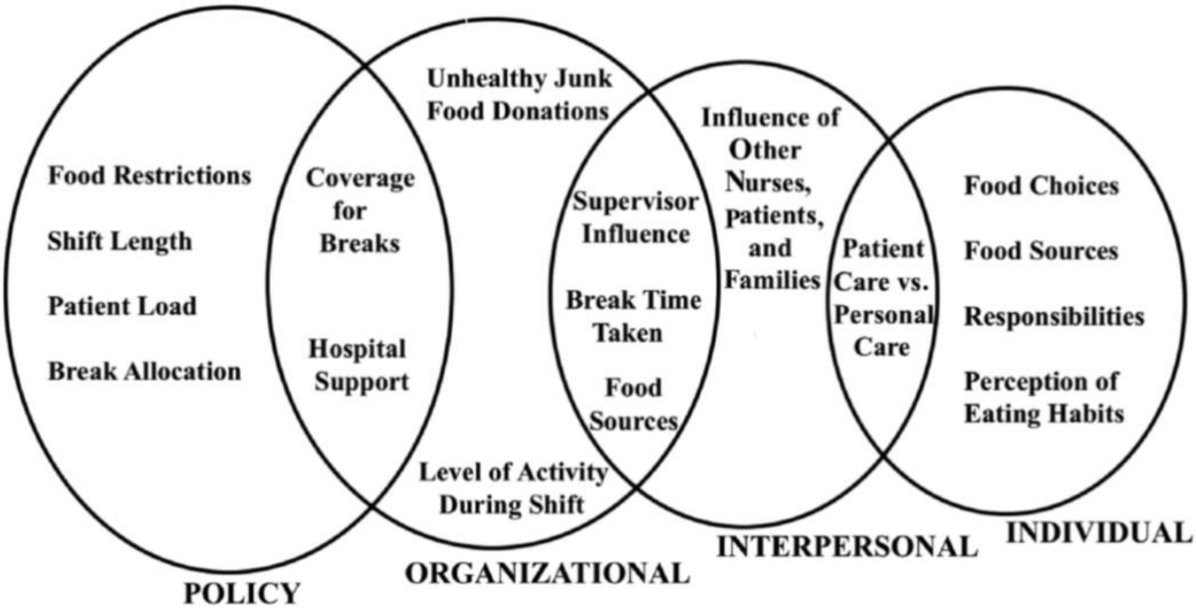

Figure 6: Factors influencing eating practices of hospital nurses during shift work (Monaghan et al., 2018). Copyright 2018, with permission from SAGE Publications.

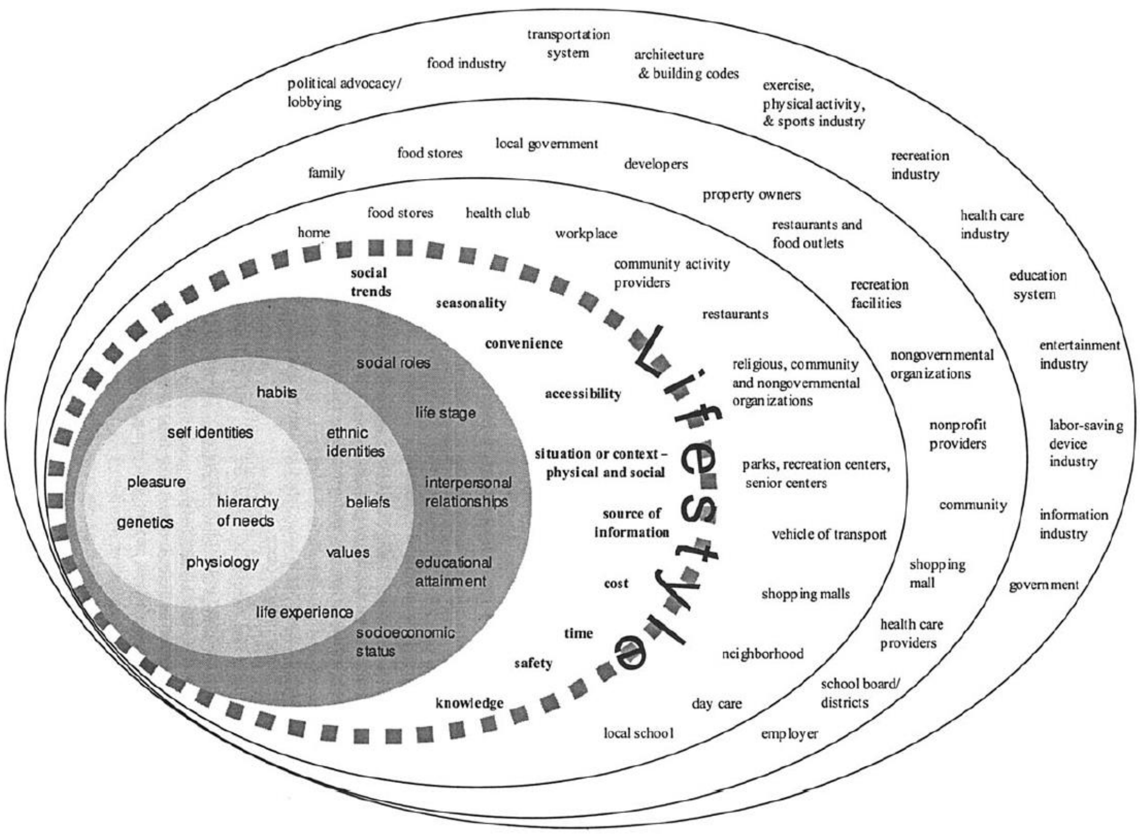

Figure 7: A conceptual framework of food choice determinants from Booth et al. (2001). Copyright 2001, with permission from Oxford University Press.

Research investigating the eating practices of hospital workers has predominantly focused on the differences in dietary intake between shift patterns among nurses. This has been explored globally (including the UK, Australia, Poland, Denmark and the USA) using self-reported methods of dietary recall and food frequency questionnaires (Mittal *et al.*, 2018; Hamidi *et al.*, 2019). The evidence highlights the variability in total calorie intake between day and night shifts, which can be greater than 400 kcal/d (Fradkin, Raz and Boaz, 2019; Langenberg *et al.*, 2019). Interestingly, although certain groups demonstrate increased calorie consumption during night shifts, this does not necessarily correlate with higher BMI (Reeves, Newling-Ward and Gissane, 2004; Booker *et al.*, 2019; Fradkin, Raz and Boaz, 2019). Conversely, those who exhibited greater variability in energy intake between rest and working day were more likely to have a higher BMI (Bonham, Bonnell and Huggins, 2016; Mashhadi *et al.*, 2016; Langenberg *et al.*, 2019).

The impact of shift work on nurses' dietary intake remains inconclusive between day and night shifts. Fradkin *et al*. (2019) asked 132 hospital nurses in Israel who worked rotating shift patterns to complete a real-time food diary for one day and one night shift. The findings indicated an approximately 200 kcal increase in energy intake during the night shift, with significant carbohydrate and fat intake increases. However, contrasting results were observed in a smaller American study of 24 nurses using a 24-hour dietary recall (Lauren et al. 2019) and 36 UK nurses who completed a six-day food dairy (Reeves, Newling-Ward and Gissane, 2004), suggested that the total nutritional intake did not differ between shifts. While the cultural variations between countries may explain these discrepancies, the statistical sample size calculations suggest that a minimum of 100 participants is required to observe a 100 ± 400 kcal difference in calorie intake between shift patterns (Fradkin, Raz and Boaz, 2019). Given the inherent challenges and lack of reliability in accurately recording dietary intake, the studies, as mentioned earlier, may not have had sufficient statistical power to detect small changes in calorie intake.

In contrast, a more substantial difference in energy intake was noted between shifts in nurses in a West Bengal (India) hospital. Calorie intake was reported to be approximately 500-900 kcal lower during a night shift (1697.5 ± 145.2 kcal) compared to a morning shift (2248.1 ± 121.2 kcal) and afternoon shift (2606.1 ± 3030. kcal) (Sahu and Dey, 2011). The authors suggest that reduced calorie intake is associated with the desynchronising diurnal rhythm, resulting in a lower appetite perception during a night shift. Indeed, during the assessment period, the nurses consumed fewer full meals during the night shift (1.43 ± 0.35 meals) compared to the day, with the data suggestive of increased snacking replacing full meals. Unfortunately, the specific dietary composition of these meals and snacks was unreported, making it impossible to determine their energy density. However, based on the low overall calorie intake, it is unlikely that the snack replacements available to nurses working in this Indian hospital were high in energy content.

An increase in snacking during night shifts is commonly reported. For example, a cross-sectional study on nurses explored their dietary and health behaviours across different working schedules, such as day, evening, or night shifts (Han *et al.,* 2016). Nurses working on night shifts were younger, unmarried, living alone or with friends with less occupational experience, and reported having more irregular meals than those without rotating night shifts or with fixed scheduled day or evening shifts (87% compared to 66% and 38%). Further, only 21% of nurses on night shifts had three regular meals per day (40% of no nights and 55% of fixed schedules) and were more likely to skip breakfast (41% vs 26% of no nights and 26% fixed schedules), citing irregular working schedules and lack of time as reasons (Han *et al., 2*016). Additionally, nurses report snacking daily because of high work demand, and night shifts exhibited a higher frequency of snacking, 72% compared to 69% on no nights and 45% on fixed schedules. This suggests that night nurses snack more due to occupational stress (18%), feelings of hunger (31%) and habitual snacking behaviour during their shift (12%).

Studies have highlighted skipping meals and opting for snacks when break opportunities were limited due to clinical workload. For example, Bae *et al.* (2018) noted how more inexperienced nurses worked more hours (>10 hours) and, especially those working in an intensive care unit, took fewer breaks (1.4 times for the night shift vs 1.8 times for the day shift) and skipped meals more regularly (7.4 times per month). However, the consequences of working long hours and occupational stress impact psychological demands. Gifkins *et al.* (2018) present the association between shiftwork and occupational fatigue contributing to nurses' poor eating behaviours. In such cases, nurses frequently snack on high-sugar and energy-dense food with caffeine consumption to prevent tiredness from night shifts. Thus, evidence could suggest the association between high work demand and limited time for eating opportunities, as evidenced in other studies (Han *et al.,* 2016; Bae *et al.,* 2018). Undoubtedly, shift workers are aware of their fatigue. However, it could also highlight the impact of eating opportunities on their energy intake and eating behaviours.

Similar patterns of meal skipping and increased snacking during night shifts have been observed in various countries. For example, nurses in a Turkish hospital were found to be three times more likely to skip meals during the night shift than during the day (Varli and Bilici, 2016). Further, Waterhouse et al. (2003) reported that UK nurses were less likely to consume hot meals and would rather skip meals or increase snacking during night shifts, with participants citing a lack of hunger and time as the main factors influencing these eating patterns. Additionally, a high workload may contribute to increased snacking, as evidenced by Taiwanese nurses, who are more likely to consume sugar-sweetened meal replacement drinks during busy periods, which is associated with an increased likelihood of obesity (Lin *et al.*, 2019). This, alongside evidence that only 16.8% of UK nurses (N = 1158) meet the recommended daily fruit and vegetable intake (Mittal *et al.*, 2018). However, considering the observed increase in snacking and meal-skipping habits, the overall dietary quality of hospital nurses may need to be improved to address health concerns. While specific dietary data are lacking for other healthcare professionals working in a hospital setting, it is conceivable that similar poor dietary practices may exist.

Adequate fluid intake is considered a pivotal aspect of a healthy diet, with the general population across Europe found to have inadequate water intake varying between 5% and 35% (Nishi *et al.*, 2023). The consequences of mild dehydration of 1.4% loss of body weight can be linked to feelings of fatigue, anxiety and impairment of cognitive function (Zulkarnain *et al.*, 2020). Meanwhile, more severe dehydration at a 3-6% total body weight loss could also be linked to impaired physical, psychomotor, and cognitive performance (Zulkarnain *et al.*, 2020). For example, a prospective cohort study based on the PREDIMED-Plus study data over two years of follow-up reported an association between lower physiological hydration status and a poorer decline in cognitive function, especially in older adults (Nishi *et al.*, 2023). Yet, the data from the Nutrition and Health Examination Survey (NHANES) reinforced the evidence on the association of hydration status with cognitive function in adults (Bethancourt *et al.*, 2020), and as a result, could be suggested that it also impacts the health services as examined in a systematic review (Edmonds *et al.*, 2021). Despite the clear link between hydration and performance, primary research on fluid intake and the hydration status of hospital workers is limited (Alomar *et al.*, 2013; El-Sharkawy *et al.*, 2016; Hahn, 2021). However, one screening study of hospital workers on concentrated urine showed that more concentrated urine across a 24-hour collection had lower water consumption (Hahn, 2021). While this study did not focus on either shift workers or DNs, it could, however, suggest the prominence of hydration and its relevance to other epidemiological studies on the general population on its association with urinary tract infections, kidney stone disease, thyroid dysfunctions and other poor health-related outcomes (Fasugba *et al.*, 2020; Gamage *et al.*, 2020; Azevedo *et al.*, 2023). Focusing on DNs, one study investigated 88 UK nurses and doctors across 130 shifts, with over one-third (36%) of the participants arriving at their hospital shift dehydrated, and almost half (45%) ended the shift dehydrated (El-Sharkawy *et al.*, 2016). Similarly, Alomor et al. (2013) observed that emergency department doctors and nurses progressively lost body water during a 12-hour shift. Furthermore, dehydration had a detrimental effect on cognitive function, with dehydrated doctors and nurses experiencing significant impairments in short-term working memory (El-Sharkawy *et al.*, 2016). Although the direct impact on work activities and overall patient care is not fully understood, the importance of hydration and its impact on cognition cannot be dismissed, especially within healthcare settings. Further work should investigate the prevalence of dehydration and fluid intake practices across hospital trusts to understand the overall risks better.

There is an intrinsic link between emotions and eating behaviour (Pelletier *et al.*, 2004; Amianto *et al.*, 2013; Markey *et al.*, 2023), with individuals turning to episodes of binge eating to cope with stressful experiences (Mourilhe *et al.*, 2021; Hill *et al.*, 2022). However, the overall effect as a coping mechanism on health and wellbeing is questionable, as binge eating can lead to negative emotions such as guilt, depression and anxiety (Polivy and Herman, 2005). The prevalence of binge eating, described as "uncontrollable eating", is reported to be high among UK doctors who work in a hospital or a community setting (Medisauskaite and Kamau, 2019). Using the Eating Disorder Diagnostic Scale, it was found that the risk of binge eating and associated negative emotions after overeating might be enhanced during periods of high occupational stress. In particular, doctors who reported feelings of burnout and work-life imbalance and those who cope with stress through self-blame are more likely to engage in binge eating as a coping method (Medisauskaite and Kamau, 2019). King et al. (2009) further suggested that nurses have a high risk of developing disordered eating due to feelings of boredom, anxiety and stress experienced at work. Workload, administrative tasks, and frequent interruptions were identified as significant stressors for nurses, impacting their job productivity. Therefore, the demanding daily workload in hospitals may contribute to the development of disordered eating behaviours among nurses and doctors. However, it could be argued that food cravings do not solely drive the relationship between emotions and eating behaviours during occupational stress. However, it may also relieve physiological discomfort, such as bowel symptoms during the night shift, and fulfil psychological needs to stay awake (Yoshizaki *et al.*, 2018; Dhemaid *et al.*, 2021). Thus, the link between emotions and eating behaviours goes beyond the impact of shift work but is influenced by multi-faceted factors.

Looking into doctors' health, this is, to date, not fully understood, given the complexity of understanding the impact of doing shift work (Miron *et al.,* 2019). Miron *et al.* *(*2019)'s cross-sectional study examined doctors' health-related behaviours and perceptions of their personal and work characteristics. The study reported that 36% of doctors experienced a 'high or a very high level of emotional stress', with females being more stressed than men (40.5% vs 33.2%, respectively). The findings concluded that those of 'younger age, senior status, good nutrition score, meeting the physical activity target and lower emotional stress' were perceived to have good health status. In contrast, those with a higher stress level were 'female, younger age, poor nutritional habits, not achieving the recommended physical activity target and inadequate sleep'. As a result, these findings suggest that shift work could be a barrier to nutrition, impacting their health status. They also highlight the need for workplace health promotion initiatives that support individuals' food and nutrition behaviours. However, it is important to note that the data from this study cannot be generalised to all doctors. For example, the participant recruitment process was highly selective, involving an Israelite professional association, and the participants were already engaged with opportunities from their professional organisation, which may not be representative of the broader population. Nevertheless, Miron *et al.* (2019) acknowledged the lack of understanding of other confounding factors, such as shift work type, workload level, and nutrition habits, which could provide further insights into the causal interaction between doctors' shift work and nutrition and dietary behaviour.

Shift work impacts dietary patterns, leading to changes in meal patterns such as skipping meals, increased snacking and consuming energy-dense foods and drinks to cope with work-related stress and time constraints. While studies in this section have provided valuable insights, it is important to consider their research limitations (Han *et al.,* 2016; Bae *et al.,* 2018; Gifkins *et al.,* 2018). For instance, Han *et al.* (2016) had a high response rate (79.4%) in the questionnaires. However, similar to other studies (Bae *et al.,* 2018; Gifkins *et al.,* 2018), participants were self-selected and lacked population representation, thus could skew the data due to self-consciousness about their diet and health. Furthermore, all studies were cross-sectional, limiting their ability to establish causal relationships over a long period. Furthermore, the studies were conducted in different countries with different participant demographics, shift work culture, and education awareness, making generalisability challenging. Despite these limitations, shift work leads to changing eating habits, especially meal patterns, with a higher total energy intake from snacks and drinks high in saturated fat among shift workers to compensate for occupational stress. These findings could suggest that more workplace support is required to support employees' diet and nutrition.

Table 2: Summary of cross-sectional studies exploring healthcare professionals (predominately nurses) on dietary patterns and food content

Reference	n	Sample	Country	Measures Regarding Dietary Behaviour (in addition to physical/ anthropometric)	Food Dietary Related Results
Almajwal (2016)	395	Female nurses	Saudi Arabia	EB via questionnaire, FFFS, NoS, PSS	Stress & education assoc with all eating styles. BMI and frequency of nights per month asso with restrained and emotional eating
Fradkin *et al* (2019)	132	Female nurses in surgical or internal medicine departments	Israel	Food diary, real-time food intake (food content, portion size, time in detail)	↑ intake of energy, protein, CHO, total fat, sat fat, and calcium on night shifts. No sig change in cholesterol, fibre or iron by shift. Consume more energy on days with day shift, less of an increase in calorie intake on days they work the night shift
Hamidi *et al* (2019)	245	Doctors (community)	USA	FFQ, Sleep-related	Female doctors had sig higher intake of green leafy veg, sig lower intake of fish, poultry, red meat and fast and fried food

				impairment assessment, PA	than males. Three dietary patterns were identified: plant-based, high protein and low CHO, high sat fat and high sugar. No sig asso between a high protein diet and sleep. No asso between gender, PA, alcohol and olive oil consumption and sleep
Han *et al* (2016)	397	Female nurses	Korea	Meal pattern (frequency, duration, regularity). Snacking (frequency, time, amount of stress under) Intake patterns (habits, macronutrients)	>75% ate irregular meals (mainly on nights). 73% skipped breakfast Most overeat three or more per week. 84% of snacks every day (esp nights). >50% reported a healthy dietary intake. 57% eat fried food at least once every other day. 42% eat fatty food at least every three days
Heath *et al* (2019)*	40	Nurses from public hospitals	Australia	Mood, sleep, work, food diary	CHO intake was higher on nights than mornings, protein was lower on nights than on mornings or afternoon. Energy intake was lower in the afternoon shift with gender and stress rating as predictors. Shift and sleep efficiency were predictors of CHO intake, though not sig between afternoon and night

					shifts. Shift type and sleep efficiency were predictors of protein intake – lower on nights though not sig compared to the morning
Lauren *et al* (2019)[1]	24	Female nurses and medical staff/ technicians	USA	Sleep, PA and 24-hour dietary recall	No sig diff in total daily dietary intake in nights (total energy, total fat, CHO, sugar, protein, fibre). Duration of the eating period was sig longer in night workers than a day.
Leedo *et al* (2017)[2]	59	Physicians, nurses and nursing assistants	Denmark	PA, reaction time test, mood, dietary intake records	No sig diff in reaction time, mood-related scores between control and intervention (meals provided) groups. Greater intake of lower fat, CHO, dietary fibres in the intervention group than the control. No sig diff in energy, sat fat or protein. The intervention resulted in sig higher intake of water
Lin *et al* (2019)	854	Hospital nurses	Taiwan	Workload, work characteristics, dietary consumption esp, sugar-sweetened beverages	Almost half of all consumed commercial sugar-sweetened beverages as a meal replacement and as handmade drinks during high workload shifts.

Mittal *et al* (2018)	1158	Doctors and nurses	UK	Diet from short-form FFQ Work and barriers to a healthy lifestyle	Based on SFFQ, 168% met five portions of fruits/ veg, no diff in intake between clinical/non-clinical staff. 47.4% consumed one or more servings of oily fish per week, being higher in the clinical group. 11% and 16% of staff met the recommended fat and NMES intake, respectively. 39% not drinking alcohol – only 18% drank above the recommended limit of 14+ units per week; a greater proportion of clinical staff exceeded the limit. 69% felt responsible for their help, esp the clinical group. 15% feel their job prevents them from staying fit (68% lack fitness facilities, 43% managerial support, 25% healthy food options in canteens. Only 24% of the managers knew the NHS health and wellbeing policy.
Peplonska *et al* (2019)	522	Nurses and midwives	Poland	Chronotype questionnaire FFQ	Median total energy intake at nights exceeded the median recommended value, but energy intake was slightly below the median for day workers. 28% of night workers consume more energy than recommended (18% for day workers). In both groups, animal protein and fatty acids esp sat fat, frequently exceeded recommendation; polysat fat and fibre were below (other micronutrients were lower in both groups). Night workers had higher total energy, total fat acids (sig: sat, monosat, polyunsat, cholesterol, CHO, sucrose); but sig lower

					in Vit A and C and protein than day workers. Night shift sig inverse assoc between calcium, phosphorus, Vit A, Vit C and % energy from protein and night shift work seniority. Night shift not asso with nutrient intake except Vit A
Perry *et al* (2015)	381	Nurses	Australia	Tobacco, smoking, alcohol intake, fruits seven vegs, fat intake by type of milk consumed PA	Chronic disease present (see paper for full). 34.7% of female nurses are more likely to report drinking habits than the relative general population. 18% self-reported smokers, higher in females. 18.1% met the fruit recommendation; 9.4% met the vegetable recommendation Use of reduced/ low fat milk accepted as an indicator of managing sat fat intake (25.1% consumed full-fat milk. 17.6% do not consume cheese, 37.3% consume full fat, and 30.9% consume lower fat soft type. Spread – 26.9% none, 35.2% butter or butter and margarine blends, 22.8% preferred mono or polyunsat. 19.8% chose white or white high-fibre bread; 65.6% wholemeal, multigrain or rye bread
Reeves *et al* (2004)	36	Nurses	UK	Food intake via 6-day food diaries (canteen facilities only	Female day workers consume more energy than night workers. Day workers consume more fat than night workers. Time sig affects food intake – more food is consumed on workdays than rest days. No diff in macronutrients in both men/and females. Protein contributes to more energy intake in

				available during the day)	the afternoon on workdays but in the evenings on rest days. Fat to be highest in the early hours of the morning on a workday but around midday on rest days CHO are eaten more in early morning or at night. Alcohol only on rest days and typically after 7pm. Day staff are more likely to consume more meals daily and fewer snacks than night workers. Female night workers drank more tea and coffee than day workers. Night workers are more likely to smoke more cigarettes than day workers per 24hrs.
Sahu and Dey (2011)	75	Nurses	India	Rating of eating satisfaction and appetite. Diet survey – record items eating and their quantity at mealtimes	Sig in: actual vs preferred time of food intake in evening snacks, dinner time and breakfast of all workers. Night workers – full meals were sig lower compared to other shifts and off days. Appetite and eating habit satisfaction were sig lower and number of snacks higher when working at night. CHO, protein, and fat intake was sig low in night shifts compared to other shifts and off days. Vitamin and mineral consumption were not sig diff btwn rotating shifts, and general duty shift, bit iron intake was less in rotating shifts
Terada *et al* (2019)[3]	73	Female nurses	Canada	3-day dietary logs on total energy,	Snacking frequently was asso with % body fat, day to day energy intake variability was +ve asso with BMI and waist. Majority snack were unhealthy, only 30% healthy

				macronutrient intake, record consumption, time, location, meal type. Mood and eating disorder	Overall energy intake did not differ between shifts/non-shifts. 61.5% of workers had energy intake discrepancy >400kcal/day between shift working and off days.
Van de Langenberg *et al* (2019)[1]	69	Female healthcare workers	Netherland	48 hours of lifestyle parameters, alcohol consumption, caffeine intake and overall eating patterns	Higher CHO intake, 2.3% less protein and sig more fat and sat fat for night workers during winter (no sig in summer). In night shifts, -ve correlation btwn CHO intake and protein intake; sig shorter 3.7hr max interval between eating episodes and 0.9 higher frequency of meals compare to non-shift sessions. Night shift sessions: peaked calorie intake during the night (3am) and morning (9am) but no peak during lunchtime. Peak of calorie intake for both groups also at 19:30 (dinner)
Varli & Bilici (2016)	110	Nurses	Turkey	3-day food consumption log, 24hr recall	Mean daily number of main meals = 2.5 (+/-0.5), mean daily number of snacks = 1.9 (+/-0.8). Higher total number of main meals per day for day workers (2.8(+/-0.5) than shift workers. 69.6% of shift workers skipped meals (vs 22.3% of day workers)

					Higher daily mean energy intake for shift workers than day workers; CHO and fat intake were also higher while protein intake was lower, though no sig diff in protein, fat and CHO. Mean daily Vit B (1,2,3) was similar in both groups, though mean daily intake was higher in day workers and no sig diff. Sig diff only in mean daily intake of calcium, sodium and all minerals higher in day workers. Vit C was adequate in shift workers but excessive in day workers; iron was more adequate in shift workers than in day workers. Day workers frequently ate afternoon meals (90.6%), vs 83.9% of shift workers ate evening meals.
Waterhouse *et al* (2003)	93	Nurses	UK	Survey on eating habits and types of meals	Higher sig decreases in the frequency of eating on workdays. Sig higher intake of snacks and sig lower intake of large hot meals by night workers – consumed less hot food. Mean hunger before the meal was less for night workers. On rest days, hunger before meals was sig less in night workers but no difference in satiety after meals.

*Repeated measure within and between-subject design study

[1]Observational study

[2]Randomised cross-over design study

[3]Single centred randomised trial study

EB = Eating Behaviour on restrained eating, emotional eating, external eating

FFFS = Frequency of fast food and snacks

NoS = Number of servings of fruits and vegetables

PSS = Perceived stress scale

BMI = Body mass index

Assoc = Association/ associated

CHO = carbohydrate

Sat = Saturated

Sig = Significant

FFQ = Food Frequency Questionnaire

PA = Physical activity

Table 3: Summary of studies of doctors' workplace health and nutrition

Reference	Aim	Design Study	n	Measures	Key Significant Results	Conclusion	Knowledge Gap
Hamidi *et al* (2019)	Evaluated the association between dietary patterns as assessed by FFQ & SRI in community physicians	Cross-sectional observational	245	FFQ, SRI, PA	No sig gender diff in SRI; females had sig higher intake of green leafy veg but sig lower fish, poultry, red meat, and fast & fried food; 3 dietary patterns – plant-based, high protein/ low CHO, high SF/ sugar; increase working hours = increase SRI score	Barriers to sustaining healthy workplace diet' limited access to healthy meals; lack of organisational support for SRI & work performance	Assess the effects of dietary interventions on SRI and work performance.
Leedo *et al* (2017)	Effectiveness of increased availability of	Randomised cross-over	59	Maintain BW & habitual PA; 1 wk intervention	Intervention group: lower intake of fat, CHO, dietary fibre,	Providing healthy meals during working hours	Assess the increased availability of

	healthy meals at work; examine data separately for those on shifts			(meals provided); anthropometrics, reaction time, mood, 4-days dietary intake record (pre/ during/ post)	sig higher water intake than the control group; no sig diff in reaction time or mood	improves employees' dietary intake & long-term health benefits; increasing water in the short term improves mood	healthy meals at work on total dietary intake & compare between types of shift workers
Lemaire *et al* (2010)	Examine the effect of nutrition-based intervention with scheduled nutrition breaks during work day on cognition, glycose & hypoglycaemic symptoms	Prospective	20	Nutritional intake (inc fluid), cognitive function, anthropometry, glucose, PA, stress during working hours on 2 separate days,	Lower glucose, fewer fatigue & drowsiness symptoms, improved hydration & nutrient intakes on intervention day	Adequate workplace nutrition is a contribution to improving cognition, acting as a snowballing effect on patient and health care system	How cognition function varies on food consumed with a possible effect on patient outcomes

Lemaire *et al* (2011)	Examine the experience of workplace nutrition & its personal and professional impacts; attitudes towards workplace nutrition for a nutritional-based intervention at scheduled breaks	Qualitative	20	Nutritional intake, cognitive function, hypoglycaemic symptoms	Inadequate nutrition impacted emotional, physical, and cognitive symptoms; negative impacts on work completion/ interactions; difficulties eating/drinking during work hours; barriers to adequate nutrition (time, limited access, limited food choices, work ethic, professionalism); impacts of participating in the initiative (awareness of workplace	Inadequate workplace nutrition had sig negative impact on personal wellness and professional performance. Need to address barriers to basic self-care & implement workplace initiatives for positive influences	Perceptions of experiences in poor workplace nutrition – personal & professional impacts and contributing barriers. Feelings after given free nutritious meals at work

					nutrition, intention to change)		
Mittal *et al* (2018)	Assess CVD factors in NHS staff, measure compliance with national dietary & PA guidelines, compare between clinical & non-clinical staff	Cross-sectional	1158	Compliance against general health guidelines, BMI, diet (via FFQ), PA (via IPAQ), barriers to heathy lifestyle	Sig less prevalence of hypertension & smoking in clinical than non-clinical; high proportion of staff suffered from stress-related conditions in non-clinical group; higher consumption of oily fish in clinical group; greater proportion of clinical staff exceeding drinking limits; more sitting in non-clinical group; PA barriers – inc time, motivation; & felt responsible for	Low compliance with the recommended intake of fruits & vegs; low prevalence of CVD risk factors compared with general population; majority felt they have a responsibility for their own health	Comparing dietary consumption against public health recommendations; barriers to healthy lifestyles

					own health esp those in clinical group; limited knowledge of NHS health & wellbeing policy		
Miron *et al* (2019)	Examine health-related behaviours & perceptions; effect of personal and work characteristics	Cross-sectional	4832	Questionnaire on PA, nutrition & eating habits, smoking, sleep, perceived health status, emotional stress, GP engagement, height, weight, BMI, personal & work characteristics	High level of emotional stress, more so in females than males & residents; hospital setting was associated with higher perceived level of stress than community; males more overweight/ obese than females; PA higher in males; PA high in those working in the	Physicians should be provided with healthier food & beverage options during long work hours & encouraged to partake in PA & stress reduction options	Explore PA level, nutrition & eating habits, smoking, sleep, perceived health status & emotional stress, BMI, regular GP contact, and personal & work characteristics across all shift patterns

					community; female had healthier nutritional habits than male; healthier health status = less stress & better sleep		
Mota *et al* (2013)	Identify possible negative effects of residency shift work on food intake, anthropometric variables, metabolic & sleep patterns	Cross-sectional	72	Anthropometry, food intake (3 non-successive days), Healthy Eating Index, PA, sleep, metabolic evaluation	Men: greater weight gain after starting residency, higher PA, higher caloric intake. Women: higher HDL-C, hs-CRP & cortisol, lower beans & dairy intake, higher cholesterol & oil scores. No sig diff in sleep & energy, macronutrient intake	Need more support from hospital management for coverage & education to improve healthier workplace diet; to address social norms, coverage policies & supervisory involvement for break opportunities;	Measure workload: what are the negative effects

			redirecting patient food donation to improve the working environment

FFQ = Food Frequency Questionnaire

SRI = Sleep-related impairment assessment

PA = physical activity

BW = body weight

IPAQ = International Physical Activity Questionnaire

Sig = significant

Diff = difference

SF = saturated fat

Table 4: Summary of studies of doctors' workplace health and nutrition (Cristina *et al.*, 2014; Beebe *et al.*, 2017; Booker *et al.*, 2019; Langenberg *et al.*, 2019)

Day Shifters	Night Shifters
Depends on work environment and facilities (fixed and predictable meals)	Depends on work environment and facilities (fixed and predictable meals)
Healthier food options	Poorer diets
Less meat and fruit consumption – yet inadequate intake than the recommendation	Less informed on the relationship between nutrition and exercise →affects meal patterns
Better sleep	High energy intake (carbohydrate, fat, calcium) and dense consumption, reduced fibre
	Poorer sleep
	↑ BMI, ↑ restrained eating, emotional & stress
	↑ the proportion of inappropriate feeding practices

1.4.2.3 Determinants of dietary behaviours during shift work

Dietary behaviours are affected by a range of modifiable to non-modifiable factors such as self-beliefs, culture, accessibility, support system, work environment, and occupation types, as demonstrated by the conceptual framework (Figure 7) (Booth *et al.*, 2001). As such, this framework provides opportunities to understand the relationship between the inter- to intrapersonal factors affecting diet and nutritional behaviours. Previous research has explored how changes in social and environmental factors are associated with nutritional behaviour and dietary consumption (Escoffery *et al.*, 2011; McNaughton *et al.*, 2012; Okoro, Musonda and Agumba, 2017). In the context of different working patterns and healthcare occupations, this section highlights common factors that apply to shift work.

a) Social and cultural environment

High-pressure healthcare environments such as hospitals are unique settings where internal politics, influences, and cultural behaviours shape employees' experiences. Shift work contributes to poor dietary behaviour among healthcare professionals (Reeves *et al.,* 2004; Pridgeon and Whitehead, 2013; Han *et al.,* 2016; Dias and Dawson, 2020). Yet, Han *et al.* (2016) reported that cultural differences are associated with eating habits and the psychological impacts that extend into the workplace. For example, Han *et al.* (2016) conducted a study with Korean nurses whose knowledge and cultural practices differ from other countries. In contrast to their US counterparts, Korean nurses work eight-hour shifts compared to 12 hours. Further, the Korean diet primarily comprises grains and vegetables, with fermentation technology highly influencing food preservation – for instance, kimchi, a fermented vegetable, is served at every meal (Kim *et al.*, 2016). Thus, these cultural factors can shape dietary patterns and behaviours in the healthcare setting.

Traditional eating habits differ between Eastern and Western cultures, with significant implications for dietary behaviours and health outcomes. The INTERMAP study, a cross-sectional epidemiological study of 4880 participants from across four countries (Stamler *et al.*, 2003; Aljuraiban *et al.*, 2020), has revealed distinct patterns in these regions. Those individuals from the East are known for their fast-paced eating habits, often resulting in overeating and potential health issues like hypertension and diabetes due to the high sodium content in their cuisine (Anderson *et al.*, 2010; Zhou *et al.*, 2019; Bhat *et al.*, 2020). Conversely, those from the West prefer baked or fried food, frequently incorporating deep-fried cooking, red meat, and highly processed foods rich in sugar and saturated fats (Odegaard *et al.*, 2012). Such cooking methods have been associated with increased risks of cancer, cardiovascular disease, and risks of depression (Odegaard *et al.*, 2012; Sánchez-Villegas *et al.*, 2012; Gadiraju *et al.*, 2015; Sun *et al.*, 2019). These external stimuli demonstrate that cultural influences shape identity and food consumption, which could impact dietary behaviours and overall health outcomes within each respective environment.

Shift work contributes to an individual's socioeconomic status and traditional cultural eating habits that can influence their food choices. Within healthcare, a typical 'norm' exists that people culturally sub-consciously follow as part of their workplace identity. For example, Korean nurses experience a greater intensity of physical demands. Culturally, they are more vivid in following other peoples' behaviours (through the Confucian principles), such as unhealthy practices for weight loss purposes, leading to negative health consequences of malnutrition and depressive symptoms and suicidality (Han *et al.,* 2016; Kim and Seo, 2020). Eastern countries, including Korea, experience higher work demands in healthcare, with a nurse-to-patient ratio of 1:11.4 (Cho *et al.*, 2015) compared to 1:3.7 patients in Norway (Aiken, Sloane *et al.*, 2013), 1:5.7 patients in the US (Aiken, Shang, *et al.*, 2013) and 1:8 patients in the UK (Hodgson, 2014). These intense clinical demands also hinder individuals from practising healthy dietary behaviours, such as not taking the allocated meal breaks, disrupting their eating times, and reducing healthy food choices (Han *et al.*, 2016).

Pridgeon and Whitehead (2013) highlighted the complexity of healthy eating and food provision in the workplace. Factors such as food availability, cost, and institutional responsibilities were identified as key influential barriers to adopting healthy eating behaviours in the workplace. In healthcare settings, staff recognised the need for workplace changes to address their workload demands. However, finding time for break opportunities and having the freedom to move freely was challenging, often leading to working through breaks (Pridgeon and Whitehead, 2013; Dias and Dawson, 2020). Further, the oppressive hospital environment limited employees' control over food choices, often resulting in reliance on vending machines, cafes, and free food options. This lack of control hindered the motivation to initiate cultural changes in the workplace that could promote healthier dietary consumption (Pridgeon and Whitehead, 2013; Dias and Dawson, 2020). Thus, changing the workplace culture could arguably facilitate healthier eating behaviours during shift work, removing barriers such as limited time for eating opportunities.

b) Food availability and accessibility

Physical workplace infrastructures play an important role in determining access to food and the availability of appropriate facilities such as kitchen space or café (Hemiö *et al.*, 2015; Osei-Kwasi *et al.*, 2016; Naicker *et al.*, 2021). The hospital is an obesogenic working environment, yet inaccessible healthy food, limited storage and food preparation facilities, and cost-effective of unhealthy food from on-site outlets hinder the individual's healthy dietary choices (Reeves *et al.,* 2004; Pridgeon and Whitehead, 2013; Almajwal, 2016; Torquati *et al.*, 2016; Bonnell *et al.*, 2017; Bae *et al.,* 2018). For example, many workplaces have food facilities such as canteens and vending machines for employees throughout the day (Alinia *et al.*, 2011; Feig *et al.*, 2019; Wyse *et al.*, 2021). However, previous literature indicates that shift workers often struggle with adopting healthy eating behaviours due to the limitations or closures of canteen facilities during their shifts (Horrocks and Pounder, 2006; Leedo *et al.*, 2017; Brennan *et al.*, 2019; Rimmer, 2021). This situation leads healthcare workers to frequently skip meals due to limited access to food, such as leaving the ward (Nabe-Nielsen *et al.*, 2016; Sharma *et al.*, 2016). As a result, shift workers often rely on vending machines and other food available at nurses' stations during their shifts (Lemaire *et al.*, 2011; Sharma *et al.*, 2016; Torquati *et al.*, 2016).

Vending machines are often considered an alternative food provision source due to their feasibility, particularly during night shifts when staffing is limited (Lawrence et al., 2009). However, its content is considered poor food choices, consisting of high fat, sugar and sodium, that are convenient to individuals when healthy food options are restricted (French *et al*., 2001; Sahu and Dey, 2011; Dias and Dawson, 2020; Utter and McCray, 2021). Previous research has explored interventions aimed at influencing the eating behaviours of hospital shift workers by introducing healthier products such as fruits, nuts and low-sugar drinks (Keogh, 2014; Carrad *et al*., 2015; Utter and McCray, 2021). For example, Pechey et al. (2019) introduced an intervention by altering the product range in a hospital's vending machines, split across nine locations for seven four-week study periods, and randomised to one of the two sequences. Despite no changes in the sale numbers, increasing the availability of healthier drink options did not result in significant energy (kcal) consumption differences. Other results also showed no differentiation of improved dietary behaviour and vending machine usage between shift types, perhaps due to the varied cravings between day and night (Spiegel *et al*., 2005). However, those who used the improved vending machines reported increased satisfaction and were willing to pay for healthier food options (Utter and McCray, 2021). Despite vending machines being a common place for food sources, improving the nutritional quality in vending machines plays a critical role in shift workers' workplace health and wellbeing.

c) Workforce

Staff shortage and an ageing workforce have been found to impact dietary behaviour (Perry *et al.,* 2015; Almajwal, 2016; Bae *et al.,* 2018; Bridges *et al.*, 2019; Winter *et al.,* 2020). A study on a cohort of Saudi Arabian nurses revealed that increasing workload due to staff shortage was associated with occupational stress, leading to poorer eating behaviours during shift work (Almajwal, 2016). The results indicated a positive correlation between job stress and various eating styles, with a higher percentage of those working in abnormal shift patterns engaging in binge eating and consuming more fast food. Additionally, these individuals consumed fewer servings of fruits and vegetables (less than two servings) than those with healthier eating styles, such as restrained, emotional and external (Almajwal, 2016). Similar conclusions regarding eating behaviours during shift work have also been drawn from studies conducted on Korean nurses (Bae *et al.*, 2018). While there is a lack of direct research on the interaction between increased work burden resulting from staff shortages and dietary choices, these studies exemplify how staff shortages in shift work settings can impact the dietary behaviour of healthcare professionals.

d) Education and awareness affect dietary behaviour

Doctors possess extensive knowledge in addressing patients' health needs; however, research demonstrated the "unfilled role for medical education" in preparing doctors to provide nutrition care to their patients (Chisholm *et al.*, 2013; Mogre *et al.*, 2018; Macaninch *et al.*, 2020). Previous studies have highlighted the inadequacy and insufficient nutrition knowledge and education that doctors learn during their medical training (Adams *et al.*, 2006, 2010; Chung *et al.*, 2014; Grammatikopoulou *et al.*, 2019). For example, Adams et al. (2006) surveyed all 126 US-accredited medical schools to assess the amount and type of nutrition they taught during their training.

On average, students received only 23.9 contact hours on related nutrition topics, falling short of the recommended 44 hours from the American Society for Clinical Nutrition (Weinsier *et al.*, 1989). Likewise, 32 European medical schools from 10 countries presented, on average, 23.68 hours of required nutrition education during their medical school (Chung *et al.*, 2014). On the other hand, only 16.4% of Japanese medical schools dedicated more than 5 hours to nutrition education, with substantial nutrition education only 4.2 hours (Orimo *et al.,* 2013). These findings undoubtedly demonstrate that doctors lack sufficient training in nutrition education, thus creating an opportunity for future work to provide them with a greater understanding of how food and nutrition contribute to both health and disease.

Existing literature has highlighted how medical students would consider their patient-facing professional role as an opportunity to improve clinical strategies, incorporating nutrition into their education and practices (Mogre *et al.*, 2018). However, doctors have encountered various barriers that could have hindered the development of their comprehensive nutrition learnings. These barriers include the lack of facilities, inadequate application of nutritional science, limited collaboration with nutrition professionals, and a perception that nutrition care may not be the primary responsibility of doctors. As a result, Crowley *et al.'s* (2019) systematic review demonstrated that doctors have insufficient confidence in providing nutrition care, a significant barrier to acquiring nutrition knowledge. For example, doctors are perceived to have limited knowledge or awareness of the connection between nutrition, lifestyle, and chronic disease, thus unable to integrate nutrition into patient care (Perlstein *et al.*, 2016). Furthermore, Macaninch *et al.* (2020) cited that UK medical trainees reported ‘not confident at all’ in applying nutrition assessment during their clinical practices due to the limited opportunities and lack of confidence and knowledge in providing nutritional advice to patients. The authors reported that their participants only engage in nutritional discussions with patients less than once a month, highlighting the need for improved nutrition knowledge. Hence, organisations need to demonstrate a commitment to supporting doctors’ professional development and fostering collaboration with nutrition professionals to equip doctors with the necessary knowledge and skills to support their patients and promote their health.

e) Sleep and its implication for dietary behaviour

In our lifetime, we spend around a third of our time asleep (Kitamura *et al.*, 2016), with the sleep duration and timing reported to decline with age but also vary according to behavioural, social, and environmental exposures explaining the insufficient sleep (Chaput *et al.,* 2018). A cross-sectional survey examined sleep quantity against gender, age and the prevalence of sleep problems in 2000 British adults aged 16 years and above (Groeger *et al.,* 2004). Results presented that, on average, men and women sleep for 7.04 hours (±1.55 hours), with men aged 40-49 years sleeping less than women of the same age (at 7 hours). Those who were employees (with shift or no shift work, as the study was not explicit) reported that sleep duration on workdays was significantly shorter than on non-work days (6.94 ± 1.25 hrs; 7.32 ± 1.62 hrs). Thus, this study shows that employees supposedly had more time on rest days for self-care, with more sleep quality to catch up, feeling "more refreshed" and satisfied with more energy to perform on their daily tasks (Groeger *et al.,* 2004).

Insomnia, a common sleeping disorder characterised by difficulty falling asleep, affects approximately one-third of the UK population, as evidenced by multiple longitudinal studies based on the UK Biobank (Morphy *et al.*, 2007; Kyle *et al.*, 2017; Brito *et al.*, 2021). Sleep deprivation resulting from insomnia not only leads to feelings of sleepiness but also contributes to a decline in cognitive performance (Kitamura *et al.*, 2016; Stout *et al.*, 2020). An example experienced by healthcare workers doing shift work was during the COVID-19 pandemic. Pappa *et al.* (2020) examined the prevalence of depression, anxiety and insomnia in healthcare workers during the pandemic. Anxiety, depression and insomnia were prevalent during the lockdowns (23.2%, 22.8%, and 38.9%, respectively). However, these findings could be attributed to various factors, such as the heightened transmission and mortality rates associated with the virus during the outbreak, which added extra stress and exhaustion to the already burnout healthcare workforce.

Caffeine consumption often alleviates sleepiness, stimulates the brain, and suppresses adenosine, is a sleep-promoting chemical. However, caffeine intake disrupts the natural circadian rhythm due to its rapid absorption into the stomach and small intestine with a half-life of six to eight hours, affecting the inability to sleep and maintain sleep (O'Callaghan *et al.,*2018; Shriane *et al.*, 2020). Healthcare shift workers use caffeine to stay awake due to the long working hours and cope with high clinical workloads. A cross-sectional study on Norwegian nurses demonstrated a significant association between workload during a night shift and caffeine consumption, with a mean coffee (drink) consumption of three drinks (± 2.7) (Buchvold *et al.*, 2015). Similarly, Centofanti *et al.* (2018) conducted a mixed-method study on nurses exploring the association between caffeine intake, coping strategies for shift work and health outcomes. The findings indicated that caffeine was a common strategy to manage their shift work, with consumption increasing from 15% to 33% during a shift and, on average, consuming four beverages (± 2). Unsurprisingly, it also disturbs sleep, increasing psychological distress and weight gain since starting shift work (Centofanti *et al.*, 2018). These findings reemphasise that caffeine intake helps individuals overcome the tiredness and exhaustion experienced during shift work. As a result, regular caffeine consumption becomes a common practice to help healthcare workers navigate their demanding shifts.

Sleep disturbances, particularly in shift work, can impact appetite and dietary patterns (Morselli *et al.*, 2010; Lin *et al.*, 2020). Inadequate sleep leads to increased ghrelin levels and decreased leptin, which are hormonal signals that promote hunger and appetite (van der Lely *et al.*, 2004; Lin *et al.*, 2020). For example, Tajiri *et al.* (2020) found that sleep restriction presented a higher preference for sweet-tasting foods, with individuals who slept for five hours exhibiting a greater preference for foods with higher sucrose concentration compared to those who slept for eight hours (20.9% ± 11.1% vs 12.9% ± 10.8%). Similarly, the effects of shift work on diet suggest that sleep deprivation affects mood and macronutrient consumption (Heath, Dorrian and Coates, 2019). Research conducted on nurses found that they slept an average of 6.9 hours before a shift, had the shortest sleep before morning shifts, and felt the most tired on night shifts, with stress perceived as the highest on nights. The study also indicated that stress levels predicted increased fat and saturated fat consumption during night shifts, with each unit increase on the stress scale (100 points) was associated with 0.07% fat and 0.06% saturated fat intake. Similarly, Hamidi *et al.* (2019) evaluated the impact of sleep deprivation on dietary patterns. The results showed that female shift workers consume a higher intake of green leafy vegetables with lower amounts of fast and fried foods, fish, poultry and red meat compared to their male counterparts. Furthermore, there was a significant association between a plant-based diet and reduced sleep-related impairment, as every one standard deviation increase in a plant-based diet was associated with a 0.72 point decrease in sleep-related impairment score, while increased saturated fat and sugar intake were associated with a 0.77 point increase in sleep-related impairment score. Considering these result, this can suggest that sleep disturbances during shift work contribute to poor dietary choices, as sleep deprivation affect appetite regulation, food preferences and macrinutrient consumption.

The use of food as a coping mechanism to improve mood is a common phenomenon among individuals. However, research limitations (Hamidi *et al.*, 2019; Heath, Dorrian and Coates, 2019) restrict the comprehensive understanding of the relationship between shift work, sleep and dietary behaviour. Firstly, these studies relied on participants to serve as their control through the study, comparing their own experiences under different conditions. Although this approach allows for direct comparison, it is important to note that methods used to assess sleep, such as self-reporting, may not always be reliable. Secondly, the short study period for collecting self-reported data raises concerns about the validity of the results. Participants were required to remember to log their data daily, and this reliance on individual memory may introduce errors and bias. Furthermore, these studies may not fully capture the complex causal interactions and the long-term exposure to poor sleep. Thus, it could be argued that workplace nutrition contributes to sleep quality and overall work performance. Hence, this highlights a need to justify the importance of organisational policies that address nutrition to reduce exhaustion among healthcare professionals. Organisations can create a supportive environment that positively impacts their staff's health, wellbeing and performance by prioritising better nutritional practices within the workplace.

1.5 Summary, limitations, and gaps in current research

Health professionals form a diverse and multidisciplinary workforce responsible for delivering high-quality patient care across the life stages. This chapter indicates the reason for retaining health professionals such as doctors and nurses: to ensure the smooth functioning of the day-to-day services and to retain valuable and highly skilled individuals who can provide continuous, high-quality patient care. The general population faces numerous, including obesity, sedentary lifestyles, and other chronic health problems. In this context, frontline professionals, such as medical doctors and nurses, recognise their imperative role within the healthcare ecosystem and diligently deliver care around the clock. Despite the inherent challenges, such as lifelong career commitments and long working hours, medical doctors and nurses persist in overcoming them, emphasising the significance of workplace health and wellbeing implications.

Indicative evidence suggests a correlation between working hours (i.e., shift work) and health implications, impacting psychological factors (i.e. cognitive function, emotional behaviour and stress, cardiovascular disease risks) and conditions like diabetes and obesity, resulting in poor health and wellbeing. Shift work contributes to poor eating behaviours, with different shift types (i.e. day and night shifts) influencing diet composition. This is particularly relevant for healthcare professionals such as nurses and doctors (Tables 2 and 3). For example, night shift workers exhibit a higher prevalence of inappropriate feeding practices than their day shift colleagues, with several factors contributing to their dietary choices. Night shift workers often eat dinner early before starting their shift and subsequently compensate themselves and distract their fatigue during the night shift through unhealthy snacking. Thus, night shift workers tend to consume higher fat and sugar content in food and drinks. Furthermore, the level of work experience is also associated with diet management, with less experienced workers relying more on unhealthy food (i.e. snacks) for shift survival due to poor meal planning and limited awareness of dietary considerations.

The dietary pattern is inconsistent during shift work, with working conditions implicating the food timing rather than the quality or quantity of nutritional factors. However, there is a lack of studies that consider other factors. These include whether the food consumed is purchased on-site or brought from home or nearby food places, the method used for data collection (i.e. currently used food diaries, questionnaires, and recalls heavily relying on subjective feedback), the ability to establish the causal relationship between mood and diet, and the importance of considering different workloads in different departments within the hospital when recruiting participants. As a result, considering these factors would enhance our understanding of dietary patterns and consumption during shift work. Consequently, it emphasises the importance of focusing on the quality of food consumed within healthcare settings, such as hospitals, over a more extended period to gain deeper insights into dietary habits during shifts.

Shift work impacts dietary behaviours across all healthcare professionals, including doctors and nurses, yet the validity and generalisability of the existing data could only be sceptically accepted. A key understanding was the importance of recognising and considering the complexity of multiple health determinants influencing shift work and their overall health and wellbeing. For example, previous literature has focused on the association between doctors, stress, and resilience. Thus, there is an opportunity to explore doctors' health by examining their nutrition and dietary behaviours and comparing them to nurses who work in a similar environment. As such, a more comprehensive understanding can be gained by integrating concepts of addressing occupational stress, physical activity, and nutrition in the context of shift work. Moreover, considering the time healthcare professionals spend at work each day, exploring the workplace environment and its influence on their nutrition provides valuable insights into other related nutrition and dietary behaviours which may influence their overall health and nutrition.

The healthcare environment can be stressful and often overburdensome, with inconsistent attitudes towards dietary choices. This review presented the foundation knowledge of the topic, examining the current research and its limitations and discovering the potential future research to address doctors’ and nurses’ nutrition experience and dietary behaviour during their shift work. While considerable literature on nurses’ health and wellbeing, such as nutrition and dietary behaviour (Table 2), and other confounding factors, such as occupational stress, the impacts of shift work on doctors’ health and nutrition have not been extensively studied. Given the prevalence of shift work and its prominence in today’s society, it is important to develop services, policies, strategies, and interventions to mitigate the negative health effects on shift workers. Therefore, improving nutrition and health outcomes for doctors and nurses requires considering the multiple layers, including the individual, organisational and policy levels, to foster long-term behaviour change with the need to understand the “what” and “how” to address long-term nutrition behaviour. Hence, the findings from this chapter and future nutrition investigations should ultimately aim to consolidate evidence on diet and health, focusing on effective strategies for addressing nutrition behaviour at various levels. Furthermore, it helps inform guidelines and promote adherence to public health recommendations on nutrition and dietary consumption among shift workers, reducing associated health risks.

1.6. Thesis' research aim and objectives

Drawing from this chapter, the overall aim and objectives to fill the knowledge gap in doctors' and (nurses') workplace health and nutrition for this thesis are as follows:

Overall aim:

To understand workplace nutrition and its impact on UK doctors and nurses undertaking shift work to improve their health and nutrition.

Objectives:

1. Determine and characterise doctors' and nurses' current diet and eating practices during shift work using a semi-structured interview.
2. To explore the occupational barriers and facilitators (such as food provisions and facilities) to good workplace nutrition for doctors and nurses and identify possible strategies to promote workplace nutrition.
3. To explore the dietary intake/ dietary quality between UK doctors and nurses with shift work using the UK Biobank
4. To determine the impact of different shift work patterns on dietary intake/ diet quality in UK doctors and nurses using the UK Biobank

1.7. Thesis' structure

Following this introductory chapter, the second chapter will provide a comprehensive overview of the research methodology adopted, aligning it with the proposed aim and objectives. Chapter 2 will be divided into three sections. The first section will present the rationale for utilising a mixed-method approach, demonstrating its suitability for capturing diverse aspects of the research topic. Subsequently, detailed accounts of both qualitative and quantitative research methods employed in this study will be provided. The qualitative aspect involved conducting semi-structured interviews with doctors and nurses to gain insights into their dietary practices during shift work. Interview questions were carefully designed based on relevant research in healthcare to explore their nutritional behaviour and food choices. The latter part of this chapter will delve into the quantitative approach, utilising the UK Biobank dataset to fulfil research objectives 3 and 4.

Chapter 3 will summarise the results from the qualitative research involving semi-structured interviews with doctors and nurses. This section will focus on their dietary practices during shift work, with thorough analysis conducted using NVivo, a qualitative data analysis package. The aim is to understand the participants' dietary intake before, during, and after their shifts and evaluate whether their eating practices align with recommended nutritional guidelines.

Chapter 4 will build on the research conducted in Chapter 3, further exploring the occupational barriers and facilitators to good workplace nutrition for doctors and nurses. The chapter will identify potential strategies to promote healthier eating practices during shifts, derived from insights obtained through the semi-structured interviews. Emphasis will be placed on assessing changes that can be implemented within the workplace to support shift workers' occupational responsibilities while encouraging healthier nutrition.

Moving onto Chapter 5, the focus will shift to summarising the doctors' and nurses' dietary intake results from the UK Biobank dataset. Utilising validated calculations, their dietary intake will be compared against recommended guidelines, enabling an assessment of their adherence to healthy eating practices during work shifts. The findings from this chapter will contribute to developing future workplace interventions to promote better nutrition among doctors and nurses.

Chapter 6 will extend the results from Chapter 5 by quantitatively exploring dietary intake patterns concerning different shift work patterns, such as day and night shifts, using the UK Biobank dataset. This section will shed light on how various shift work patterns may impact the dietary practices of doctors and nurses, further informing potential workplace interventions to support and promote workplace nutrition.

Lastly, Chapter 7 will serve as the concluding chapter of the thesis, consolidating the key findings from the mixed-method studies. The chapter will also address any limitations encountered during the research process and discuss the implications for practice. Moreover, future research propositions will be presented to advance the promotion of doctors' and nurses' workplace nutrition during shift work.

CHAPTER 2: METHODOLOGY

2.1 A mixed-method research

This chapter aims to provide an overview of the research methodology, drawing on relevant literature to justify using a mixed-method approach for this thesis. It will then delve into the specific research method employed for the qualitative studies, including semi-structured interviews with doctors and nurses. Additionally, this chapter will outline the quantitative research method used to analyse DNs' dietary intake, utilising the data from the UK Biobank database.

As discussed in the literature review (Chapter 1), nutrition is a multifaceted topic influenced by various health determinants (Booth *et al.*, 2001; Gedrich, 2003). As such, to comprehend its effect on the human body's psychological and physiological aspects, there is a need to grasp the underlying reasons for individuals' food choices. This thesis investigates DNs' dietary intake and nutritional behaviour during shift work, building upon the complexities and challenges healthcare professionals encounter within health services, as discussed in Chapter 1.

Previous literature has emphasised the importance of considering multidimensional aspects, such as social and environmental factors, when conducting healthcare research. This comprehensive approach helps researchers understand, analyse and evaluate problems and their impact on large organisations such as the NHS and the broader population (Pope and Mays, 1995; Campbell, 2000; O'Cathain, Murphy and Nicholl, 2007). Traditionally, quantitative methods have been utilised in healthcare research to estimate health-related parameters for the general population, assessing the health outcomes and conditions to deliver relevant clinical care (O'Cathain, Murphy and Nicholl, 2007; Hannigan, 2018; Shah, 2019). Thus, quantitative data collection in healthcare facilitates a better understanding of how service deliveries perform and their impact on improving patients' health. For example, such data can measure the real-time improvements resulting from changes implemented at different levels within the healthcare system. For example, patient test results can provide an understanding of their health outcomes, while data at the service level assesses waiting time and complaint numbers. At the organisational level, financial performance metrics can evaluate the effective management of separate departments, and at the population level, data can measure employment, mortality and morbidity rates in specific geographical locations (Moffatt *et al.*, 2006; Shah, 2019). However, given the complexity of healthcare, relying solely on quantitative research may not fully uncover the underlying rationales behind the statistical data. Thus, using a single methodology cannot fully explain the complexities within healthcare practices and translating the data into effective applications in practice.

Unlike quantitative research, the qualitative research method offers the opportunity to interpret results based on the assumptions from individuals having different experiences of the same topic, gathered from text, images derived from interviews and or focus groups (Wasti *et al.*, 2022; Houghton and Paniagua-Avila, 2023). For example, qualitative research is based upon constructivism rather than empiricism (Sale, Lohfeld and Brazil, 2002; Houghton and Paniagua-Avila, 2023), enabling researchers to consider a single topic from multiple lenses, uncovering the personal experiences and lived insights (Curran *et al.*, 2012; Wasti *et al.*, 2022). In contrast, quantitative research, relying on statistical numbers from closed-ended and structured questions, may not fully uncover individuals' subjective truths (Houghton and Paniagua-Avila, 2023). Qualitative research employs purposeful recruitment for in-depth exploration until data saturation, while quantitative research leans towards a more generalisable approach using convenient sampling to establish statistical trends and connections between variables (Tariq and Woodman, 2013; Houghton and Paniagua-Avila, 2023). Nevertheless, qualitative and quantitative research methods offer relevant benefits to research approaches, with qualitative research excelling in understanding behavioural actions in different contexts and unravelling factors that might influence specific activities (Kaur, 2016).

2.1.1 Justification for mixed method research of this thesis

Health service researchers in the UK have traditionally favoured quantitative research methods. However, the popularity of mixed methods research designs is slowing growing within healthcare (O'Cathain, Murphy and Nicholl, 2007; Tariq and Woodman, 2013; Kaur, 2016; Vedel *et al.*, 2019; Wasti *et al.*, 2022). For example, a review by

O’Cathain *et al.* (2007) found that only 18% of health service research conducted in England between 1994 and 2004 was classified as mixed methods. Despite this small proportion, the main rationale for using a combined research approach has been viewed as “*pragmatic rather than ideological grounds”,* especially in complex and multifaceted health service research (see Chapter 1), aiming to improve healthcare services. Elsewhere, Wasti *et al.* (2022) highlight the benefits of mixed methods in healthcare research, noting that it involves more than just combining the two methods. Instead, it entails the integration of the *“underlying philosophy and/ or the skills to apply each set of methods appropriately”* to align with the research paradigm and address the overall research aim and objectives. As a result of providing a more comprehensive understanding of the research topic, mixed methods research can inform actions to tackle healthcare challenges faced by the healthcare professional and the population.

To achieve the aim and objectives of this thesis (see Chapter 1), a mixed-method approach has been selected (Creswell and Creswell, 2022). Considering the limited knowledge in the field regarding DNs' dietary intake and nutrition behaviour during shift work, as discussed in the literature review (see Chapter 1), this mixed-method approach allows us to explore DNs' experiences through semi-structured interviews, gaining insight into their dietary intake and eating practices from various individual perspectives. This qualitative approach delves into the lived experiences and stories of DNs, providing a deeper understanding of the what, how, why and for whom aspects that need to be addressed to improve their dietary practices at work, placing DNs at the heart of the research. Simultaneously, the quantitative aspect of the research facilitates a broader understanding of the trends in nutrition intake within the wider DNs population, utilising existing databases like the UK Biobank. However, the limitations of qualitative and quantitative methods in this thesis must be acknowledged when interpreting the result. For example, the preexisting sample from the UK Biobank covers a wide range of DNs’ recruited from across the UK, such as the participants’ working patterns, geographical locations, educational background, socioeconomic status, household income, ethnicity, age and gender. The data from the qualitative study was collected at a more specific period, with the COVID-19 pandemic highly influencing the recruitment and availability of participants. Though these limitations may make the comparison of data from each study challenging, the narrative data from the qualitative research complements the quantitative results (Tariq and Woodman, 2013), generating a comprehensive understanding of DNs' workplace nutrition. For example, the qualitative study allows an understanding of how dietary intake and nutritional behaviour were experienced at a single time point. At the same time, the UK Biobank data offers a wider lens to the broader DN population and confirms similar themes from the qualitative results, with opportunities to see how the qualitative study could be replicated. Thus, by triangulating the data, we can generate deeper insights into the research aim and objectives, addressing the complexities DNs face during their shifts to improve their health and nutrition. Overall, combining both research methods in a mixed-method approach not only counterbalances the weaknesses of both research approaches (Tariq and Woodman, 2013) but integrates and strengthens the research, allowing the development of valuable insights to expand existing knowledge and address the improvements of DNs' dietary intake and nutritional behaviour during their shifts.

2.2 Qualitative study design

This investigation employed a qualitative design, using one-to-one semi-structured interviews conducted by video call or, in a minority of cases, telephone. In healthcare, qualitative research can enable a deeper understanding of the complex meanings and dynamics underpinning individuals' lived experiences (Black *et al.*, 2018; Moser and Korstjens, 2018). Furthermore, qualitative research enables an in-depth exploration that is flexible in examining the phenomenon under investigation, enabling researchers to reveal a rich understanding of the topic (Polit and Beck, 2012; Castleberry and Nolen, 2018). Here, linking back to this study's research aim, this method provides the opportunity to better understand attitudes and behaviours of doctors during their shift work, to shed light on eating practices, health and wellbeing issues. Further, data are often open-ended, unlike statistics, which examines the facts using a precise measurement (Polit and Beck, 2012); this allows for interpretations, though attention is given to ensuring transparency in findings (Nowell et al., 2017; Castleberry and Nolen, 2018). Thus, there is the opportunity to use a qualitative approach to accommodate narrative data to understand DNs' lived experiences. This qualitative method provides a rich insight into doctors' and nurses' diet and nutrition eating behaviours during shift work.

2.2.1 Participants

Due to the unprecedented COVID-19 global pandemic (since March 2020), the study experienced challenges throughout. As a result, engaging doctors, the core healthcare professional group for this study was a continuous challenge. Therefore, this section illustrates the changes made during participant recruitment in response to the interruptions caused by the pandemic.

Participant inclusion and exclusion criteria

Original plan

To obtain a range of experience, we recruited a heterogeneous sample of doctors doing shift work, including different genders, ethnicities, geographical locations (Trusts) and medical grades. Inclusion criteria included medical doctors currently working in either a private or NHS England hospital, undertaking shift work, including night shifts, and being available to be interviewed either face-to-face in London or online. Exclusion criteria: retired or not currently practising medicine, General Practitioners (GPs), and working in the community, online (digitally) or outside England.

Amendments (8 months later)

Following discussions with the supervisory research team, the inclusion and exclusion criteria were amended due to the busyness of hospital doctors during the COVID-19 pandemic and, thus, the risk of recruiting a sample of doctors only. As such, General Practitioners (GPs) were included in an ethics amendment to increase the scope of the sampling frame for doctors. Furthermore, given that registered nurses were also working in similar working environments and with much literature surrounding their diet in the previous literature, they were also recruited with opportunities to compare and contrast the research data between doctors and nurses on workplace nutrition. Inclusion criteria: qualified medical doctor or registered nurse working in a private or NHS England hospital, doctors or nurses undertaking shift work, including night shifts, and general practitioners working in the community. Exclusion criteria: retired or not practising medicine or nursing and those working outside England. The study focused on doctors' and nurses' shift patterns. However, GPs and nurses were included in the study as they work in a similar environment. Differences in GPs, hospital doctors and nurses' experiences were gathered to shed light on nutritional experiences by comparing findings. Participants' demographics are further discussed in Section 2.2.2 of this chapter.

2.2.2 Recruitment strategy

Participants were recruited through several sources, including more than twenty relevant UK medical professional bodies, via their mass email communications and newsletters (i.e. Association of Anaesthetists, Association of Surgeons on Training, British Medical Association, British Society of Lifestyle Medicine, Foundation of Intensive Care Medicine, NNedPro, Nutritank, Royal College of Medicine, Royal College of Surgeons, The Doctors' Association UK, etc.), relevant charities (i.e. Nutritank, Nutfield Trust, Nutfield Health) conferences that doctors attend (i.e. Integrative and Personalised Medicine Congress) BSPHN Annual Conference and other professional bodies' organised meetings) as part of their continuous professional development training, and via supervisors' professional contacts. A list of contacts (100+) of relevant professional bodies and medical professionals was also compiled. These contacts were invited via the researchers' social media: 1) Twitter using appropriate hashtags and tagging relevant professional bodies and doctors to generate engagement and views, 2) posting on doctors-related Facebook groups and 3) direct email invitations (with follow-ups). Snowball sampling was also used to recruit doctors via those already interviewed. However, the number of participants coming via this route was limited (n=2). A similar approach was applied for nurses' recruitment, predominantly recruiting via the researchers’ social media: 1) Twitter using appropriate hashtags and tagging relevant professional bodies and nurses to generate engagement and views, and 2) posting on nurses-related Facebook groups. Likewise, snowball sampling was also used by the nurses who had already been interviewed. Considering that during the COVID-19 pandemic, social media has become widespread for different health-related purposes, such as health promotions, research and education (Chen and Wang, 2021; Leighton *et al.*, 2021), this strategy was opted as the main reason considering also the limited time for data collection within the research.

Participants were self-selected, and the sampling frame was convenience sampling (Etikan, Musa and Alkassim, 2016; Naderifar, Goli and Ghaljaie, 2017). Those who expressed an interest were invited to complete an online consent form and an online pre-interview short demographic questionnaire (including demographic questions and shift work hours) to ensure the final sample covered different doctors' and nurses' grades and specialities. At the end of the questionnaire, participants supplied their contact details to arrange a convenient interview time (Appendix 3). Recruitment continued until data saturation (i.e., no new themes of interest to the study were being elaborated on (Braun and Clarke, 2021).

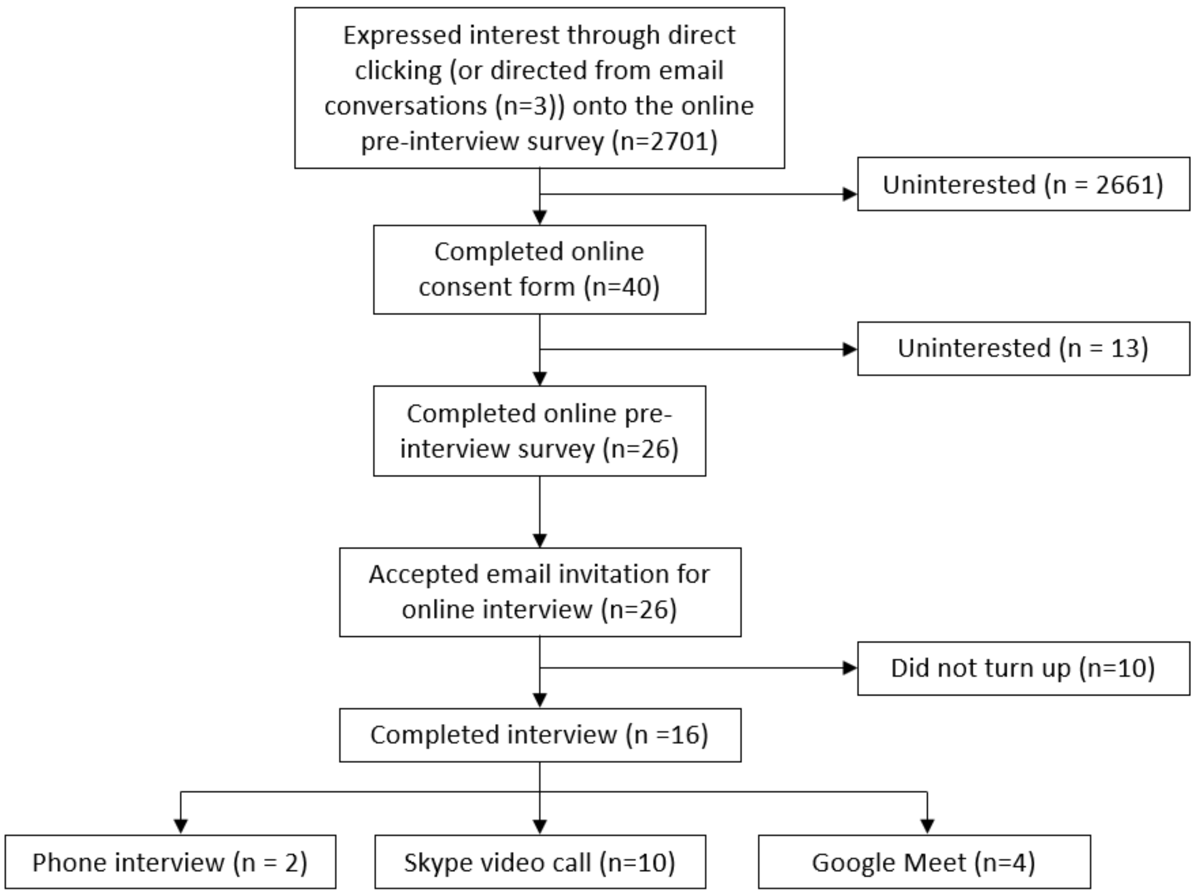

Figure 8: Participant recruitment flow diagram between March 2020 – July 2021

Figure 8 summarises the participant flow chart illustrating the number of people interested in completing the online pre-interview demographic survey (and consent form) who responded to the interview invitation and conducted the study. Note that the data shown in Figure 8 was taken between March 2020 – July 2021.

2.2.3 Demographics of participants

During the recruitment period (March 2020 – July 2021), 2,701 visits were made to the online study site (via JISC) that contained the study's information, the consent form and the pre-interview demographic survey. Figure 8 illustrates the flow of potential participants through the recruitment process. In the first round of recruitment (under the original inclusion/exclusion criteria), three participants completed their interviews (March – November 2020). Then, with the expanded inclusion criteria to include GPs and more intensive recruitment, 13 participants were recruited (December 2020 – July 2021). Thus, 16 participants were included in this study (n = 5 nurses, n = 11 doctors). Table 5 provides a breakdown of the demographics. See also Table 8 for the individual participants' characteristics.

Table 5: Comparison of demographics and occupation characteristics across nurses and doctors (n = 16)

	Nurses n (%)	**Doctors n (%)**	**All n (%)**
Number of Participants	5 (31.3)	11 (68.8)	16 (100)
Sex:			
Male (%)	0	2 (18.2)	2 (18.2)
Female (%)	5 (100)	9 (81.8)	14 (96)
Age:			
18 – 24	1 (20)	0	1 (6.3)
25 – 34	0	4 (36.4)	4 (25)
35 – 44	2 (40)	4 (36.4)	6 (37.5)
45 – 54	2 (40)	2 (18.2)	4 (25)

55 – 56	0	1 (9.1)	1 (6.3)
Ethnic origin:			
White	5 (100)	5 (45.5)	10 (62.5)
Asian or Asian British	0	6 (54.5)	6 (37.5)
Speciality:			
Geriatrics		1 (9.1)	1 (6.3)
Anaesthetics	1 (20)	1 (9.1)	2 (18.9)
Intensive Care Medicine		3 (27.3)	3 (18.8)
General Practice		3 (27.3)	3 (18.8)
Psychiatry		1 (9.1)	1 (6.3)
Emergency Medicine	1 (20)		1 (6.3)
Community	1 (20)		1 (6.3)
Paediatrics & child health	1 (20)	1 (9.1)	2 (18.9)
Surgery		1 (9.1)	1 (6.3)
Oncology	1 (20)		1 (6.3)
Grade:			
Specialist training (ST1 – ST9)		4 (36.4)	4 (25)
Specialist status (GP/ Consultant)		7 (63.6)	7 (43.8)
Band 5	3 (60)		3 (18.8)
Band 6	1 (20)		1 (6.3)
Band 7	1 (20)		1 (6.3)
Length in current role:			
< 6 months	1 (20)	3 (27.3)	4 (25)
6 months – 1 year		1 (9.1)	1 (6.3)
2 years – 5 years	2 (40)	2 (18.2)	4 (25)
6 years – 10 years	1 (20)	3 (27.3)	4 (25)
11 years – 20 years	1 (20)	1 (9.1)	2 (18.9)
21 years +		1 (9.1)	1 (6.3)

Participants were recruited across 15 NHS Trusts across the UK (n = 14 in England) with varied definitions of shift patterns (e.g., length in rota, short days, long days, etc.). The length of the rota was mixed, ranging from weekly to six months and ongoing, with 11 participants undertaking night shifts. 11 participants indicated their rota had not changed in the past six months.

2.2.4 Data collection

2.2.4.1 Interviews

Data collection for qualitative research can stem from various approaches. Yet, due to the limitations imposed by the COVID-19 pandemic on face-to-face interactions, alternative methods such as online and telephone-based data collection offer not only means to promote inclusivity and equality in research (Lefever, Dal and Matthíasdóttir, 2007; Saarijärvi and Bratt, 2021) but also greater opportunities for flexibility and accessibility particularly for our participants with irregular shifts. Considering this, the researcher emailed the participant to arrange a date and time convenient for the participant for an online or telephone semi-structured interview. A Calendly (online appointment scheduling software) link was sent to the participant to choose their preferred date between Monday-Friday 9am-7pm, along with further interview details such as content expectations. A follow-up email was sent seven days after the initial email if the potential participant had not yet replied, with a further reminder three days later, after which no further follow-up was made. Following the interview invitation with the agreed date and time, the researcher sent a calendar invite to confirm the appointment with the online joining details.

Interviews lasted between 33 and 65 minutes and took place virtually between the interviewer and participant via phone (n=2), Google Meet (n=4) and Skype video calls (n=10). All interviews were conducted remotely due to the pandemic restrictions on face-to-face meetings. Data collection commenced in March 2020 and ended in July 2021.

During the interviews, participants were encouraged to freely share their experience in nutrition, dietary behaviour, and impacts from their shift work to bring forward the richness of participants' stories. This free-flowing approach produced many specific initial codes (Appendix 2).

2.2.4.2 The design of the interview topic guide

Existing research amongst healthcare professionals around behaviour change in health and wellbeing was considered to help shape the interview questions. For instance, Keyworth *et al.* (2019) examined the barriers and enablers to delivering "opportunistic behaviour change interventions as part of routine practice" in medical consultations. The authors enabled participants to answer the questions with opportunities to share the expectations and responsibilities of the occupational roles concerning the study's aim and objectives. Similarly, Ojo *et al.* (2019) and Sargent *et al.* (2017) also used semi-structured interviews to explore facilitators and barriers to healthcare professionals regarding GPs. A common aspect of all these studies was that the interview questions were informed by the "COM-B model" (Michie *et al.,* 2011; Michie *et al.,* 2014), representing the capability, opportunity, and motivation model of behaviour. In the present study, this model helped inform the development of the interview questions, enabling a better understanding of how individuals behave within the environmental and organisational constraints that may influence their behaviour at the individual level (see Chapter 1). In addition, the COM-B model helped ensure that the data we collected were on different health determinants, addressing individual behaviour and noting the barriers and facilitators for workplace nutrition and future behaviour change interventions (Cane, O'Connor and Michie, 2012).

Interview topics were developed systematically. Firstly, key areas that should be covered to address the study's aim and objectives were identified in consultation with supervisors. This was also achieved by consulting past healthcare studies with similar research methods and, where possible, with similar research aims and objectives. For example, studies exploring the impact of shift work on frontline healthcare professionals' (i.e., nurses, paramedics, and physicians) eating behaviour and self-care strategies (Lemaire *et al.*, 2011; Anstey *et al.,* 2016; Bonnell *et al.*, 2017; Monaghan *et al.*, 2017; Gifkins *et al.,* 2018; Savic *et al.*, 2019; Horton Dias and Dawson, 2020). Six key areas were identified: role, shift work, nutrition, mood and emotions, health, and facilities and interventions.

Next, following a similar methodology concept as Keyworth *et al.* (2019) and Sargent *et al.* (2017), typical questions (as the interviews were semi-structured, this allowed for questions to be modified during the interview, such as by asking follow-up questions), were brainstormed under the six topic areas. These questions were then consolidated and mapped against the COM-B model (Table 6). This ensured that questions related to the possible relevant behaviour when considering workplace nutrition (Michie *et al.,* 2011; Cane *et al.,* 2012).

Table 6: Mapping interview questions against the COM-B model

Topic Section	**Questions**	**COM-B Model**		
		C	O	M
Role	1. Could you outline your current role and how you got there after medical school?	✓		
	2. How have you managed your own health and wellbeing?		✓	✓
Shift Work	3. How does your rota impact your overall health?		✓	✓
	4. How do you think this rota impacts your mood and emotions?		✓	✓
	5. When on shift, could you share your typical diet?		✓	✓
	6. How do the habits differ when at work/ and outside of work?		✓	✓
	7. How confident are you about eating healthily during your night shifts?	✓	✓	✓
	8. What are the challenges you find during your shift to looking after yourself?	✓	✓	✓
	9. What are the key facilitators during your shift to looking after yourself regarding nutrition?		✓	✓

Nutrition	10. What influences your food choices during your working hours?		✓	
	11. How important it is to eat well as a doctor?			✓
	12. Do you keep track of what you eat?	✓		✓
	13. Have you seen a change in your nutrition over the past 6 months? If so, why?	✓	✓	✓
Mood and Emotions	14. Thinking about a busy day at work when don't have time to eat or drink, how did you feel or affect you physically/ mentally?	✓		✓
	15. Thinking about a busy day at work when don't have time to eat or drink, how did it affect your daily activities with colleagues and patients?	✓		✓
	16. How is your dietary intake affected when stressed at work?		✓	
Health	17. Are you aware of any challenges from your shift that are preventing you from being healthy?	✓		
	18. By assessing your own health, how satisfied are you with your health?			✓
	19. Does it contribute to your health and cardiometabolic risk factors?	✓		✓
Facilities & Interventions	20. Does your workplace provide support for your health and wellbeing and nutrition intake?		✓	
	21. What food facilities/ breaks are there available for you at your workplace?		✓	✓
	22. What immediate workplace support would be useful for your health and nutrition?		✓	
	23. What longer-term support or training would be useful for your nutrition?		✓	

2.2.4.3 Pilot testing and quality check

Following the list of questions summarised in Table 6, an interview topic guide was formulated, highlighting the high-level questions with subsequent sub-questions related to the study's aim. A pilot test with a doctor, whose data was included in the final data set, was conducted using the topic guide (Kallio *et al.,* 2016). This pilot interview enabled the researcher to test the research questions regarding comprehensibility and relevance to the research aims, understand the potential topics generated by the questions, and explore the length of the interview and any possible ethical considerations. Importantly, it brings rigour to the research, assessing the feasibility of the main research study to ensure the semi-structured interview guide becomes an authentic and valid source of data collection relevant and appropriate to the main research aim and objectives (Jordan, Clarke and Coates, 2021).

The pilot testing also supported the planned recruitment approach, as recruiting volunteers can often be challenging (Jordan, Clarke and Coates, 2021; Allen, Palermo and Hay, 2022). Recruitment is imperative to support the research aims and objectives; however, the implications to the study could be experienced if insufficient participants (appropriate and relevant to the study design) are not recruited (Ellard-Gray *et al.*, 2015). Snowball sampling has been included in this qualitative study design especially due to the period when the research was conducted – e.g. at the start of the COVID-19 pandemic. As a result, this strategy was implemented to help increase awareness among doctors and nurses (Naderifar, Goli and Ghaljaie, 2017; Chambers, Bliss and Rambur, 2020) in addition to using social media, where it has been evidenced as an effective recruitment method for medical research studies (Topolovec-Vranic and Natarajan, 2016; Christensen *et al.*, 2017) for greater efficiency and exposure of the research.

Elsewhere, the pilot testing of conducting a qualitative interview enabled the researcher to reflect on their role during the interview process in eliciting data. For example, it was possible to reflect and understand whether the questions asked were repetitive and whether the answers given were the same or similar, prompting the questions' relevance. Additionally, it was the opportunity to learn how to manage the interview throughout, for example, technical difficulties that may affect the interview qualities and possible silences to build the researcher’s ability to communicate clearly with the participant (Johnson, Scheitle and Ecklund, 2021; Thunberg and Arnell, 2022)

Given the thought that went into its development, it was hoped that the final semi-structured interview guide could contribute to a better understanding of the topic (Kallio *et al.*, 2016), with the structure provided clear guidance for the interview to stay focus on one topic area at any one time. Thus, participants could be encouraged to provide examples related to the sub-topic.

2.2.5 Data analysis

2.2.5.1 Data preparation

The semi-structured interviews were digitally recorded using Open Broadcaster Software (OBS) Studio, a free, open-source, cross-platform screen casting and streaming app downloaded onto the computer. Following interviews, the MVK files were remuxed to MP4 to be read and used for the transcription process, where it was transcribed verbatim by the researcher/ interviewer over two steps. Firstly, audio files were uploaded into the Otter.ai software, an automatic transcription software, and transcribed online – note that the audio files were subsequently deleted from the online platform and stored in the university's cloud with all password-protected computer files. Secondly, the researcher manually reviewed each transcript to check for accuracy against the original audio and made corrections accordingly. Participants' personal information and identifying details were removed from transcripts to ensure anonymity. Each transcript was given a unique identification number and kept in a separate digital file from the original raw transcript with the participant's identifiable number. Each transcript was then uploaded onto NVivo 12 Plus (QSR International) for analysis.

2.2.5.2 Steps to Thematic Analysis (Braun and Clarke, 2006)

Data were analysed using thematic analysis, which is widely used in qualitative research to identify themes developed from the data collected (Braun and Clarke, 2006; Nowell et al., 2017). The use of thematic analysis facilitates flexibility in interpreting the data gathered and helps provide a better understanding of the what, why and how behind participants' reasonings in response to the research's aims (Braun and Clarke, 2006; Kiger and Varpio, 2020). Hence, a thematic analysis helps identify, analyse, organise, describe, and report themes (Braun and Clarke, 2006; Nowell *et al.*, 2017).

Inductive thematic analysis was used for this study, which is the *"process of coding the data without trying to fit it into a preexisting coding frame or the researcher's analytic preconceptions"* (Braun and Clarke, 2006; Nowell *et al.*, 2017). This meant that the data collected did not use a pre-existing list of themes related to the topic, as the knowledge of doctors' nutrition is still relatively limited (see Chapter 1: Literature Review). As a result, Braun and Clarke (2006) support the method for identifying themes and explicitly list six steps to follow; these are detailed below, including how the researcher approached each step.

2.2.5.2.1 Phase One: Familiarising yourself with your data

Phase One suggests that the researcher actively immerse and engage with the data by re-reading the transcripts. This allows the researcher to fully understand the content to provide foundation knowledge of the data.

The researcher conducted all the interviews for this study, checked all the transcripts themselves, and re-read them for familiarisation. In addition, initial thoughts and ideas related to the data were briefly noted on a file to support familiarisation.

2.2.5.2.2 Phase Two: Generating initial codes

Phase Two suggests that the researcher generate initial codes representing the data meaningfully. These codes are limitless and specific to the data.

For this study, the researcher interrogated the transcripts line-by-line through an open-coding-inductive approach, using NVivo 12, with no initial restrictions on the types and the number of codes (the number of initial codes was 187, then subsequently 31). Here, short statements or phrases that captured the meaning were noted and put under initial codes in NVivo. For example, *"…I guess, in the jobs that have increased amounts of shift changes and switches. Sleep is hugely affected. I think it can, you know, switching from nights to days is never easy at all. I think I always thought it* *would get easier the more I do it; actually, I find it much harder to do."* – here, this was 'coded' as 'rota impact overall health – sleep'. Also, participants' quotes could sometimes be used as an initial code where appropriate.

The researcher remained open by interrogating each transcript, ensuring equal attention was given to determining themes or patterns. This provided the opportunity to generate any unexpected new themes.

2.2.5.2.3 Phase Three: Searching for themes

Phase Three suggests streamlining the codes generated from the previous phase to provide a higher level of themes by collating similar topics. This is the start of the interpretive analysis.

For this study, data from the list of codes generated from the previous phase were organised, consolidated, and refocused to create themes relevant to the study's aim and objectives. Overarching and sub-themes were identified from the codes. To support this process, the researcher developed initial thematic diagrams (codes grouped/ organised under higher-order themes in PowerPoint) to allow visual mapping of the information to view the inter-relationship between the codes for each topic question. As participants included DNs, there were two sets of diagrams illustrating the codes relevant to each profession for each interview question – initially giving 48 diagrams with an average of at least 20 codes per diagram. However, as the themes overlapped, datasets were combined to help under the nutritional experiences of health professionals.

2.2.5.2.4 Phase Four: Reviewing themes

Phase Four suggests reviewing and refining the previous phase's themes to combine, separate, or discard the initial themes. It recommends checking themes using a two-level approach. Firstly, the themes should be checked according to the extracts, and secondly, they should also be checked against the overall dataset.

The 48 diagrams from the previous phase were used for this study. As suggested by Braun and Clarke Field (2006), codes were refined. All data extracts against each code were re-read to determine if they aligned with other data within the theme and that allocated code to check for relevance. Secondly, the whole dataset was re-examined to determine if the themes reflected the data and were identifiable to provide meaningful distinctions and relevance to the topic questions and the study's objectives.

If, for any reason, themes did not align during Phase Four to provide a meaningful representation, they were re-examined with the original interview extracts to determine if they should either be 're-housed or merged' with another theme or discarded. The researcher continued to use the diagrams to support this process: the initial 48 diagrams were consolidated into 12 specific diagrams, six for doctors and nurses (to coincide with the six umbrella topic questions as noted in Table 6, during the design of the interview questions), where themes continued to be kept separately at this point.

The next step required grouping the themes and sub-themes into more coherent and higher-level headings to meet the overall study's aim and objectives. Both doctors' and nurses' themes remained combined as developed themes overlapped with both occupations working in the same working environment. Next, the sub-themes from the 12 diagrams were re-examined again. This process was done manually using paper and pen, grouping all common themes across the study where applicable, deleting duplicate themes, merging similar themes, and identifying higher and sub-themes within the grouped themes. For example, determining if those themes were evidently "themes" or could be embedded with other themes. Following this manual process, a high-level qualitative thematic figure (Figure 9) was developed comprising the five overarching themes and sub-themes.

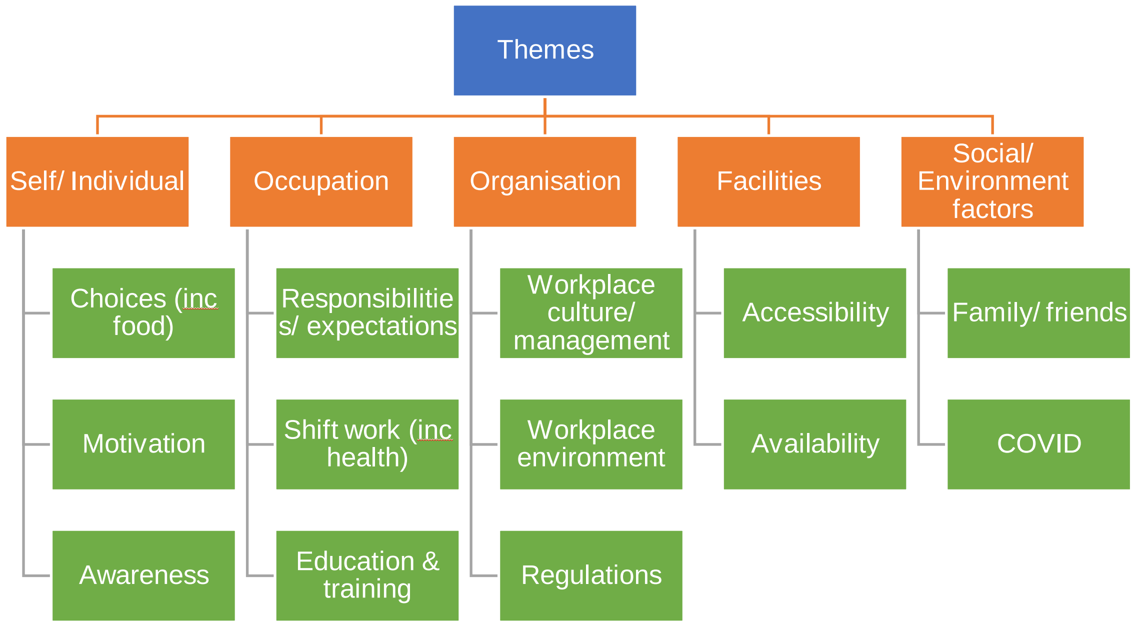

Figure 9: High-level qualitative thematic figure derived from the interviews.

2.2.5.2.5 Phase Five: Defining and naming themes

Phase Five suggests refining and defining the themes from the data to enhance the identified themes further, capturing the meaning of the data.

As noted above, while themes overlapped across the study for the current study, each theme was distinct and had its focus. Therefore, themes and sub-themes were listed and described for this stage, see Table 7.

Table 7: Definitions for the overarching themes from the interviews.

Overarching themes	Definition
Self/ individual	Issues related to the individual with external influences/ factors/ stimuli impacting their actions, choices, beliefs, motivation, awareness, sense of self-worth
Occupation	Anything related to the participant's job description. For example, working hours, responsibilities, or

	professional development and its impact on the individual
Organisation	At the organisation level, it is shared with members of the organisation and represents the individuals collectively.
Facilities	Any nutrition and health-related facilities and services available for the individual during their working hours
Social/Environmental factors	Physical and social stimuli surrounding the individual's environment in which they live

With the thematic figure and definitions produced (Figure 9 and Table 7), the extracts under the already defined themes and subthemes were re-read not to generate new codes but to confirm their suitability. Subsequently, a supervisory team meeting was held to discuss the themes and ascertain their representation and accuracy. All supervisors received a copy of the original list of codes, codes' reports, and a random sample transcript to check the themes' suitability. The discussion resulted in minor refinements, such as defining the themes distinctively with justifiable rationales of having them as stand-alone codes and deciding how best to group the themes for the resulting chapters. To check if the defined themes aligned with the existing dataset (Figure 9 and Table 7), existing data were re-coded in NVivo using the final themes and sub-themes.

2.2.5.2.6 Phase Six: Producing the report

Phase Six suggests using the identified themes and interpreting the data analysis into a narrative with extracted examples to provide the reader with the merit of the evidence collected.

Based on Figure 9, which shows the themes and subthemes for this study, two results chapters will address this study's aim and objectives. The first chapters will focus on understanding doctors' eating behaviours during shift work, exploring their current diet (i.e., eating practices), and how it impacts their health. The second chapter seeks to understand the barriers and facilitators to good workplace nutrition. These factors include the individual's characteristics, occupation, organisational context, current facilities, and the overall working environment. Additionally, the second chapter explores potential interventions and strategies that can foster improved workplace nutrition, specifically emphasising doctors' wellbeing and dietary needs.

2.2.6 Ethics

Two ethics submissions and related approvals were obtained from the University of Westminster College of Liberal Arts and Sciences Ethics Committee (refs: ETH1920-0694 and ETH2021-0473). Section 2.2 of this chapter details the amendments of the second ethics submission to include GPs and nurses due to the implications of recruitment during the COVID-19 pandemic and enabling the opportunity to compare and contrast the workplace nutrition between the two professions working in a similar environment.

General Data Protection Regulation (GDPR) 2016/679 is the UK regulation that governs the processing of personal data to ensure that individuals (i.e., in this study's case, are the participants). As semi-structured interviews were conducted online due to the pandemic, Google Meet and Skype, both GDPR compliant, were used to conduct the online interviews. The data collected were kept and stored confidentially according to the university policy and considered in the GDRP guidelines, such as all computer data files being encrypted and password-protected.

The interviews raised potentially sensitive topics for participants, e.g., moods and emotions during shift work. Thus, measures were put in place to reduce the risk of distress. Firstly, it was made clear to participants the topics that would be covered in the interviews: the Participant Information Sheet (PIS) was provided before the interview outlining the details, topics to be covered, and the research purpose. Participants were also informed of withdrawing from the study before, during, or after the interview without any reason. Secondly, a Sensitivity Protocol (Appendix 6) guided the interview. This was adapted from the research supervision team's previous experiences in researching sensitive areas. For example, this included monitoring participants' distress during the interview and supporting the researcher and the participants. Participants were reminded that they did not need to share or disclose any information or experiences they did not wish to. During the interview, the interviewer assessed participants for any signs of distress. Participants had the opportunity to take breaks and/or leave when they liked, reducing the possibility of stress.

For participant confidentiality, audio files were transcribed verbatim by the doctoral researcher with the support of Otter.ai software. Transcripts were checked manually, and any personally identifiable information was removed. A unique participant number was assigned to each participant to identify participants. Health professionals' contact details and personal data were kept in a separate database from the transcripts and password-protected. All electronic copies of consent forms and other electronic data were stored on the University of Westminster H-drive and OneDrive in a password-protected file.

Data reported in any reports, papers, and thesis (via common themes) were anonymous, and any identifying details were removed if quotes were included.

2.2.7 Researcher's position

Cutcliffe's (2003) definition of the 'researcher's position', *'the credibility of the findings by accounting for researcher values, beliefs, knowledge, and biases',* highlights the importance of being reflexive to produce good qualitative research. The researcher's viewpoint in qualitative research is to seek the '*why*' behind the actions and thoughts on how they might impact the individual's behaviours. Unlike quantitative research, the researcher can consider and reflect on the data gathered and their place in the research process. Thus, this is to adopt a different standpoint, not avoiding subjectivities and biases but rather safeguarding the participants and their data. Here, I attempt to outline my position in this study, giving the reader a clearer sense of my approach to the research.

I previously completed a BSc(Hons) in Human Nutrition and was quantitatively trained with my dissertation project on 'Evaluating the effects of physical activity intervention on risk factors of cardiovascular diseases and obesity' (Sum and Tewfik, 2018). This project also involved gaining experience in a cohort study, recruiting university employees for a physical activity intervention, and examining their health status.

Following this, I further completed an MRes Clinical Research (Human Nutrition) with my research focusing on "Barriers to tracking nutrition consumption and possible solutions" to explore mobile apps' current and future possibility and their contribution to nutrition goals. A systematic review and a qualitative study were conducted to understand the barriers individuals experienced to their desired nutrition outcomes and identify if technologies would aid them in fulfilling their nutrition objectives. With limited qualitative training, my MRes was very much "learning as I went along" in the limited ~ six months and predominantly based in a design engineering school with a diverse supervisory team of a design engineer, sensory and consumer scientist, and a dietitian. Though this gave me insights into other disciplinary lenses, my qualitative research method training could be considered somewhat untraditional.

The struggle to understand qualitative research is still somewhat intriguing – I have always been interested in extending my knowledge into the social sciences and connecting this with my nutrition background. Yet, this paradigm shift of switching between my quantitative and newly acquired qualitative knowledge is something I continue to develop to the best of my ability through this study.

This study's topic of doctors' nutrition experience during their shift work allows me to delve into an area where I wanted to understand from a behaviour lens – more so, the rationales of the attitudes and beliefs – of nutrition experience. Thus, the process from participant recruitment to interviews and data analysis pieces my prior nutrition knowledge of the casual associations and goes deeper into the psychological understanding of individuals' perceptions to undertake those initial actions.

With the lack of professional engagement with this professional group before this study, my initial understanding of doctors' occupational experience was somewhat superficial. When I was employed, my working hours were not irregular; thus, I did not have personal experience with what hospital shift work might be like. My experience with doctors has predominantly been a patient, where I have often been misdiagnosed, left undiagnosed, or depersonalised, or my patient knowledge and experience were undervalued. Therefore, before conducting this research, my view was somewhat open, knowing the study's aim was not about their medical knowledge and patient-doctor relationship but rather about their nutrition experience and health as individuals.

I continue to learn, adapt, and be flexible with this research process, with the key lesson that qualitative research is very different from quantitative study. Further, learning to 'let go' and enabling the data to tell the narrative, rather than trying to fit the results into a framework or model with no opportunity to uncover the possible unseen and unanticipated knowledge that may arise. Another implication during this process was the mixed research experience and background within the research team. While this may bring initial confusion about how I proceed with the study, the team's feedback and guidance provide opportunities to understand different perspectives when interrogating the same data without diverging from what this study aims to convey.

Table 8: Participants' Key Characteristics

Participant No.	Age	Ethnicity	Gender	Occupation	Specialism	Years worked in their role
1	25-34	Asian/ Asian British	Female	GP trainee	Geriatrics	<6 months
2	35-44	White	Male	Specialist Registrar (also Post CCT Fellow)	Anaesthetics	6 months – 1 year
3	25-34	White	Female	Specialist Trainee (ST3)	Intensive Care Medicine	
4	45-54	Asian/ Asian British	Female	Salaried GP	General Practice	11 – 20 years
5	25-35	Asian/ Asian British	Female	Registrar ST8	General Surgery	2 – 5 years
6	45-54	Asian/ Asian British	Female	Speciality Doctor	Psychiatry	6 – 10 years
7	35-44	White	Female	Junior Sister, Nurse	HIV and Oncology	2 – 5 years
8	35-44	White	Female	(Emergency Care Practitioner) Nurse	Emergency Medicine	2 – 5 years
9	45-54	White	Female	Nurse	Community	6 – 10 years
10	35-44	White	Female	GP	General Practice	6 – 10 years
11	25-34	White	Female	Consultant	Paediatrics & Child Health	<6 months
12	18-24	White	Female	Nurse	Paediatrics	<6 months
13	25-34	White	Female	Specialty Trainee Doctor	Acute Medicine	2 – 5 years

14	56-65	Asian/ Asian British	Male	Doctor	Intensive Care Medicine	>21 years
15	35-44	Asian/ Asian British	Female	GP	General Practice	6 – 10 years
16	45-54	White	Female	Nurse	Anaesthetics	11 – 20 years

2.3 Quantitative Study Design – UK Biobank

2.3.1 Introduction

Shift work has been evidenced to contribute to healthcare professionals' poor health outcomes, as supported in our earlier chapter (see Chapter 1, Literature Review). In addition to our qualitative study's findings (see Chapters 3 – 4), previous research further indicates the challenges and barriers doctors and nurses experience during shift work to maintain satisfactory health status. For example, shift work impacts overall health and wellbeing, such as poor cognitive function and performance, and its association with sickness and stress (Leedo *et al.*, 2017; Persico *et al.*, 2018; da Silva *et al.*, 2021b) due to their high clinical workload, leaving limited time to look after themselves. In addition, shift work contributes to poor dietary choices due to various determinants influencing food choices (Booth et al., 2001; Monaghan et al., 2017), as evidenced in our earlier work (see Chapters 3 – 4). Though the literature has identified barriers to good workplace nutrition, to our knowledge, no studies have yet utilised large datasets examining the impacts of different shift work patterns, such as day, night, and weekend shifts, on UK DNs' nutrition intake. Considering the limited research, this investigation employed a quantitative analysis using the UK Biobank.

Established by the Medical Research Council and the Wellcome Trust, the UK Biobank is a large prospective cohort study of 40-69-year-olds from the general population based in England, Scotland and Wales – see Sudlow *et al.* (2015) for the detailed research method. In brief, over 500,000 participants, both men and women, between 2006 and 2010 were recruited from within 25 miles of an assessment centre via the National Health Service central registers, providing an extensive collection of phenotypic and genotypic data. Previous studies have provided evidence to emphasise the need to explore the relationship between the environment and individuals' lifestyles (Shepherd, 1999a; Booth *et al.*, 2001; Gedrich, 2003; McNaughton *et al.*, 2012). Therefore, this open-access resource facilitates researchers in reporting on the interactions between health outcomes, determinants, and baseline characteristics to assess health issues in the general population. The baseline characteristics in the UK Biobank data include a touchscreen online questionnaire, a verbal interview and comprehensive physical measures (Figure 10

(Sudlow *et al.*, 2015)). Such methods were important to enable a large number of participant recruitment while the ability to collect results efficiently.

Questionnaire and interview	
Sociodemographic	Social class; ethnicity; employment status; marital status; education; income; car ownership
Family history and early life exposures	Family history of major diseases; birth weight; breast feeding; maternal smoking; childhood body size; residence at birth
Psychosocial factors	Neurosis; depression (including bi-polar spectrum disorder); social support
Environmental factors	Current address; current (or last) occupation; domestic heating and cooking fuel; housing; means of travel; shift work; mobile phone use; sun exposure
Lifestyle	Smoking; alcohol consumption; physical activity; diet; sleep
Health status	Medical history; medications; disability; hearing; sight; sexual and reproductive history
Hearing threshold	Speech reception threshold*
Cognitive function	Pairs matching; reaction time; prospective memory*; fluid intelligence*; numeric memory†
Physical measures	
Blood pressure and heart rate	two automated measures, one minute apart
Grip strength	Left- and right-hand grip strength
Anthropometrics	Standing and sitting height; weight and bio-impedance; hip and waist circumference
Spirometry	Up to three measures
Bone density‡	Calcaneal ultrasound
Arterial stiffness¶	Pulse wave velocity
Eye examination§	Refractive index, intraocular pressure; acuity; retinal photograph; optical coherence tomography
Fitness test§	Cycle ergometry with electrocardiogram (ECG) heart rate monitoring

* assessed in 170,000 participants;
† assessed in 50,000 participants;
‡measured in one heel for 170,000 participants and in both heels for 320,000 participants;
¶ measured in 170,000 participants;
§ measured in 100,000 participants

doi:10.1371/journal.pmed.1001779.t002

Figure 10: Data collected at the baseline assessment of the UK Biobank dataset (Sudlow et al., 2015)

Given the UK Biobank dataset's relevance to DNs and its comprehensive data, utilising it as our research approach is a logical choice to bridge the existing knowledge gap in the literature.

2.3.1.1 Research aim

Using the UK Biobank database, our research aims to characterise and investigate the differences in dietary intake between UK DNs with different shift work patterns.

2.3.1.2 Research objectives

1. To explore the dietary intake/ dietary quality between UK doctors and nurses at work.

2. To determine the impact of different shift work patterns on dietary intake/ diet quality in UK doctors and compare that against nurses at work.

<u>2.3.2 Participants</u>

The UK Biobank dataset participants were volunteers who agreed to provide extensive data on their health, illness, and incapacitation over time. Participants also had the opportunity to withdraw from the UK Biobank at any time without providing any reasons. Further details on participant recruitment and the data collection processes can be found in Sudlow *et al.* (2015).

To find participants who were doctors and nurses with shift work that addressed our study's aim, we used the UK Biobank filtering system under the "Search" tab on the website (https://biobank.ctsu.ox.ac.uk/crystal/search.cgi). Our participant inclusion criteria specifically for our study were:

- UK Biobank Job code at visit: 'medical professionals' (data field: 22113066 - medical doctor, general practitioner, hospital consultant) and 'nurse' (32113072 – nurse, of any kind, at any level)
- All participants answered 'sometimes', 'usually' or always' to data fields 826 (Job involves shift work) and 2436 (job involves night shift work).

Only the variables of interest were extracted with results from the two above criteria were then subsequently exported to a folder downloaded into the researcher's password-protected laptop and backed up onto the institution's online cloud (see Ethics section, Section 5.4)

2.3.2.1 Variables/ data collection

Of specific interest to our present study were the 5,777 participants of doctors (n=1,962) and nurses (n=3,815) with shift work. Participants were assessed based on the characteristics highlighted in Figure 1. To address our research question and aim, we assessed the dataset on the DNs' diet and their working patterns. We used the following fields to facilitate our understanding of our research aim:

- Sociodemographic (Category ID 100063)
- Lifestyle and environment (Category 100050)
- Health and medical history (Category 100036)
- Age diabetes diagnosed (Category 100044)
- Employment (Category ID 100073)
- Blood pressure (Category ID 100011)
- Anthropometry (Category ID 100008)
- Employment history (category 130)
- Food preference (category 1039)
- Diet by 24-hour recall (category 100090)
- Family history (Category 100034)

A MySQL database was created to import the UK Biobank data after suitable participants were identified from the dataset. SQL queries were then written to obtain the participants' required variables (see Appendix 7 – 8). To assess our research question, we used the data at its baseline, the initial assessment visit, for direct comparisons between DNs and across all variables to ensure consistency (see Appendix 7 – 8).

2.3.2.2 Assessment of food consumption

Total vegetable intake

Total vegetable intake was calculated using equations from previous studies on the UK Biobank dataset (Bradbury *et al., 2*017; Bradbury *et al.*, 2018; Bradbury *et al.,* 2020; Hepsomali and Groeger, 2021b, 2021a). Participants directly entered the number of tablespoons of cooked vegetables, salad, and raw vegetables consumed daily. If none was consumed, participants selected the ‘less than one’, ' do not know’, or ‘prefer not to answer’ options. As a guide, one serving represented two tablespoons of vegetables. The total vegetable intake was the sum of the cooked vegetable intake (Field ID:1289) and the salad/ raw vegetable intake (Field ID 1299). Results with “more than 50” were rejected and automatically excluded from the dataset. The overall results were grouped by the following categories: <2.0 servings per day, 2.0-2.9 servings per day, 3.0-3.9 servings per day, and ≥4.0 servings per day.

Total fruit intake

Total fruit intake was calculated using equations from previous studies on the UK Biobank dataset (Bradbury *et al., 2*017; Bradbury *et al.*, 2018; Bradbury *et al.,* 2020; Hepsomali and Groeger, 2021b, 2021a). Participants directly entered the number of pieces of fresh fruits and dried fruits they consume a day. If none was consumed, participants selected the ‘less than one’, 'do not know’, or ‘prefer not to answer’ options. As a guide, one piece of fresh fruit and two pieces of dried fruit were counted as a serving. The total amount of fruit intake was the sum of the fresh fruit intake (Field ID 1309) and the dried fruit intake (Field ID 1319). Results with ‘more than 50’ were rejected and automatically excluded from the dataset. The overall results were grouped by the following categories: <2.0 servings per day, 2.0-2.9 servings per day, 3.0-3.9 servings per day, and ≥4.0 servings per day.

Total meat intake

Total meat intake was calculated using equations from Papier *et al.* (2021) on the meat intake of men and women from the UK Biobank dataset. Participants entered the number of times they consume meat weekly. Responses (‘never’, ‘less than once a week’, ‘once a week’, ‘2-4 times a week’, ‘5-6 times a week’ and ‘once or more daily’) from each of the five questions, (see Papier *et al.* (2021) for details) were converted into its weekly intake equivalents (0, 0.5, 1, 3, 5.5 and 7 times). The total intake frequencies for all meat types were then categorised into the following groups: <3, 3-4, 5-6, and ≥7 times per week. Total meat intake was constructed by summing all meat types together: unprocessed red (consists of beef intake (Field ID 1369), Lamb/ mutton intake (Field ID 1379), and pork intake (Field ID 1389)) and processed meat (consists of processed meat (Field ID 1349) and poultry intake (Field ID 1359)).

Total unprocessed red meat intake

Total unprocessed red meat intake was calculated using the equation from previous studies using the UK Biobank dataset (Bradbury *et al., 2*017; Bradbury *et al.*, 2018; Bradbury *et al.,* 2020; Hepsomali and Groeger, 2021b, 2021a). Participants inputted the number of times they consumed each item with possible answers of: 'never'. 'less than once a week', 'once a week', '2-4 times a week', '5-6 times a week', 'once or more daily', 'do not know', 'prefer not to answer'. To rank the participants by weekly red meat intake, the total frequencies for beef (Filed ID 1369), pork (Field ID 1389), and lamb/ mutton (Field ID 1379) were coded according to the following: 'never' = 0, 'less than once a week' = 0.5, 'once a week' = 1, '2-4 times a week' = 3, '5-6 times a week' = 5.5, 'once or more daily' = 7. Subsequently, categories for unprocessed red meat intake servings were: <1.0, 1.0-1.9, 2.0-2.9, 3.0-3.9, and >4. Bradbury *et al.* (2017) further classify types of meat eaters based on: high meat-eaters (three or more times a week) and low meat-eaters (fewer than three times a week).

Total fish intake

Total fish intake was calculated using the equation from previous studies using the UK Biobank dataset (Bradbury, Murphy and Key, 2020; Hepsomali and Groeger, 2021b, 2021a). First, participants inputted the number of times they consumed oily fish (Field ID 1329) and non-oily fish (Field ID 1339) with the possible answers being: 'once or more daily', 'do not know', 'prefer not to answer'. Data were then converted into weekly intake equivalents of: 'never' = 0, 'less than once a week' = 0.5, 'once a week' = 1, '2-4 times a week' = 3, '5-6 times a week' = 5.5, 'once or more daily' = 7. Subsequently, frequencies for total fish intake were grouped into the following categories: <1.0 times per week, 1.0-1.9 times per week, 2.0-2.9 times per week, and ≥3.0 times per week.

Cheese intake

The total cheese consumption was calculated using equations from a previous UK Biobank study (Bradbury, Murphy and Key, 2020). Participants were asked how often they consumed cheese (Field ID 1408) per week with the following possible answers: 'never, 'less than once a week', 'once a week', '2-4 times a week', '5-6 times a week', 'once or more daily', 'do not know', 'prefer not to answer'. Answers were then coded between 0 and 7, respectively, on the list. Subsequently, cheese intake was categorised by combining the bottom two and top frequencies: <1.0 times per week, 1.0 times per week, 2.0-4.9 times per week, and ≥5.0 times per week.

Milk intake

Total milk intake was calculated using the equations from previous studies using the UK Biobank dataset (Bradbury, Murphy and Key, 2020; Hepsomali and Groeger, 2021b, 2021a). The calculation was based on the following fields: milk type used (Field ID 1418), cereal intake (Field ID 1458), tea (including black and green tea) intake (Field ID 1488), and coffee (including decaffeinated coffee) intake (Field ID 1498). First, participants were asked about the milk type used and coded as follows: 'full cream' = 1, 'semi-skimmed' = 2, 'skimmed' = 3, 'soya' = 4, 'other type of milk' = 5, and 'never/ rarely have milk' = 6. For participants who selected: 'full cream', 'semi-skimmed', or 'skimmed', their total milk consumption was estimated by summing up their daily consumption, assuming that 100ml of milk is added to one (each) bowl of break cereal, 35ml of milk to one (each) cup of tea, and 25ml of milk to one (each) cup of coffee. (Note that the touchscreen did not ask participants if they did not add milk to tea or coffee.) Participants were then divided into three categories based on their total milk consumption: <150 mL of milk, 150-299 mL of milk, and ≥300 mL of milk daily.

Tea and coffee intake

Tea and coffee intake were calculated using the equations from previous studies using the UK Biobank dataset (Bradbury, Murphy and Key, 2020). Participants were asked to input the number of cups of tea, including black and green tea (Field ID 1488), and coffee, including decaffeinated coffee (Field ID 1498), they drank daily. Other data inputted included 'less than one', 'do not know', or 'prefer not to answer'. Tea consumption was categorised as <2.0 cups per day, 2.0-3.9 cups per day, 4.0-5.9 cups per day, and ≥6.0 cups per day. For coffee, data were grouped according to the following: 0 cups/day, 0.5-1.9 cups per day, 2.0-2.9 cups per day, and ≥3.0 cups per day.

Water intake

Water intake was not calculated based on any previous studies. Participants were asked to input the number of glasses of water consumed per day into the questionnaire. Water intake was subsequently categorised based on the number of glasses per day, from 0 to 8 increments, and more than eight glasses daily.

Alcohol intake

Alcohol intake was calculated using equations from previous studies using the UK Biobank dataset (Lourida *et al.*, 2019). Participants were asked about their alcohol drinker status (Field ID 20117) and alcohol intake frequency (Field ID 1558). The latter was measured and converted into its numerical codes based on the following answers: ‘prefer not to answer’ = -3, ‘daily or almost daily’ = 1, ‘3-4 times a week’ = 2, ‘once or twice a week’ = 3, ‘one to three times a month’ = 4, ‘special occasions only’ = 5, and ‘never’ = 6. Participants also inputted their average weekly and monthly intake (in the number of glasses) of the following: average weekly red wine (Field ID 1568), average weekly champagne plus white wine (Field ID 1578), average weekly beer plus cider (Field ID 1588), average weekly spirits intake (Field ID 1598), average weekly fortified wine (Field ID 1608), average weekly intake of other alcoholic drinks (Field ID 5364), average monthly red wine (Field ID 4407), average monthly champagne (Field ID 4418), average monthly beer plus cider (Field ID 4429), average monthly spirits (Field ID 4440), average monthly fortified wine (Field ID 4451), and average monthly intake of other alcoholic drinks (Field ID 4462). Data were subsequently converted from glasses to grams of pure alcohol, according to Lourida *et al.* (2019).

2.3.2.3 Assessment of diet and calculations of dietary quality score

Partial fibre score

The partial fibre score was calculated using equations from previous studies using the UK Biobank dataset (Bradbury *et al.*, 2018; Hepsomali and Groeger, 2021a, 2021b). Food items used for this equation were the following: fresh fruit (Field ID 1309), dried fruit (Field ID 1319), cooked vegetables (Field ID 1289), raw vegetables (Field ID 1299), bread type (Field ID 1448), bread intake (Field ID 1438), breakfast cereal type (Field ID 1468), and breakfast cereal intake (Field ID 1458). The above list of food items was assigned to its portion size in grams based on the standard (Food Standards Agency *et al.*, 1994) with the approximate non-starch polysaccharide content, based on McCance and Widdowson's The Composition of Foods (McCance and Widdowson, 2014). Subsequently, each food item's fibre content was multiplied by the frequency of consumption, where those with 'less than one' were coded as 0.5. For bread and breakfast cereal, inputted results were converted into daily average by dividing the answer by 7 (converting the frequency of consumption from per week to day). Finally, all fibre content from each food item was summed up for the total daily estimated partial fibre intake. If participants selected 'prefer not to answer' or 'do not know' to any questions, they were coded as missing in the calculation. Based on the cohort's quintile splits, each participant's partial fibre score was categorised into low, low/medium, medium/ high, and high.

Healthy diet score

The Healthy Diet Score was calculated using equations from previous studies using the UK Biobank dataset (Lourida *et al.*, 2019; Hepsomali and Groeger, 2021a, 2021b; Papier *et al.*, 2021). The Healthy Diet Score consists of seven categories. It is deemed healthy if 4 out of the seven healthy behaviours meet the required criteria: fruits (≥3 servings/day), vegetables (≥3 servings/day), fish (≥2 servings/week), processed meats (≤1 serving/week), unprocessed red meats (≤1.5 servings/week), whole grains (≥3servings/day), and refined grains (≤1.5servings/day). Subsequently, the total healthy diet score is then categorised according to the increments of the score (from 0 – 7).

2.3.2.4 Assessment of diet intake against different shift work patterns

Objective two of this study explores the impact of different shift work patterns on dietary intake in DNs from the UK Biobank dataset. Using the calculations above for the dietary intake, shift work patterns were calculated for DNs to measure their association with dietary consumption. MySQL (an open-source relational database management system) determined the number of DNs with specific working hours/ patterns.

Work hours and jobs with shift work were categorised based on the following variables: job coding (Field ID 22601), work hours (Field ID 22604), work hours per week (22605), and the job involved shift work (Field ID 22620). Four questions were considered using these fields: 1) the number of DNs within the UK Biobank dataset, 2) the number of hours DNs worked per week, 3) the number of doctors with shift work and the hours they worked per week, and 4) the number of nurses with shift work and the hours they worked per week.

Day and night shifts were calculated for DNs using the following variables: a mixture of day and night shifts worked (Field ID 22640), the period spent working a mix of day and night shifts (Field ID 22641), the usual length of each night shift during mixed shift periods (Field ID 22642), number of night shifts worked monthly during mixed shift periods (Field ID 22643), consecutive night shifts during mixed shift periods (Field ID 22644), rest days during mixed shift periods (Field ID 22645). Ten questions were considered using these fields: 1) the number of doctors with a mixture of day and night shifts, 2) the number of doctors and the period spent working a mix of day and night shifts, 3) the number of doctors and the length of each night shift during mixed shift period, 4) the number of doctors and the night shifts worked monthly, 5) number of doctors with consecutive night shifts, 6) the number of nurses with a mixture of day and night shifts, 7) the number of nurses and the period spent working a mixture of day and night shifts, 8) the number of nurses and the length of each night shift during mixed shift period, 9) the number of nurses and the number of night shifts worked monthly, and 10) the number of nurses with consecutive night shifts.

2.3.3 Statistical analyses

All data analyses were performed in IBM SPSS Statistics 28.0. It involved analysing secondary data on lifestyle and health collected by the UK Biobank. Descriptive data were used to summarise the outcomes of each dietary component under section 2.3.1 of this chapter. Thus, a non-parametric test, Mann-Whitney U, was used to assess the association between dietary intake and DNs to test the trends between the two independent groups derived from the same dataset population. (Mann-Whitney U test was used as the population distribution was unknown between doctors and nurses; for example, there were more nurses in the UK Biobank sample than doctors.

Therefore, in the case of this thesis, parametric tests such as t-tests, Pearson's, or ANOVA were not used when the population distribution of the sample needed to be known.) The confidence interval was 95% with a significance level of 0.05. Answers from the UK Biobank respondents with either 'do not know' or 'prefer not to answer' were treated as missing values in the dataset and were excluded from data analysis.

SPSS was also used to perform all the data analyses to assess objective two, examining the impact of dietary intake on shift work patterns. Similarly, descriptive data were used to summarise the population's demographics between DNs. The Kruskal–Wallis test was used instead of a Mann-Whitney U test due to the number of shift work pattern groups. The confidence interval was 95% with a significance level of 0.05. Answers from the UK Biobank respondents with either 'do not know' or 'prefer not to answer' were treated as missing values in the dataset and were excluded from data analysis.

Variables were selected based on their relevance to our research study's aim and objectives and previous research (See Section 5.2 of this chapter). Predominantly, variables associated with dietary consumption and quality, such as food items, were included.

2.3.4 Ethics

Approval was obtained from the UK Biobank (UK Biobank Application 66159). An ethics submission and related approvals for a Material Transfer Agreement to access the UK Biobank database were also obtained from the University of Westminster's College of Liberal Arts and Sciences Ethics Committee (refs: ETH2021-0784).

General Data Protection Regulation (GDPR) 2016/679 is the UK regulation that governs the processing of personal data to ensure that individuals (i.e., in this study's case, the participants). The data received from the UK Biobank were kept and stored confidentially according to the university policy and considered in the GDRP guidelines, such as all computer data files encrypted and password-protected.

CHAPTER 3: QUALITATIVE STUDY RESULT 1 – DOCTORS' AND NURSES' EATING PRACTICES

This chapter aims to explore the current eating practices of DNs during their shift work. More specifically, to understand their eating behaviours on working days, such as the food they consume and the eating practices associated with that throughout the day. To achieve this research aim, the interview data will outline our participants' dietary intake and practices before, during, and after a shift and, where applicable, compare against their practices on non-working days. Findings will be presented in six sections. The first section examines the dietary intake and behaviour (i.e., what was eaten) before participants start a shift. This will be followed by eating practices during their shift, the food consumed if working long shifts, and after their shift. The fifth section considers dietary consumption during the night shift. The final section seeks to understand variations in eating behaviours on non-working days.

3.1 Eating practices on working days

3.1.1 Eating practices before work

Our participants showed a mixed response regarding whether they would consume food (i.e., breakfast) at home before going to a shift. For those who prioritise, breakfast would consist of a cup of tea or coffee with carbohydrate-based food (e.g., cereal such as Weetabix or bread/ toast) complementing a dairy-based food product (e.g., yoghurt or milkshake) and some fruits. To note, changing seasons also contributed to consuming more berries and fruits during the summer to help increase fibre intake. Here, doctors indicated their motivation and awareness of being healthy in their breakfast before work.

> *So I am usually at home for breakfast, but it will usually be cereal, so the granola type cereal, and trying to get ones with extra protein or fibre or something in them. And then, in the summer, a little bit better at putting fruity stuff in there as well. (Participant 1, female doctor)*

Our participants had the knowledge and intention to eat healthily and described the benefits of having breakfast before their shift. For example, working in an unpredictable environment and with constant occupational responsibilities, eating breakfast was noted to help regulate their mood and emotions, providing the necessary energy to sustain their long day shifts. Across the sample, participants defined day shifts as either a ‘long day’ (e.g., 07:45 – 18:00/ 07:45 – 20:30/ 08:00 – 21:00/ 08:30 – 21:30) or a ‘short day’ (e.g., 09:00 – 17:00/ 08:30 – 17:30/ 10:00-19:00), ranging between 8 – 13 hours shifts with no nights spent at the hospital. For example, consuming adequate calories and good nutritious breakfast food helped doctors maintain their energy until lunchtime, or sometimes, if there were no lunch or snack opportunities during their shift, until after work. Aside from providing physical energy, doctors shared feelings of negative moods and emotions if breakfast was not consumed, impacting their cognitive performance.

> *I always have breakfast before I go to work. Because if I don't eat, then I'm extremely grumpy and don't function very well. But I always have breakfast…at the moment, I normally either eat porridge or muesli in the mornings, partly because it's quick…it's something that will give me energy from any lethargic feelings that will last until the early afternoon if you don't get to have lunch earlier enough. (Participant 2, male doctor)*

Conversely, some participants would skip breakfast before work or be inconsistent with having their daily breakfast. Those skipping breakfast depended on the time before their workload began or the time of day and work duties, contributing to the decision to consume breakfast. For example, the type of work doctors did was also a factor, whether their shift would require long concentration and focus on their tasks. One surgeon recognised how conducting surgical operations could vary in length, depending on the procedures and complications. Hence, eating breakfast before their shift could prolong their hunger if eating opportunities were limited during their shift. Otherwise, these doctors noted that skipping breakfast and waiting until lunch would be typical.

> *It depends if I have time or not. And, or if I'm feeling like it…I don't eat breakfast unless I'm operating…But on the days I operate, I go to see patients, so I need*

to have some food, some substantial things, otherwise I might feel a bit unwell, and also you don't know when you're going to your next meal… if it's just a normal day where I go in and do a clinic, and I can get away to eat something if I'm hungry, then of course, I'd probably skip breakfast and then just go straight for lunch. (Participant 6, female doctor)

Nurses also described how they would skip breakfast before work when time is limited. This made breakfast an irregular meal, with time as a key barrier. For example, working long shifts means starting early in the day, and some nurses do not have the energy to eat that early as they do not feel awake enough. However, unlike doctors, nurses would wait until their scheduled morning break to catch up on eating opportunities and eat the breakfast they had taken with them from home.

I usually don't eat before I go to work. I don't really like eating that early, I don't feel awake enough to eat. So I'd normally eat on my first break. That kind of varies, but it could be nine and it also could be mid-day. So, I'd usually just have a bowl of porridge on my first-morning break. (Participant 12, female nurse)

Overall, there was mixed feedback on our participants' eating practices before work. Doctors were conscious of eating a meal before their shift, with the knowledge and awareness of doing so. However, the challenges, such as the on-the-job workload, responsibilities, and limited time, contribute to their eating decisions before their shift.

3.1.2 Eating practices during the day shift

Doctors were unable to eat when they wanted to due to clinical events, resulting in eating unpredictable food quantities to fuel their working hours when possible. On the other hand, nurses had scheduled breaks: *"Whether you do a short shift or a long shift, you're still entitled to your break and time off your feet" (Nurse Participant).* Unlike other healthcare colleagues (such as healthcare assistants, midwives, and porters) who work in the same working environment and shift, doctors did not routinely have scheduled lunchtime or breaks during the day. Consequently, the extent and timing of doctors' food consumption could differ between workdays and off days.

Doctors' availability often influenced their food choices for lunch. For example, food choices could be influenced by departmental staff numbers available to cover clinical events and proximity to onsite food facilities (e.g., workplace canteen). Food was mainly brought from onsite food outlets or the canteen if there was an eating opportunity, with purchases consisting of more money, often a combination of a sandwich, a packet of crisps or chocolate and a drink. Therefore, purchasing food may not necessarily be the food they want, but rather is driven by its easy accessibility and availability.

> *Typically there are mass expenses in the hospital. So I typically go to Marks and Spencer's, and we'll buy a sandwich and a packet of crisps or a sandwich and a little, like, chocolate bar type thing. (Participant 3, female doctor)*

Portable snacks (e.g., cereal bars, chocolate bars, packets of biscuits, and bags of sweets) were popular due to their convenience, especially at unexpected clinical locations where they might be working. These snacks were typically brought from home, and doctors described how they depended on them: "W*hat I bring is what I have to eat. And I say I'd bring cereal bars. It's like snack food." (Participant 11, female doctor).* However, participants reported struggling to make healthier choices with these snacks and often relied on other people, such as family members, to remind them. In addition, doctors reported that the constant availability of snacks in hospital wards and the doctor's mess made it hard not to reach for them. It was further noted that doctors lack the conscious effort to choose healthier food choices, citing that poor food choices were easier and more convenient despite knowing the poor nutritional value of those snacks. For example, one doctor shared how his team recognised how they would offer him sweet snacks, knowing he liked them, yet unable to resist the temptation of refusing them. Therefore, portable snacks were just as tempting and accessible to eat on the go.

> *I've been making a conscious effort not to go where I know there are sweets and cakes so that I don't I'm not tempted by them. Unfortunately, everybody at work knows my love for sweets so they leave it there, text me and tell me there's some cake in here…you know, I can't get away from that. It's a problem. (Participant 14, male doctor)*

And in terms of snacks, it will be whatever is available because we have a doctor's mess. They're usually stocked up on Christmas with chocolate and biscuits. I'll probably have some of that as well throughout the day, which means maybe one or two. (Participant 6, female doctor)

Nurses reported experiencing similar issues of eating whatever is available on the ward – with unhealthy snacks often gifted by patients, described as a way to "keep them going" during the shift. At other times, nurses reported skipping their meals because of the number of snacks they had consumed. As a result, food convenience and availability became a priority for doctors and nurses during working hours, rather than contemplating the nutritional value of the snacks.

If there's like a biscuit at work mid-morning, I will have it, you know. Sometimes we get things brought into the wards, you know, sweets for staff. So I must admit I do have a sweet tooth. So I will have a couple of those, or something keeps me going, but then I might not eat at 12pm. (Participant 10, female nurse)

We always have chocolate on the ward because people are nice enough to offer us when they have been discharged. For me, that doesn't help. Because if there is chocolate available, I will be eating chocolate. (Participant 7, female nurse)

3.1.3 Eating practices during long shifts

An increase in caffeine consumption was observed in increased length of shifts, impacting DNs' food and drink consumption. Participants were more inclined to fall into bad nutrition habits during longer shifts when eating opportunities were not at regular intervals but spread across a longer period: *"My meals were unhealthy, as they were not timed appropriately" (Participant 14, male doctor).* Working longer hours on consecutive days resulted in trying to stay awake with the ability to perform optimally. The long 12-hour shifts presented limited eating opportunities, with doctors waiting even longer before going home for dinner. This resulted in consuming a higher caffeine intake to cognitively energise them with chocolates eaten more commonly over the lunch break. Doctors also spent more money in their workplace food outlets, purchasing chocolates and coffee during their breaks to support the duration of their shifts. However, doctors felt it impacted their cognitive performance if the coffee was unavailable. While not eating could "be tolerable," coffee was often considered the primary "go-to thing" to alleviate exhaustion.

> *A long day is actually not particularly different. I do end up normally having to eat chocolate and have coffee, and things kind of sort of gaps throughout the day to shrink up going into the evenings, and I'll eat properly in the evenings when I get back. (Participant 2, male doctor)*

> *So if you took away my coffee for a full 12 hours, that wouldn't be very compatible with me being cognitively very bright and making good decisions for my patients or not being right. So I would be grumpy mostly because of lack of caffeine…I could tolerate not eating so I would rather stop for a while and have a coffee. If it was super, super busy, then stop and eat my food. (Participant 13, female doctor)*

Working weekend shifts was described as a regular working pattern for short/ long or night shifts. Collectively, the weekend shift diet remained the same as during a weekday, having the same types of food for breakfast, lunch, and dinner. However, doctors described two distinctive differences in a weekend shift. Firstly, doctors who have family or household support will have a packed lunch brought to work. Secondly, there was more work culture and social aspects on weekend shifts. For example, the hospital would 'look after the employees' by ordering fast food (e.g., pizzas) for lunch to raise staff morale and the opportunity to connect and engage within the working environment. Thus, doctors shared how they would rely on this food during their shift and not bring in any food, knowing it is available on the weekends.

> *In the hospital, they bring in a pizza order every Saturday. I think it's just to raise staff morale, really. Some people bring their own lunches no matter what, but I tend to rely on the pizza order, I'll be honest. And there they just order in plenty. So whatever time you go between 12 and 3ish, there'll usually be something there for you. (Participant 1, female doctor)*

3.1.4 Eating practices during their night shifts

There was confusion about how and when to eat during the night shift due to sleep and routine disruptions. One doctor reflected on their journey from doing night shifts, describing how they started the night shifts by flipping their meal, for example, having breakfast when waking up, 'lunch' during the night, and then dinner when going home. However, the consequences of doing so were poor sleep and reflux: *"I would just get horrendous reflux, I wouldn't be able to sleep very well when I'd got home"*. This subsequently led to exhaustion, with interrupted sleep as they woke up feeling hungry and had little time to recover between shifts. With more years of experience, doctors improved their dietary patterns for night shifts by "having a relatively chilled out day", eating meals at normal times, and then napping in the afternoon. Before their night shift, they would *"have dinner at about six o'clock"* by eating not a full heavy meal and avoiding dense carbohydrate food during the night shift. Instead, drinking water throughout, eating light salad-based meals, and *"having lots of snacks like bananas and nuts"* in the middle of their night shift sustains their energy. Despite acknowledging the lower calorie intake, the participant described the benefits of this eating practice: *"Physiologically, I feel so much better".* This reflection suggests that no approach can fit all. Another eating practice was eating through the night to stay awake, whether through the readily available snacks or brought from home, to have *"something to keep your brain busy" (Participant 13, female doctor).* On the other hand, some participants did not eat anything throughout their night shift, therefore citing that eating practices at night are individual. Though there was mixed feedback on coping with sleep and eating disruptions through the night, doctors remained unclear on how best to control their eating practices during their night shifts.

Doctors reported that eating during the night shift was important for staying awake and preventing them from experiencing a "ditzy energy". This was interpreted as light-headed but with enough energy and awareness to cope with their surroundings. Accessible and available snacks such as sweets, chocolates, and cereal bars were consumed for energy boosts, which helped sustain their hunger and energy until after their shift. These eating opportunities typically occurred when doctors waited for colleagues for clinical discussions, with food lying around and available. Hunger, tiredness, not knowing when they would next be able to eat, and proximity to food in their bag all influenced this kind of snacking. However, others found drinking tea and coffee more helpful, keeping them going throughout the night.

> *I've been called to another place [in the hospital] at that time. And while I'm waiting for colleagues to call me back or I'm waiting for some blood to come back, I just really need to eat something because I'm feeling really drained at this…I'll grab whatever is there – and packets of biscuits in hospital are notoriously coming in threes, and you never need three biscuits at a time. (Participant 1, female doctor)*

> *So I literally just take sugary snacks, I bring, like, things that keep me going…So I don't want to eat a full meal in the middle of the night. (Participant 12, female nurse)*

Doctors described how challenging situations during a night shift would make them feel emotional, for example, irritable, feeling out of sync, in isolation, or suffering from chronic fatigue after a shift, thus impacting their eating behaviours. In addition, due to the limited eating opportunities during the shift, feeling emotional post-work influences them to reach for readily available food as a coping mechanism to overcome the difficult clinical challenges. For example, doctors would purchase high-sugar food from shops, often open for 24 hours, and eat on the way home. In addition, the short-tempered yet feeling hungry could also suggest eating unmindfully due to prolonged hunger.

> *I don't tend to have a cup of tea because I can't wait for it to cool down to drink because I am tired. So I might even go to Marks and Spencer's on the way home and buy like chocolate and things to eat on the tube on the way home…If it's a busy night, I can often go without it. I do get hungry on night shifts. (Participant 3, female doctor)*

Eating due to boredom was another issue contributing to changes in dietary behaviour during night shifts. Boredom arose when there were fewer clinical cases overnight. This often gave doctors time to visit the limited small onsite food shops with extended opening hours, tempting them to purchase the readily available unhealthy food items such as chocolates, sweets, and other high-sugar and carbohydrate products. This could also mean that emotional eating is an approach to coping with boredom and shifting their focus to eating food in the available time.

> *On the night shift, you tend to eat a lot of crap as well. Because you don't really know, it's just a bit very easy to sit there, most of the time, you're not doing anything, and then they call you to go do something. (Participant 6, female doctor)*

The low number of colleagues around during a night shift allowed doctors to use the night as a "free pass" and "cheat" their way through the snacks they craved. This suggests that the food doctors craved does not count towards trying to eat healthier but could demonstrate a reward for themselves by surviving the night shift. Furthermore, participants also felt they could snack on anything they wanted without worrying about being judged by others. Despite being aware of eating unhealthy food, doctors felt night shifts offered more freedom for them to eat anything they wanted. Conversely, nurses did not mention if the night shift allowed them to "cheat" through the snacks.

> *I definitely used to give myself a free pass if I was on night shifts. It meant that I could just eat anything because it didn't count. (Participant 1, female doctor)*

3.1.5 Eating practices after a shift

DNs consider dinner their main meal, the one meal they rarely miss throughout the day, unlike breakfast and or lunch if time is a barrier. Dinner would predominantly be eaten after work at home, typically a hot cooked meal by their spouse or themselves. Eating at home also provided a positive opportunity to have family time at the end of the day. Dinner was described as a home-cooked meal consisting of carbohydrate-based food (for example, pasta, rice, or potatoes) with either a type of fish or meat complimenting portions of vegetables. Further, any evening food leftovers were saved as lunch for doctors' shifts the next day to save time preparing food at another time.

On a short day, because you're coming home or kind of normal time, I would come home and cook, normal evening meal, so like any sort of variety of stuff that I would eat, we would eat together (Participant 3, female doctor)

I'll probably have some rice with something like lamb and with some stir-fried veggies, or something like that, where a salad or to go with it. And then what I'll do is I'll save some of the rice or whatever veggies or meat I've got left for tomorrow's lunch. (Participant 6, female doctor)

However, occasional barriers could influence what doctors have for their evening meals. For example, those with limited support from home would alternatively opt for more readily available food that requires less food preparation time after a long shift.

I would eat once I got home because my partner had cooked food. I do tend to eat if he's been at home. If he hasn't, I wouldn't then cook any food. I would probably graze or eat some cereal or have like a piece of toast and then just go to bed. (Participant 3, female doctor)

Consuming snacks between meals was a habit, for example, after a shift and before dinner (or after a shift meal). Participants described how a stressful workday resulted in ending work and coming home late, tired and hungry. They would use snacks such as easily accessible and available biscuits and high carbohydrate-based cakes to treat themselves after a well-earned day at work. A pre-dinner snack would sometimes evolve into a long dinner, merged into the main evening meal, described as "a graze". Alcohol was also seen as a treat for having accomplished the night shifts.

I've always used food as a treat…you're on a night shift. So you can have whatever you want. And then I will also when I've come off the night shift, so that day between nights or post nights, I'll say, " Oh well, you're post nights. So you'd have a little treat like I have, a cookie after lunch or something that I 100% don't need, but I just want or have a glass of wine in the evening because I've been doing nights of the week. (Participant 3, female doctor)

And what I will do is usually sort of dinner becomes a bit of a graze…In the hour before, I might be having some crudités and hummus, so the nibbling starts, and then we'll actually have dinner. So it's a kind of like long, drawn-out dinner. (Participant 9, female nurse)

3.1.6 Eating practices on off days (non–working days)

Our participants highlighted how their eating frequency on off days was more regular, with more time spent thinking and preparing homecooked food using fresh ingredients. Having more time on non-working days allowed doctors more time to appreciate their food instead of focusing on consuming it for energy purposes or relying more on processed food. Doctors also appreciated more time with their family at mealtimes. Some used this additional time to use fresh ingredients to prepare and cook dishes to take to work as a packed lunch. However, doctors described how being at home would influence higher food consumption with more opportunities to eat and drink when they want more available food at home to snack — for example, walking past shops on their dog walk and purchasing food. However, having time to cook on off days was not always possible due to other life commitments, such as childcare, family commitments, hobbies, and social activities.

I would say when I'm at work, I eat less food than when I'm at home. Because at home, I have the opportunities like, oh, I have a cup of tea and a biscuit or lunch. And then like, if I'm walking the dog, and then we pass the bakery, I'm like, oh pop in and get something whereas, at work, there's almost like a more structured time to it. And there isn't the availability of foods to just snack on. (Participant 3, female doctor)

On my days off, I usually cook more and tend to make my own lunch and more frequently, I might cook at lunchtime rather than having just sort of sandwiches and crisps and stuff. My diet is definitely more varied but more vegetables during my off days and so forth…The other big difference is most of my non-working days, I'll be at home with my wife, so between the two of us again, we might cook at home rather than eat highly processed food. (Participant 2, male doctor)

3.2 Discussion

This study investigated the eating practices of doctors and nurses with shift work. The main findings from our semi-structured interviews demonstrated six key points of doctors' and nurses' eating practices at work. Firstly, our data suggested that DNs prioritised their clinical responsibilities to maintain patient care ahead of dietary intake at work and, therefore, missed appropriate eating opportunities. As a result, our participants often relied on caffeine to stay alert during their shift work. Secondly, DNs viewed working night shifts as an opportunity to eat what they want, termed as a "free pass" or "cheating", for example, unhealthy snacks, as they felt that the food consumption during a night shift does not count towards being healthy. Thirdly, doctors demonstrated their intention to eat well during the shift despite the clinical workload challenges faced. However, due to clinical responsibilities such as tending to patients' care in clinics or operating theatres, eating regular nutritious meals throughout the day was challenging. Similarly, nurses did not often eat before a shift but waited for their first scheduled break to consume what they would have eaten before a shift. Finally, despite the lack of meal consumption before and during the shifts, DNs valued their meal after a shift as the most important meal of the day, as often, this could be the only big meal they eat to fulfil their prolonged hunger. Thus, our results suggest that doctors' and nurses' eating practices are sub-optimal, and dietary workplace interventions may be necessary for this cohort to improve dietary behaviours.

There was a mixed response about consuming or skipping breakfast, largely due to the lack of time in the morning. A plausible reason for those skipping breakfast was perhaps prioritising sleep due to the previous day of long working hours with little recovery time between consecutive shifts (Lowden *et al.*, 2010; Gupta *et al.*, 2019). While shift workers are more likely to skip breakfast than non-shift workers (Kim et al., 2013; Han, Choi-Kwon and Kim, 2016), poor eating practices may also contribute to individuals suffering from malnutrition due to a lack of sleep. For example, Han *et al.* (2016) found that nurses with irregular meal schedules, such as skipping breakfast regularly, contributed to a higher percentage of underweight. Conversely, evidence from Kim *et al.* (2013) contradicts the result, suggesting that those skipping breakfasts were at risk of being overweight or obese due to overeating, were compensating for their hunger with high-fat and sugary snacks later during the shift and a lack of sleep (Kagan *et al.*, 2022). This discrepancy in research highlights the value of viewing dietary intake throughout the day rather than in isolated periods. Based on this, it should be noted that this cohort's tendency to skip breakfast may also contribute to the prevalent snacking during the workday.

However, the clinical rota influences morning eating practises, with nurses also tending to skip breakfast, but in the knowledge that they could plan their dietary intake around the scheduled work breaks. Indeed, the ratio between nurses' and doctors' availability during any single shift and the mandatory breaks (Shekelle, 2013; Hodgson, 2014) give nurses greater flexibility to plan their dietary patterns throughout the day. Our data suggested that doctors plan their dietary intake when they have a clinically demanding schedule where they are unlikely to have time for breaks, such as complex surgeries. As a result, participants would fuel themselves with breakfast before the shift to ensure they could cope, especially when operating on complicated patient cases. This demonstrates that doctors recognise the benefits of consuming food before a shift to maintain clinical performance. However, dietary patterns in UK hospital workers have not been extensively investigated. While our data allude to differences in the morning eating patterns between doctors, nurses and certain specialities, further research is needed to quantify the energy and nutrient patterns throughout the day to identify opportunities where doctors and nurses could be better supported.

This study found that the eating practices at work depended on "eating when and where possible, rather than eating when they want", for example, eating between seeing patients and often on the go. Our results suggest that DNs' food intake was minimal, and they did not eat anything filling during their working hours, whether on a short or long day. Instead, food that was either readily available, portable for storing in pockets or purchased onsite in the shortest time possible was consumed. For example, food bought onsite would typically be a meal deal consisting of a sandwich, a packet of crisps or chocolate with a drink. This could suggest the portability of these food items without the necessity of sitting down to consume a hot meal, which can be eaten on the go (i.e., walking back to their primary working area from the shops). Considering this eating practice of *“eating when and where possible, rather than eating when they want”,* previous research of hospital workers from across a range of countries (such as Australia, Poland, Denmark, the USA and the UK) addressed the differences between day vs night shift eating patterns and their influences on the overall daily energy intake (Mittal *et al.*, 2018; Hamidi *et al.*, 2019). Evidence suggested a greater calorie intake of more than 400 kcal/d between rest and working days (Fradkin, Raz and Boaz, 2019). Those who exhibited more significant variability in energy intake between those days were likelier to have a higher BMI (Bonham, Bonnell and Huggins, 2016; Mashhadi et al., 2016; Langenberg et al., 2019). However, the data comparing day and night shifts were less consistent with studies (Reeves et al., 2004; Booker et al., 2019; Fradkin et al., 2019), demonstrating no differences despite increasing calorie intake carbohydrates during a night shift. Perhaps the cultural differences between countries in those studies could explain the differing results when comparing the dietary intakes and practices. Here, our study suggests that doctors, more so than nurses, lack the scheduled time for eating opportunities during their shifts.

The alternative food options consumed were the readily available snacks found in the staff room (i.e., doctors' mess). Coupled with the lack of time and the feeling of acute hunger due to the minimal food intake during their shifts, doctors (more so than nurses) often reach for snacks such as chocolate and or biscuits found either at the nurses' stations (often gifted by patients) and or in the doctors' mess (Torquati *et al.*, 2016). Perhaps nudging individuals' eating behaviour toward healthier snack options could help improve eating practices. But the effectiveness of this has remained a challenge when snacks are often widely available, leading to challenges in improving the nutrition environment (Bell *et al.*, 2013; Boelsen-Robinson *et al.*, 2017; Tsai *et al.*, 2018; Law *et al.*, 2021). Yet, the rash decision to consume snacks could harm doctors' poor health and nutrition, as supported by previous studies in individuals across all stages of life (Almoraie *et al.*, 2021). In addition, snacking has increased over the past three to four decades, contributing to daily energy intake (Miller *et al.*, 2013; Onwezen *et al.*, 2016). A plausible rationale could be that portable snacks are more easily stored in pockets to be eaten on the go, where they are often high in fat and sugar, leading to the risk of overheating due to the higher proportion of energy (kcals) consumed as snacks.

On the other hand, consuming too many snacks with poor nutrition content could influence poor health outcomes. A review by Miller *et al.* (2013) addresses the conflict and the relationship between snacking on body weight and behavioural and metabolic responses. However, findings suggest that snacking can encourage overeating, leading to increased food portion sizes and poor health when consumed in addition to habitual meals. Yet, it can also be a health benefit dependent on the type of snack consumed and if physical activity is all taken into consideration, therefore snacking more frequently due to its greater energy expenditure (de Assis *et al.*, 2003; Whybrow *et al.*, 2007; Miller *et al.*, 2013; Onwezen *et al.*, 2016). In comparison with the recommended snacking guidelines, there is an inconsistency of the scientific evidence in the field (Sebastian, Cleveland and Goldman, 2008; Johnson and Anderson, 2010; Miller *et al.*, 2013; Zizza, 2014; Hess, Jonnalagadda and Slavin, 2016; Potter, Vlassopoulos and Lehmann, 2018). Recommendations on healthy eating, including portion size and type of food, are well documented in the Eatwell Guide in the UK (Public Health England, 2016; Buttriss, 2017), but the separation between food on what is part of a meal and a standalone snack remains unclear. Evidence has suggested poor oral health with increased snacking, leading to recommendations of limiting the frequency of consuming snacks with fermentable carbohydrates “to six eating occasions per day” (European Food Information Council, 2006; Miller *et al.*, 2013; Hassan, Hamilton and Morris, 2018; Kingsnorth *et al.*, 2021). Within healthcare, nurses have a high prevalence (57%) of sugar-sweetened meal replacement drinks throughout the day instead of consumption of meals, leading to an increased risk of obesity (Lin *et al.*, 2019). Further, evidence also suggests that only 16.8% of UK nurses meet the recommended daily fruit and vegetable intake (Mittal *et al.*, 2018), indicating that increased snacks lower energy consumption when eating a proper meal at breakfast, lunch and dinner (Wong *et al.,* 2010; Phiri *et al.*, 2014; Langenberg *et al.*, 2019). Considering previous evidence and our results, our findings suggest that the lack of time and increased occupational responsibilities meant that doctors and nurses lacked the opportunities to eat anything substantial when needed. Instead, it was eating when and where possible with what they had within their reach rather than eating when they wanted. Thus, the health-promoting properties of a hospital diet can be questioned if snacking is the alternative to skipping meals.

Despite healthier eating practices during day shifts, participants viewed working night shifts as a "free pass" or "cheating" their way through the snacks they ate. Participants shared how working night shifts meant most of the time would be spent waiting around for clinical cases if not being on call. Therefore, DNs often use food as a coping strategy to stay awake, alleviate their boredom through the night or keep their emotions stable. Alternatively, they would consume snacks in the staff room or at the nurses' station. In addition, night shifts were often understaffed as the workload could be somewhat quieter than during the day. Hence, DNs viewed this shift as eating whatever they wanted without being judged by others and as a reward for surviving the night shift. Perhaps this explains the overeating of snacks, as noted by the participants. A plausible justification for cravings for sugary food that is readily available during tiredness could influence the eating behaviours associated with the individual's chronotype (Maukonen *et al.*, 2016, 2017; Loef *et al.*, 2019), supporting the high consumption of hypercaloric meals (Mendoza, 2018).

In addition, DNs' eating practices during the night were inconsistent; some often "flipped" their routine to fit their night shift working patterns and practices. Despite participants' conscious effort in this behaviour from day to night shift, these consequences led to participants experiencing poor sleep and gastrointestinal problems, causing gastric reflux. This could suggest that a prolonged period without food and fluid upsets their diet routine as the gastrointestinal system slows gastric emptying during the night (Sveinsdottir, 2006; Wong *et al.,* 2010; Dias and Dawson, 2020). As a result of the physiological consequences of flipping their routines, doctors and nurses tested and trailed their night shift routine on their own with limited support received. (Nojkov *et al.*, 2010). Likewise, results presented by other observational studies indicated gastrointestinal symptoms were more prevalent in nurses with night and rotating shifts (Saberi and Moravveji, 2010; Rijk *et al.*, 2021). Here, it could suggest that night shifts could lead to a greater prevalence of gastrointestinal disorders such as irritable bowel syndrome, constipation, abdominal pain and diarrhoea (Waterhouse *et al.*, 1997; Caruso, Lusk and Gillespie, 2004; Nojkov *et al.*, 2010; Hofmeister *et al.*, 2020). Though it could be argued that the total energy consumption during the night shift could differ in studies (Reeves, Newling-Ward and Gissane, 2004; Sahu and Dey, 2011; Naghashpour *et al.*, 2013; Roskoden *et al.*, 2017), the key aspect here could suggest the limitations of using quantitative research methods to address the inconsistency use of dietary practices assessment tools when results are often self-reported. Conversely, some DNs reported treating their night shift as a normal routine and did not eat during the shift as they would not normally eat during the night.

This demonstrates that diet practices are currently varied and individual eating on the night shift does not apply to all.

Working long, irregular hours with increased and often non-stop clinical responsibilities and limited eating opportunities meant DNs often relied on caffeine intake to stay awake for their shifts. Our cohort values their caffeine intake throughout their working hours and cites caffeine as their "go-to" beverage simply because of the around-the-clock availability and accessibility. This could suggest the positive effects of caffeine on optimising cognitive performance, the ability to cope with heavy work responsibilities with the mood-enhancing effects for doctors and nurses during long working hours, as reported by previous studies (Clark and Landolt, 2017; Temple *et al.*, 2018). But further, caffeine was often consumed due to the sleep disruptions, leading to sleep deprivation where our study found doctors and nurses on night shifts feeling moodier, irritable and emotional, as previously reported (Rouch *et al.*, 2007; Brown *et al.*, 2010; Han *et al.,* 2016; Ganster, Rosen and Fisher, 2018; Persico *et al.*, 2018). In addition, our participants with consecutive working days with little recovery time in between suggest that caffeine consumption was a coping strategy despite the detrimental consequences of greater sleep disturbance and psychological distress caused by the constant high consumption (Centofanti *et al.*, 2018). Our result highlighted the heavy reliance on caffeine compared to other types of fluid intake, especially during night shifts. Perhaps again is the effect of caffeine on the psychological and physiological aspects post-consumption, promoting alertness, especially during shift work (O'Callaghan, Muurlink and Reid, 2018; Temple *et al.*, 2018; D'Annibale *et al.*, 2021).

Interestingly, this cohort did not mention the importance of other fluid intake and hydration status at work. Given the high mental demand and the requirement to make several important clinical decisions in a shift, adequate hydration is vital for healthcare professionals to maintain cognitive performance (Lemaire *et al.*, 2010; Alomar *et al.*, 2013; Masento *et al.*, 2014; El-Sharkawy *et al.*, 2016). Though the participants did not explicitly report this, previous evidence considered how interruptions at work could reduce fluid intake, especially in a healthcare environment (i.e., hospitals) (Alomar *et al.*, 2013; Lin *et al.*, 2014). Yet, primary research on hospital workers' fluid intake and hydration status is limited (Alomar *et al.*, 2013; El-Sharkawy *et al.*, 2016). For example, El-Sharkawy *et al.* (2016) cited how over one-third of the UK nurses and doctors (n=88) across 130 shifts arrived at their shift dehydrated, with 45% ending the shift dehydrated. As body water loses progressively over time, i.e. over a 12-hour shift, dehydration is associated with impaired cognitive function and short-term working memory in doctors and nurses (El-Sharkawy *et al.*, 2016). In contrast, it is unknown if this directly impacts work activities and overall patient care; the importance of hydration and its impact on cognition cannot be dismissed. Our data suggested that doctors and nurses constantly face overwhelming patient demands and clinical responsibilities. Thus, fluid intake was often restricted, suggesting that restricting fluid consumption often depended on bathroom break opportunities and available facilities (Brake and Bates, 2003; El-Sharkawy *et al.*, 2016; Sebesta *et al.*, 2022). Our current cohort reflected this practice due to the lack of time for bathroom breaks and hydration opportunities. Though caffeine remains the first port of beverage for doctors and nurses to consume with the main reason of staying alert for the duration of shifts, the value of hydration beyond fatigue was not prominently reported in our cohort. Therefore, more awareness on the importance of hydration status may be needed in this occupational setting.

Our final key finding reveals that DNs value their meal after a shift as the day's most important meal. This was often perceived as the only big meal, or in most cases, the only time they would eat to fulfil their prolonged hunger. As such, our cohort values food being eaten and the time spent during the eating process. For example, those living with family shared how eating with family in the evening for dinner presented rare opportunities for "quality time" catching up with others; however, they might often return home late due to working overtime. Thus, participants would often choose this option after their shift, especially when the meals would usually be cooked for them when returning home, taking out the challenging experience of needing to prepare and cook the meal when fatigued after a shift. Our result presented similar findings to Waterhouse *et al.* (2003), where evidence suggests that shift workers presented a high satiety score after a shift due to overeating or being full or bloated after a meal. Conversely, those participants living alone treated the time after a shift to wind down and often ate what was available, for example, snacks, at home. This could suggest that occupational fatigue resulted in the lack of self-care due to wanting to "go to bed" and sleeping straight after rather than spending time putting effort into thinking and cooking a meal, as previously evidenced (Bonnell et al., 2017; Leedo et al., 2017; Gifkins et al., 2018; Heath et al., 2019). Here, our findings present the importance of having a social and family support network to contribute to healthier eating despite it being only one meal of the day.

Our cohort highlighted how important aspects outside the home and workplace after a shift contribute to the differences in their dietary practices. For example, some participants who commute to and from work using public transport and going past food shops influence their purchase of snacks, including those on sale. This behaviour suggests unnecessary increased food consumption or poor eating practices. Perhaps a plausible reason was the commute length due to the limited eating opportunities during their shift; hence, travelling home while hungry contributes to poorer healthy eating practises. Thus, this suggests how different features of the environment can influence dietary practice (Caperon *et al.*, 2019). For example, the walking distance from home to shops, the public transport routes, and the food shops' opening hours have all previously been widely reported in the field (Shepherd, 1999a; Gedrich, 2003; Popkin, Duffey and Gordonlarsen, 2005; Brug, 2009; McNaughton *et al.*, 2012; Hollands *et al.*, 2017; Okoro, Musonda and Agumba, 2017; Lima *et al.*, 2021). Here, the ecological model illustrates the multi-faceted layers of health and nutrition determinants to address the understanding of poor eating behaviours (Caperon *et al.*, 2019). Studies have addressed the association between the geographical location of retail food outlets and the availability of unhealthy food with poor eating behaviours, leading to overeating due to its food conveniences with less time needed to prepare and cook a meal when home (Macdonald *et al.*, 2011; Barnes *et al.*, 2016; Bivoltsis *et al.*, 2020). As such, the time between finishing a shift and arriving home contributes to our cohort's snack consumption. Although a lack of time contributes to not eating during the shift, snack intake in doctors and nurses after work contributes to poor food choices. Future research is needed to address the environmental factors outside the workplace and home to best support doctors' and nurses' health and nutrition.

In conclusion, this study combines the key findings of DNs' workplace eating practices. Six key areas suggest that our cohort prioritises their clinical responsibilities over their nutrition due to the lack of time and the high clinical workload, as they often do not have regular healthy eating practices. Our result explored what DNs eat during their working hours. However, it lacks the details of dietary patterns and the energy and nutrient profiles to provide a holistic understanding across each working hour. However, our result shows that eating practises are varied, individual, and not applicable to all, considering the many environmental and occupational factors contributing to DNs' nutritional behaviours. Though a certain group of participants were health conscious and were very structured on what they eat and value good health as nutrition, even with that knowledge, during shift work, DNs still found it difficult due to shift work factors. We can also ascertain that there is limited evidence on DNs' eating practices before and after a shift, which we noted in our study, that could impact their overall eating practices and nutrition. The overall dietary practices for DNs are sub-optimal, considering that they do not eat regularly and at regular mealtimes, largely dependent on their clinical responsibilities. As such, understanding the why and what influences DNs' eating practices is the next step to consider when creating interventions to support and improve their workplace nutrition.

CHAPTER 4: QUALITATIVE STUDY RESULT 2 – ORGANISATIONAL INFLUENCES, CURRENT FOOD PROVISIONS AND POSSIBLE FUTURE STRATEGIES PROMOTING GOOD WORKPLACE NUTRITION

This chapter explores how shift work and working patterns influence doctors' diet and eating behaviours, focusing on exploring occupational barriers and facilitators. Further, it also aims to identify possible strategies within the Trusts to promote workplace nutrition through immediate and long-term support. Findings will be presented in four sections. The first section addresses the organisational barriers, examining the environmental factors such as workplace location and onsite facilities and exploring how staff shortages and organisational support influence workplace culture and team activities. The second section seeks to understand the current regulations and policies for doctors and nurses and their impact on workplace nutrition. The third section addresses the available food facilities and services within departments and the wider workplace. This will be followed by examining existing health and wellbeing services, specifically nutrition. Furthermore, immediate and long-term workplace strategies will be incorporated to suggest how to improve workplace nutrition suggested by participants. Findings will predominantly present doctors' data; however, nurses' experiences will also be incorporated, where applicable, to compare experiences.

4.1 Organisational barriers

This theme covers workplace environment, culture (including management), and regulations.

4.1.1 Workplace environment factors contributing to workplace nutrition

The location of the hospital acted as both a barrier and a facilitator of DNs' health. Doctors based in more urban areas described the benefits (i.e., ease of access), such as keeping up with their hobbies (e.g., weekly taekwondo training) or accessing shops to allow food purchases. For example, exercise helped them maintain their health and wellbeing, especially after a long stressful day at work: *"punch bags are sometimes* *really good to destress and let go of stuff" (Participant 11, female doctor).* However, if doctors worked at a hospital located further away from their sports/ social club, this impacted their ability to maintain a healthy lifestyle. For instance, a lengthy commute became a barrier because leaving work on time and attending classes after work required extra motivation. Furthermore, doctors rotate regularly around hospitals for their training. These hospitals may be located far apart; therefore, they may sometimes work in hospitals further from their homes.

> *We travelled a lot more distance from where I left when placements were like 50 miles away…is difficult, as you are getting home later from the long distance and keep going to Taekwondo was becoming more difficult. You have to leave home if you want to go and do it. To keep that motivation. That's quite hard. (Participant 11, female doctor)*

Relating to food and nutrition, accessibility to shops near the workplace could provide eating opportunities. However, this could also be a barrier due to the availability and variety of unhealthy food choices in some areas. For example, participants described using public transport to commute to and from work, sometimes leading them to purchase unnecessary food as a "treat" (also mentioned in the previous result chapter) after a long, stressful workday. Although doctors were aware of the links between food and healthiness, food availability tended to shape eating behaviours, regardless of living in an urban or rural area.

The location of participants' departments within the hospital illustrated doctors' workplace nutrition due to the proximity of food facilities. Participants working in specialist areas such as paediatrics and theatre, situated in more isolated areas within the hospital, experienced more difficulties accessing food outside their department. For example, vending machines were described as the only immediate food source in remote areas, yet they only serve cold snacks. This also meant no hot food facilities were available to purchase meals without travelling to the main hospital building, where the distance could vary depending on the hospital.

> *We're are often quite isolated in our own separate building and have access to a vending machine…if we want hot food, we need to take a trip to the main*

hospital and just don't have the time or motivation. (Participant 11, female doctor).

Doctors highlighted the limited staff room areas for them to use during breaks, particularly if participants want to be 'away from work', i.e. their clinical responsibilities. Doctors had offices to sit in for a break but typically worked on their computers, as there are limited places to go on breaks without 'being too far away' in case of a clinical event. For instance, a neonatal doctor shared how they would work in their office during the day when not seeing their patients and shared the challenges of having a break away from their primary working area when break facilities are limited. Thus, they would take a break from sitting in their office and go from their *"computer screen to [their] phone screen" (Participant 11, female doctor)*. Furthermore, the availability of break spaces for staff was often limited – the space was shared with all other colleagues working in the department and frequently *"is nowhere near big enough" (Participant 11, female doctor)*. This results in limited quality break time, where eating or drinking is rushed to allow seats for other colleagues as soon as they have finished eating/drinking. Hence, the lack of onsite staffing spaces for break opportunities presented time constraints for workplace nutrition.

You finished your tea. You can't just sit and chill for a little bit for someone else needs to come in and have their break, the nurse needs to come in and have their breakfast, and you're fine, I'll go you know, and then people just will go off to go off and do whatever jobs need to and having perhaps not had the time we can have or that you'd like to have. (Participant 11, female doctor)

4.1.2 Doctors' expectations within the workplace/ Responsibilities of the job impacting nutrition at different stages of career

Participants talked about unfamiliar challenges they faced as newly qualified doctors. This period of experience was described as tough and laborious. For example, new doctors were typically expected to push themselves to the limit regarding their work. However, inadequate mental health support was reported, meaning doctors often experienced issues like imposter syndrome when trying to appear knowledgeable and competent. Despite the challenges, participants felt the initial years of being doctors were great learning experiences; however, prioritising their health was perceived as a low priority.

> *…as a surgical FY1, you're kind of at the bottom of the ladder, and hours can be really long and quite daunting, you definitely don't look after yourself that well. You see everybody else working the same way you might not necessarily recognise what potentially could be an unhealthy barrier, if you will, or that because this is what is expected of you, you just push and push and push. (Participant 1, female doctor).*

As doctors developed their confidence in their clinical role, they acknowledged the importance of being responsible for their actions. However, doctors repeatedly mentioned *"putting themselves last, and you sort of getting through things for other people" (Participant 1, female doctor)*. Participants felt they were constantly responsible for patients' health rather than their own. Consequently, this contributed as a barrier (e.g., not having time for self-care) and a potential facilitator to their workplace health (e.g., staying in control of their actions, such as being mindful of their behaviours and attitudes when treating patients). For example, doctors believed that they should *"set an example as to how we should be eating"* by acting as role models to patients who are recovering, *as "what you're eating determines your health" (Participant 4, female doctor)*. There were mixed responses to the "practice what you preach" mantra regarding good health and nutrition. For example, some participants described how avoiding certain types of unhealthy food that should not be eaten in a healthcare setting with patients around. Instead, having the right attitudes and behaviours at work was regarded as more important, such as being mindful of their food choices and what patients could see them eating. For example, *"I would never like to go to McDonald's and then bring that in and in my scrubs, sit and eat out and work" (Participant 3, female doctor).*

> *It's really important because obviously, you are looking after unwell people, perhaps because it's completely out of their control. However, sometimes it can be diet-related factors, and you're very aware of that in yourself. You're managing somebody with diabetes, and then you go and eat chocolates on the ward, like, how does that make you feel? (Participant 1, female doctor)*

On the other hand, others emphasised how the stereotype of *"doctors are of a relatively slim body type" (Participant 13, female doctor)* should be questioned. Instead, it was suggested that doctors remain as professional as possible and use common sense when eating in areas near patients in the workplace. Despite the mixed responses, there was a consensus that doctors take responsibility for upholding their professionalism and *the "concept that healthy eating is good for everybody's health, regardless of whether or not patients see you and with your interactions" (Participant 3, female doctor).*

> *…doctors don't necessarily need to conform to this saintly mantra of never drinking alcohol and, never eating chocolate, and never being slightly overweight. (Participant 3, female doctor)*.

4.1.3 Workplace power dynamics and culture

Newly qualified members shared how senior colleagues would use their privileged position to ask junior colleagues to either help finish the long list of patient cases, cover their shifts or request they work overtime with little flexibility. For example, one participant described how a surgeon rewards the theatre team with unhealthy food (e.g., pizzas) to shape work practices – *"when surgeons want to reward us or encourage us to stay longer or work in a particular theatre, they often send out pizzas."* (Participant 16, female nurse). Another example was when a participant was asked to take responsibility and act as the lead person on the more complicated patient cases despite their limited experience when there was a staff shortage. Here, the doctor further described the challenges they faced when they had to cover for a night shift after working overtime after their long day shift. With the staff shortage, no one came during the shift to relieve them, leaving the doctor very stressed and tired with limited recovery time before their next scheduled shift (Participant 11, female doctor). Thus, power dynamics within the workplace could negatively influence doctors' health and nutrition.

Doctors' seniority influences break opportunities during shift work. Sometimes, senior colleagues offered to help their junior colleagues despite sacrificing their break and lunch opportunities. For example, senior doctors were aware of the risk of leaving junior staff on their own to deal with the challenging clinical cases: *"I can't go on break, knowing that my much junior colleagues will have to deal with something and clearly the person's lives are at stake" (Participant 7, female nurse).* Nevertheless, the expectation of struggling through long working hours regardless of their occupational grade would often be shared and supported by colleagues if they recognised the need. For example, doctors would take turns for breaks if enough staff were available to cover the shift. Thus, colleagues' seniority can significantly influence doctors' sense of belonging and wellbeing, particularly regarding workplace expectations. This includes factors such as taking breaks during shifts with the understanding that there will be support from colleagues to help manage their workload.

> *"But sometimes I have people with me. I have an assistant, in which case I can go out and have lunch while they sit they carry on, and we can do that. If we find that we are doing one of these sessions where we are working through lunch, then essentially, we will just support each other just to pop out for a toilet break or get a coffee, or they will get my assistant will bring me in coffee regularly to just keep me going." (Participant 14, male doctor)*

Doctors who had more service years reflected on their own trainee experience, citing the "long-standing culture" of putting patients before breaks, no matter how exhausted they are: "*There is this very false, but somehow like stoic mentality that if it's busy if patients are waiting to be seen if there's stuff that needs to be done, your timeout, your break your time to refresh, come second to that" (Participant 3, female doctor).* Furthermore, those more experienced shared the importance of recognising their own mental and physical needs, especially during night shift shifts. For example, new junior doctors lack self-awareness and do not have the "mentality of clocking in and *out" (Participant 1, female doctor) or the ability to differentiate between being on shift, finishing their shift,* and going home. This situation raises concerns about the risk of overworking without recognising the appropriate number of hours worked. However, in some instances, senior colleagues demonstrated compassion by allowing junior staff members to end their shifts early to rest before returning for another night shift the next day. Therefore, simple interactions with colleagues could influence the sense of belonging at work.

I've had senior consultants or registrar's who say, right, this is lunchtime, I expect you guys to go. Either they hold your bleeps for you, or they go, right, we go as a team, or we go for a morning coffee for a consultant ward round. Those have always been the best jobs, really well supported. They recognise that you're not just a machine or a robot and that you do need breaks, and that's always fostered a really good sense of humour, look after each other, like we look after the junior doctors. (Participant 1, female doctor)

Team activities during working hours influence workplace nutrition. Often involving food, group activities raise staff morale, especially during challenging times, whether through the COVID-19 pandemic or the complex clinical events during long shifts when nutrition may be limited. For example, having team tea breaks on the ward during the shift or ordering everyone pizzas for lunch every Saturday brought staff together as a community. Other team activities included having regular *"Cake Thursdays" (Participant 13, female doctor)* or other social events, such as food gatherings, enabling social interactions outside clinical cases. Despite the benefits of having team activities, involving food in activities did not always mean workplace nutrition. One doctor described how she felt socially pressured to eat cakes to keep her colleagues happy. Nevertheless, involving food in social settings builds connections and brings people together:

They bring in a pizza order every Saturday, I think it's just a raise in staff morale, really…there are some people that bring their own lunches no matter what, I tend to rely on the pizza order, I'll be honest…and they just order in plenty. (Participant 1, female doctor).

So I tend to be not a very snacky person. Maybe I would feel socially obliged. So my last two consultants love to bake, so sometimes you will bring in a cake that she's obviously putting a huge amount of effort into, and then you're socially obliged to eat a slice of cake. I don't really feel like I need a slice of cake. Some people really enjoy chocolate or cake, and you know, it gives them a boost and makes them happy. I'll eat the cake to make her happy…And tends to be *because it's like a social event, so if someone's baked, I'll partake. (Participant 13, female doctor)*

4.2 Regulations and policy

The participants were uncertain about the available regulations and policies related to nutrition within the workplace. Doctors expressed confusion about the workplace culture compared to their nurse and allied health colleagues; for example, whether taking a regular uninterrupted break was acceptable. This section presents three key topics regarding workplace nutrition and regulations: break opportunities, water accessibility and specific occupational roles.

4.2.1 Break opportunities

Doctors observed the different regulations regarding breaks between doctors, nurses, and allied healthcare staff. For example, doctors described how their break times were never protected, as they constantly worked because of the high clinical workload. As such, patient demands dictate workload and opportunity for breaks, leading to irregular mealtimes as they were expected to prioritise work. However, on breaks, they would often be at their office desks due to the limited break areas away from their primary workspace in their department. This resulted in higher chances of colleagues interrupting them, asking for support in clinical matters, or responding to their bleeps, which were mandatory as part of their occupational responsibilities.

And to the best of a doctor's ability, you can say I'm just having some lunch like please call me back in 20 minutes, but there's no such thing as bleep-protected free time. (Participant 1, female doctor)

So you've got an office, your computer is there right in front of you, and we'll work. But where do I go for a break? I stay in my office. To have a break and I go from my computer screen to my phone screen, and then someone else who's not having a break at the same time comes in for their shift. Like I'm asking myself, am I actually having a break? (Participant 11, female doctor)

On the other hand, nurses were content with their designated breaks during their shifts. Therefore, nurses felt looked after and supported by management more than doctors regarding breaks. For example, a junior nurse described how having enough senior nurse colleagues made *"a huge difference, and how heavy the ward is if you are the senior nurse and have other senior nurses in the same shift" (Participant 7, female nurse)*.

> *Everyone makes you a drink, which is quite nice where I normally work, so you have that prior to the shift starts and then by about 11 if most people [patients] are settled…We can all sit down, and then if we want something to eat, we can have it. (Participant 10, female doctor).*

The poor staff-patient ratio during shifts impacted doctors' number of break opportunities. Participants spoke about the experience of a constant high staff turnover and being *"unable to have a regular team"* to effectively meet *"the targets you meant to hit*" *(Participant 15),* with the constant back-to-back patient appointments and limited break opportunities. For example, often, it would be one doctor in the whole ward working alongside twelve nurses at any time, which results in limited support for the doctor. Thus, all doctor participants shared the common feeling that their breaks were an *"opportunistic break" (Participant 6*). As such, breaks were largely dependent on staff availabilities and clinical events. Doctors suggested that the inconsistency of break opportunities negatively impacted their work morale and healthier food choices.

> *I am there for, obviously, the requirement of whatever they need for those patients. But because you're on your own versus 12 nurses with 12 different patients, we don't have a culture of saying, you're not going to interrupt the doctor between 1:30 and 2, because she's going to go and get something to eat. (Participant 3, female doctor)*

> *If you need to have a break when you want them is another question. But it's also an opportunistic break if you like…If you really need to pee and there are some patients that need you, but you are the only one, you can't have a temporal break…If your friend is nice, they will see you're busy, and you're moody, they will hold the bleep for you and covers you for lunch. But it's not a*

> *set thing. If you have to pee or have to poo, then you have to take the bleep with you. You literally have to take your bleep even when it goes off in the toilet. (Participant 6, female doctor).*

4.2.2 Water access

The need for water breaks or staying hydrated is pertinent for good workplace nutrition. Participants believed that clinical mistakes, putting patients at risk, were the health consequences of the lack of eating and drinking opportunities throughout their shifts. Despite that, both DNs shared how workplace regulations discourage them from drinking in front of patients*: "we can't drink in front of patients, and it's really quite annoying. I'm sure the patients would prefer us to drink" (Participant 16, female nurse)*.

> *I mean, it's crazy. You know, we tell our patients to drink water throughout the day when they're dehydrated. So, to be honest to God, they don't make it easy for you at all! (Participant 10, female doctor).*

Additionally, accessibility to water facilities near their primary workspace was lacking. Many described the long distance to find the nearest water fountain or purchase water from food outlets. However, alternatively, accessibility to water fountain stations was also inconsistent around the workplace. For example, some fountains did not work, and in other cases, participants had to walk a distance to find the nearest water fountain. As a result, staff had limited water access when needed. Thus, DNs reported how dehydration affected their energy levels, work performance, and overall wellbeing. As such, one workplace strategy to overcome this challenge was implementing more water access points around the immediate working areas as a workplace strategy, as suggested by our participants. For example, having accessible water fountains across the workplace could help with hydration when break opportunities are limited.

> *You've got a constant pull on you all day of different things, mentally, physically. And if you don't keep up, if you don't eat, at least at certain points throughout the day, you won't have the energy or the brainpower to get through that day. First, for your our own energy levels and your brain functioning, but you're gonna make mistakes. That's the biggest thing if you don't have that coffee*

when you need it or the food and everything else…you get to the end of a shift where you can feel your brain giving up. It's almost like, you just haven't got that clarity. And that's the last thing you don't need, not having clarity on things. (Participant 10, female doctor)

One suggestion was allowing a water bottle with a lid, whether provided for or brought in by the individual. Participants suggested that allowing *"a water bottle with a lid on it surely can't be too much of a threat" (Participant 16, female nurse)* or *"having your name on the bottle" (Participant 10, female doctor)* could perhaps be the solution to staying hydrated or preventing water spillage. Yet, it was reported that the management team feared water spillage, leading to people slipping over. Further regulations prohibited staff from having water bottles during the shift. (Note: this experience was shared by participants both pre-pandemic and during the pandemic). Health professionals were also discouraged from having water bottles, suggesting it would impact their professionalism: *"water bottles on your nursing [colleagues] stations…as they look a bit like eyesores"* (Participant 10, female doctor) or *"it doesn't look good"* (Participant 3, female doctor). This demonstrates the barriers doctors and nurses face when wanting to stay hydrated, especially with limited break opportunities.

So having somewhere you can go and get fresh water, like chilled water, or even having your water bottle with you, has some challenges.But you can quite easily go four or five hours without drinking anything. And then go to the bathroom like once on an entire shift and be like oh, that was that's normal, which is definitely not (Participant 3, female doctor)

4.2.3 Specific occupational role

Workplace regulation is a challenge for health professionals with specific occupational roles. For example, working in the theatres presented additional difficulties in leaving the department for food due to the limited time between patient cases or when food facilities were far from their clinical areas. One of our participants, an anaesthetist working in the operating theatre, described the barrier of leaving the operating department when they want, as regulations require them to change out of their theatre scrub if going into the canteen to reduce cross-contamination. In addition, with the already restricted canteen opening hours, spending extra time to change their scrubs and rushing across the hospital was identified as a barrier for doctors. Therefore, this emphasises the importance of doctors' primary working areas within the hospital and how the availabilities of the onsite catering facilities could also influence the type of food eaten during their shift work. This consequently emphasised that the limited availability of food in the immediate vicinity significantly impacts health professionals' health and nutrition in these settings.

> *Again, you can't go to the canteen wearing certain clothes, that's a huge barrier. It might be we can't go to certain shops in theatre scrubs particularly. And also the restaurants, it's very frustrating that the canteen might be open from 12-2pm. But because of high [clinical] activity, it means you can't structure your breaks in and around those times, that's a problem. And then often, the food from the canteen in the hospital is pretty dire. Or it's always non-existent on night shifts. (Participant 2, male doctor).*

The regulations and policies within a hospital setting on break opportunities, water accessibility, and specific occupational roles affect workplace nutrition. However, the support by the Trust to mitigate these problems and promote workplace health and nutrition lacks continuity and does not always present opportunities for employees' health promotion. Escalating issues to management has always been a barrier, and staff members often organised activities to develop a sense of camaraderie through peer support. Even when a Trust offers support, it is not always the healthiest option. Doctors described an example where monthly financial contributions for food supplies in their staff room do not always provide the healthiest food choices, but rather *"crisps and cereal toast, bread"*, *"depending on who does the shopping and who hasn't done the shopping" (Participant 6, female doctor)*. In addition, doctors receiving health and wellbeing support from the Trust suggest inadequate care with little to no acknowledgement of the shift workers' nutrition. Thus, little is known about the Trust's role in helping to manage employees' nutrition-related issues and expectations.

4.3 Workplace facilities

4.3.1 Departmental food facilities and provisions within the immediate work area

All participants had a staff room (with chairs and tables) and a kitchen area in their department that was accessible and available during their shifts. Essential items such as a fridge, a toaster, a kettle, and microwaves were widely available and consistent across the different Trusts represented in the study. Both doctors and nurses appreciated the availability of fridges, enabling a wider variety of food storage from home rather than restricting it to sandwiches purchased onsite (though some participants thought they did not need to store food in a refrigerator). Furthermore, fridge accessibility helps doctors eat when needed during their shifts. For example, when experiencing exhaustion, doctors could eat the food they brought in from home rather than eating snacks that were conveniently accessible. The other benefit of having a fridge was the ability to cater for individuals' special dietary requirements. For example, one doctor shared how they would depend on having a fridge to *"keep [their] soya milk in" (Participant 13, female doctor);* otherwise, they left feeling *"a bit grumpy"* if it was unavailable. Thus, basic kitchen provision provides opportunities for shift workers to eat the food they have prepared.

> *…so there's a staff break room on the ITU, where there'll be a fridge for you to put your lunch, and you can also put your own milk or your own drink or whatever you have in the fridge…(Participant 13, female doctor)*

Some participants noted how the lack of space available (e.g. due to small staff rooms and the inability to cater for all colleagues to use simultaneously) meant they could not "have a break" away from their immediate working areas. Thus, they often stay in their clinical areas and eat there. Doctors and nurses, therefore, reported how they would purchase cold food and snacks onsite instead. Because of this, the participants have raised an important issue of the need for good staff room accessibility and size across all hospitals so that employees can have dedicated spaces to rest and eat.

> *Staff brought their food into the clinical area to eat because there was nowhere to actually switch off, which was affecting not only our food intake because you could*

bring any smelly food as such into work but also infection control…you don't feel like you're on the break (Participant 8, female nurse)

4.3.2 Food facilities and provisions within the hospital

The inconsistency of the hospital's canteen accessibility and availability, such as its opening hours, influences doctors' workplace nutrition. For example, its accessibility and availability, restricted by the opening hours, often do not coincide with the ward's clinical activities, preventing doctors from purchasing food when needed. Doctors acknowledged that the canteen was not always available when "on their breaks". Instead, it opened for a short period with opportunities to purchase hot food, often around midday, during weekdays and closed at other times, including the weekends. Therefore, doctors were frustrated with being unable to use the canteen due to the unexpected clinical workload: *"it's very frustrating that the canteen might be open from 12pm-2pm…but because of high activity, it means you can't structure your breaks in…"* (Participant 16, female nurse). Even participants who used the hospital canteen to purchase their hot food in between clinical cases described the canteen environment as a *"pretty dire"* place, uninviting with minimal and *"expensive and highly processed food"* (Participant 1, female doctor). There were also often small outlets, which could be very busy during their short opening hours, which resulted in doctors being frustrated and having to spend unnecessary time queueing.

Doctors' and nurses' workload is continuous and unpredictable, so they cannot plan clinical events around canteen opening hours. As such, participants reported that their nutrition was affected by the inaccessible canteen with inadequate food provisions. One doctor described how if they had forgotten to bring their pre-prepared meal from home to reheat at work, they would *"eat the snacks available in the [doctors'] mess"* (Participant 6, female doctor) due to the hospital canteen closure throughout the night. However, the consequence of eating the snacks in the doctor's mess could mean no snacks left for other colleagues on the shift or the next day. Considering the barriers to onsite food availability, doctors often opt for easily accessible food, such as vending machines, as they are available around the clock. However, this eating practice could lead to high-fat and sugary snack food. Though vending machines were available around the clock, hot food was not dispensed.

Other food outlets, in addition to the hospital's general food canteen, were available. Similar food shops, such as Gregg's, WH Smith, Costa, and Marks and Spencer's, were widely available across all Trusts and, in some cases, open for 24 hours. This meant those working late evening and overnight shifts could access food when needed. However, those 24-hour shops did not always provide wide food options. In some cases, those working late experienced walking around the hospital in desperation for food due to inaccessible food facilities:

> *"big distances overnight to go from place to place [for food]" (Participant 1, female doctor).*

There is a lack of food facilities and provisions in participants' immediate working areas and the wider workplace when the hospital canteen and food outlets are inaccessible, including outside standard opening hours. One immediate workplace strategy, such as increasing facilities onsite near DNs' primary workplace, was suggested to help avoid spending unnecessary walking time to the canteen. Thus, a subsequent strategy such as extending the canteen opening hours suggested by all participants would enable more availability of purchasing hot food, especially for those working the night shift, to increase accessibility. However, canteen food options were limited, mainly due to a lack of healthy options. For example, highly processed food such as *"chocolate bars, bags of crisps" (Participant 2, male doctor)* and *"they don't always sell the healthiest foods. So, it's kind of like school dinner kind of foods like a jacket potato, fish and chips" (Participant 12, female nurse)*. As a result, increasing accessibility of the canteen, including the availability of healthier food options, was recommended by our participants.

4.4 Nutrition, health and wellbeing services

There was a consensus on the limited nutrition and health-related services available, except for employee benefits such as gym discounts and financial support to *"cycle to work" (Participant 7, female nurse).* Any existing support groups for health were often employee-led activities to improve team camaraderie, such as yoga classes or peer support groups. Conversely, DNs were aware that the Occupational Health department was available onsite due to the emails sent by the Trust. Nevertheless, these health facilities required a referral from their general practitioner, which was a barrier due to the prolonged waiting time. Nevertheless, the participants felt that these services were not for their welfare but to support the hospital's functioning, including reducing sickness absences so that services could be delivered effectively.

> *…we can speak with someone at health services about this and that. But I don't think it's like a walk-in. I think it has to be referral-based. So there are services available, both referrals based and not very convenient access, I would say (Participant 6, female doctor)*

Doctors and nurses believed that improving their nutrition, health, and wellbeing was more of an individual responsibility than their employer's duty. For example, one doctor (Participant 6 female doctor) shared that *"nutrition is a very personal thing"* and, as such, will depend on the individual to make changes rather than *"waiting for the employer to look out"* for them. The quote demonstrates that individuals are responsible for their health, not organisations or governments. Conversely, employers play an important role, with the workforce's expectation of being looked after well enough to do their role. Nevertheless, participants raised the issue that the time it takes for workplace nutrition and/or health and wellbeing improvements by the employer could be a barrier, with no recognition of the urgent need for such improvements.

This finding suggested a long-term workplace strategy for DNs to know how to improve their health and nutrition during working hours. While our participants suggested that they knew the medical information needed to support patients' diagnoses and treatment, they shared how they had limited nutrition knowledge. For example, one doctor shared how training in medical school did not prepare them to manage their nutrition when doing shifts, and thus struggled to understand *"how to eat well [during their shifts]…" (Participant 9, female nurse).* Thus, doctors were often left unsure how to cope with those matters, whether their patients or themselves were experiencing nutrition-related problems. Thus, a long-term strategy to support DNs is to provide them with nutrition knowledge to understand how to manage their nutrition during working hours.

4.5 Discussion

This chapter investigated the occupational influences on doctors' and nurses' workplace nutrition in the NHS and addressed the current food provisions and facilities impacting workplace health and nutrition. Additionally, it aimed to identify possible strategies within the Trust to promote workplace nutrition through immediate and long-term support. The findings focused on four areas. Firstly, the DNs' primary workplace environment (e.g., the hospital and/or in the community) contributed to their eating practices before, during, or after their shift work, in particular, the food accessibility or availability onsite and off-site. Doctors found it challenging to settle into the workplace as new and/or junior doctors. Our results suggest junior doctors often feel overwhelmed with their clinical responsibilities, impacting their workplace health and nutrition. Conversely, workplace culture in the context of social gatherings presented as a facilitator of good workplace nutrition, with opportunities to eat and drink and for psychological support. However, such gatherings could also be a barrier to good nutrition, with poor food choices, including high fat and sugar consumption. Thirdly, despite these opportunities for social gatherings, workplace culture and regulations were significant barriers to good eating practices. Staff shortages meant our cohort could not have break opportunities for a sit-down food meal due to a high workload. However, access to water, such as a water fountain or carrying around a water bottle, was a barrier to staying hydrated during their shifts. Lastly, implementing effective strategies is crucial to overcoming workplace barriers hindering positive health and nutrition outcomes and promoting necessary workplace nutrition.

4.5.1 Locations environment

The locations and environments of DNs' main working space are barriers to good workplace nutrition during working hours. Our findings suggest that the work location within the hospital influences eating practices due to little to no food accessibility. Doctors shared how working in peripheral sites away from the main hospital building, where the shops and cafeteria were, meant food was difficult to access. For example, our result highlights the need for DNs to take time out during their shifts to make deliberate journeys to another building for food. However, as supported by previous studies, there is often uncertainty regarding food availability upon arrival or the possibility of the canteen being closed (Lemaire *et al.*, 2011; Monaghan *et al.*, 2018). As a result, our cohort talked about how they would opt to use vending machines instead. Yet, our study did not continue to fully comprehend the impact of consuming food and drink from vending machines and the impact on DNs' health and nutrition. Nevertheless, previous research highlighted the benefits of vending machines due to their availability around the clock, despite the poorer nutritional content overall (French *et al.*, 2001; Gupta *et al.*, 2019). Another study explored shift workers' eating practices and why they chose to eat or not at particular work times (Waterhouse *et al.*, 2003). In this study, the hospital canteen was extended to the early morning hours (i.e., until 02:30) for nurse shift workers; however, hot food availability was limited. As such, Waterhouse *et al.* (2003) found that those working on night shifts had a lower frequency of eating across all food types, including the reduced amount of hot food consumed, compared to day shift workers. One plausible reason for the changes in these eating habits at work could be the environmental factors such as food accessibility and availability. Returning to our present qualitative study, our DNs finding reinforce the significance of food accessibility and availability in influencing workplace nutrition among doctors and nurses. Remarkably, even two decades after the publication by Waterhouse *et al.* (2003), the experience of DNs remain the same, often enduring prolonged periods of hunger and therefore, relying on snacks available within reach or the food brought from home. This lack of change in supporting DNs' food accessibility can consequently be perceived as something that is not a priority for the hospital's agenda, but rather described as the unimportance of DNs' workplace nutrition. Therefore, workplace locations and environmental factors can be barriers to good workplace nutrition.

The hospital's location influences DNs' nutrition before, during, and after their shift work. Our data suggest that those working in a hospital in a built-up environment have the advantages of easy food accessibility (i.e. when onsite food purchases are unavailable) and social activities (i.e., exercise to help destress after their shift). For example, if the food were unavailable onsite, perhaps due to the canteen closure, outside food sources surrounding the hospital location would be the alternative. This observation suggests a possible link between the food environment and purchasing behaviours; however, our study did not focus on this particular area concerning DNs' nutrition intake. Despite this, studies on food accessibility in the wider scope of literature have demonstrated that proximity to food sources influences the types of food purchased and the characteristics of the trips made between locations of interest (Richardson *et al.*, 2011; Kerr *et al.*, 2012; Thornton *et al.*, 2017). Consequently, in our study, environmental factors appear to be associated with eating dietary behaviours, particularly in a more populated area surrounding the hospital. Our cohort resonates with this finding, with those working in a more isolated workplace community experiencing poorer workplace nutrition when onsite food availability is limited and external options outside the hospital are inaccessible due to the hospital's location in the community.

Shift workers who use public transport to and from work cited how passing food shops, especially after work, influenced their food purchases. For example, travelling past food shops would influence participants to purchase unnecessary food, leading to poorer eating practices, thus increasing food with a poorer nutrient content (Thornton *et al.*, 2017; Gupta *et al.*, 2019). In addition, our cohort noted that travelling home while hungry due to prolonged shift work with little to no eating opportunities contributes to poorer food choices, such as unhealthy snacking. Thus, the locations where food shops with fewer healthy food options are along the commuters' routes could influence poor dietary practices (Janssen *et al.*, 2018; Caperon *et al.*, 2019; Mackenbach *et al.*, 2019), leading to poor health and risks of obesity. Another factor in using public transport is the walking distance, where food shops' opening hours (i.e., staying open late) could promote poorer nutrition outcomes due to the less healthy food available at certain times. Therefore, these factors, such as the location of food shops and the use of public transport for the commute, demonstrate the multifaceted nutrition determinants associated with individuals' dietary choices, as previously evidenced, addressing the complexity of understanding poor eating behaviour (Shepherd, 1999b; Gedrich, 2003; Popkin, Duffey and Gordonlarsen, 2005; Brug, 2009; McNaughton *et al.*, 2012; Okoro, Musonda and Agumba, 2017; Caperon *et al.*, 2019; Lima *et al.*, 2021). While using public transport has benefits (Rissel *et al.*, 2012; Mueller *et al.*, 2015), the workplace location and distance from home could impact DNs' health and nutrition.

4.5.2 Workplace facilities

The availability and accessibility of doctors' mess and staff room during working hours contribute to their workplace nutrition and health. As such, a staff room is not simply a space for employees to sit and have food. Instead, it is making the most of the break spaces to ensure that it is a place where DNs can congregate for team camaraderie and time away from their busy clinical workload to rest. The literature rarely discusses the usage of staff rooms (in particular doctors' mess) and its impacts on shift workers. However, a doctor's mess is a place that enables employees to be away from their clinical activities and is described as a "haven of relative tranquillity" (Hooke, 2008). Furthermore, it is a place where colleagues can communicate about their challenges at work, ask for advice and seek answers from more senior colleagues (Raw, 2003). Zhu and Shepley's (2022) mixed-method study explored nurses' break environment preferences, focusing on the functions and design features that restorative spaces should have to meet the shift workers' needs. Results suggest that having well-lit break areas, preferably with natural daylight and exterior views, that are quick to access from immediate working space (i.e., to deliver patient care) and separated from "on-duty" rooms with appliances and comfortable furniture equipped within the space were highly recommended. Previous literature evidenced that having a satisfactory break area and working environment was associated with lowering perceived stress and fatigue, promoting emotional, physical and cognitive restoration, leading to increased patient outcomes and of their safety (Alexandrova-Karamanova *et al.*, 2016; Cordoza *et al.*, 2018; Knupp *et al.*, 2018; Peterson *et al.*, 2019; Riley *et al.*, 2021). Indeed, understanding the physical characteristics of the working/ indoor environment could influence health and wellbeing, especially within the healthcare system (Salonen *et al.*, 2013). The staff room is an undervalued resource. However, our study suggests that not only is the availability and accessibility of a staff room for breaks important, but the environmental design of the space can also contribute to overall individual health. Thus, there is the opportunity to explore the environmental factor to understand how it can further impact doctors' and nurses' workplace health and nutrition.

The workplace canteen is a barrier to good eating practices during working hours. As noted by all our participants, its main barrier is the restrictions of opening hours, not coinciding with the DNs' clinical work breaks, and being able to purchase (hot) food when needed. Previous work evidenced that inaccessibility to workplace food facilities and the main canteen is related to poor eating habits – for example, it contributes to poor meal quality and the irregularity of consumption (Leedo *et al*., 2017; Saulle *et al*., 2018; Lucia *et al*., 2021). While our study did not specifically explore the food quality of the canteen, previous research addressed the association of access to canteen services with reaction time and the mood of the personnel (Leedo *et al.*, 2017). Results from Leedo *et al*. (2017) evidenced that providing healthy food and snacks at regular times during shifts improved employees' dietary intake, suggesting positive long-term health benefits in addition to their clinical performance. Similarly, a systematic review (Lucia *et al.*, 2021) highlighted how the food landscape, such as the hospital workplace environment, influences healthcare professionals' dietary behaviours and how having accessible food provisions and facilities can improve workplace dietary habits. Considering these results with our study, we can ascertain that the availability and accessibility of onsite canteen could be barriers to good eating practices during working hours and lead to risks of other health diseases (Nea *et al.*, 2015; Han, Choi-Kwon and Kim, 2016; Heath, Dorrian and Coates, 2019; Hepsomali and Groeger, 2021a).

On the other hand, other general food outlets onsite tended to have 24-hour availability, yet these facilities only provided cold food and a range of unhealthy choices. While this provides an alternative food source, participants still need to take time out from work to walk to these hospital facilities. However, they are often disappointed, as food or snacks are not guaranteed upon arrival. Thus, our participants experienced more frustration and hunger, indicating the importance of (healthy) food availability around the workplace – whether onsite purchase or home-brought food- to ensure they have something to eat when needed. Previous evidence also noted that shift workers preferred to eat cold and fast food rather than hot food and tended to nibble snacks rather than a full meal (Morikawa *et al.*, 2008). Additionally, having unhealthy food options in the healthcare environment can impact shift workers' work morale and motivation (Torquati *et al.*, 2016; Horton Dias *et al.*, 2022). Considering all the evidence, poor workplace facilities and food provision can negatively impact nutrition, lifestyle behaviours and work. Thus, there is a necessity to improve the healthfulness of workplace food and nutrition offerings for healthier workplace food choices.

Vending machines are easily accessible and available around the clock, despite the limitations of lack of hot food with vending machine content, which is also known to be high in fat, sugar and salt (Bell *et al.*, 2013; Pechey *et al.*, 2019; Utter and McCray, 2021). Our participants demonstrated their knowledge of the food's healthiness and poor nutritional values from the vending machines. Nevertheless, due to limited break opportunities and time to purchase food onsite, our cohort preferred vending machines as an alternative food source during working hours. Previous research has identified that vending machines could solve employees' poor workplace diet by altering food and drink availability with healthier options to reduce overconsumption of poor dietary food (Booth *et al.*, 2001; Brug, 2009; Boelsen-Robinson *et al.*, 2017; Pechey *et al.*, 2019). Pechey *et al.* (2019) employed the effectiveness of alternating the UK hospitals' vending machine content with including healthier options. Though no significant differences were reported in the reduction of energy purchased and any consistent patterns, the authors suggested that increasing availability and exposure of healthier items might lead to the purchases of those items due to their novelty effect. An Australian study indicated that increasing availability of healthier food and drink options in hospitals' vending machines also changed individuals' food choice behaviours (Boelsen-Robinson *et al.*, 2017). Considering these examples, motivating and changing individuals' behaviours towards food choices through facilities that are widely accessible and available (i.e. vending machines) could increase health promotion. As discussed previously, DNs experience various occupational challenges with no time for break opportunities. As such, while vending machines are widely available, the question remains if they are meeting the needs of the consumers, in our case DNs, during their shifts. Moreover, whether or not effective interventions to alter food and drink content could address the barriers to accessing onsite canteens and food outlets, nevertheless, special attention to environmental barriers could be the key motivator for improving shift workers' health and nutrition.

Limited water accessibility during working hours was a prominent topic in our results. Our cohort presented the barrier to staying hydrated during their shift when water intake was the alternative to limited eating opportunities. DNs recognise the benefits of maintaining hydration, such as its association with influencing cognitive function, leading to impacts on productivity and increasing work-related accidents (Adan, 2012;

Alomar *et al.*, 2013; Masento *et al.*, 2014; D'Annibale *et al.*, 2021). However, our findings indicated that water accessibility during working hours was also a challenge experienced by our cohort. For example, DNs were discouraged from drinking water even though a lid on the bottle was seen as unprofessional. Our study did not specifically result in the prevalence of dehydration in our cohort. However, previous evidence demonstrates that dehydration during shifts contributes to poorer dietary habits, sleeping patterns and cognitive experiences (Lemaire *et al.*, 2010; Kase *et al.*, 2022; Makowski *et al.*, 2022). However, the lack of functional water accessible and available points near DNs' primary working areas found in our study meant our participants could not stay hydrated without spending the extra time to find the nearest working water fountain. The Eatwell Guide recommends water as part of a healthy nutrition diet (Public Health England, 2016; Buttriss, 2017). Yet, our findings found the lack of supportive guidance from the workplace (i.e., hospitals and trusts) insufficient, preventing DNs from having the opportunity to drink when needed rather than drinking only when on breaks, if any. This could arguably suggest that DNs are expected to conduct their clinical responsibilities (Gillespie *et al.*, 2018), though the necessities of food and drink consumption with break opportunities are limited to none. Quite frankly, as Mannion and Davies (2018) described, workplace culture is a big contributing factor as both a culprit and a remedy to address DNs' workplace nutrition. As a result, our findings highlight the importance of hydration during working hours to aid work performance and cognition as DNs experience fatigue and tiredness, and thus the need to ensure that water accessibility is available as an alternative approach when food consumption was not always possible.

4.5.3 Work expectations

Junior doctors shared the challenges of work expectations, with high workload demands and limited support from colleagues to settle into the workplace. Doctors often experience being pushed to the limit, impacting their work morale and work-life balance, including their health and nutrition during working hours as they work continuously (Brown *et al.*, 2010; O'Dowd *et al.*, 2018; Hatem and Halpin, 2019; Torquati *et al.*, 2019; Riley *et al.*, 2021). Previous research evidenced the poor and toxic environment that doctors work in (Barber *et al.*, 2018; Wise, 2018; Riley *et al.*, 2021), with a blame culture experienced by junior staff colleagues and an unsupportive, vulnerable and stigmatised system resonating with our findings. For example, there is an association between workplace culture and its influence on workplace nutrition. Riley and Weiss (2015) reported that the excessive workloads and inappropriate spaces or basic facilities at work (e.g. access to nutritious food and drink) were key sources to psychological stress/ distress experienced by junior doctors. Furthermore, Solovieva *et al* (2013) identified an association between working overtime with weight gain, suggesting that being in a stressful occupation promoted unhealthy eating practices and thus consuming more food, in particularly alcohol consumption. Considering these evidence together, it could therefore suggests that a poor workplace culture such as poor morale and motivation due to lack of functional and inaccessible workplace facilities in combination with a stressful occupation could impact healthcare professionals the opportunities to eat when needed but eating nutritiously for healthier choices. As such, our result further adds to the literature, suggesting the need to support new or junior doctors settling into their workplace and embedding a healthy culture where eating is a norm can help them cope with their challenges. Therefore, supporting DNs' poor working culture is to help improve their nutrition towards healthier eating practices at work.

Our findings have suggested that high clinical workload, occupational stress and expectations could influence eating practices. DNs talked about rushing to eat food to satisfy their hungry stomachs rather than enjoying the food before them and being present (Nelson, 2017). Previous literature has cited the importance of mindfulness eating (O'Reilly *et al.*, 2014; Nelson, 2017; Mantzios, Skillett and Egan, 2019). As such, evidence supports the notion that this type of distraction can contribute to emotional and binge eating, ultimately resulting in increased weight gain and the prevalence of obesity. This can be attributed to external food-related cues, such as food's sensory aspects, which could influence food consumption (van Strien, Herman and Verheijden, 2009; O'Reilly *et al.*, 2014; Grider, Douglas and Raynor, 2021). However, relating it to the healthcare professional sector and our DNs cohort, there is limited evidence to support practising mindfulness eating and its impact on health and nutrition. A plausible evidenced link for our DNs could be the association between unhealthy snacks and mindfulness eating (Mantzios, Skillett and Egan, 2019), where our previous result (Chapter 3) identified that snack consumption is part of DNs' regular diet at work. Though Mantzios *et al.* (2019) yielded no significant difference between the control and intervention groups of exercising mindfulness eating on chocolate consumption, reduced consumption was noted post-exercise in the intervention group. Other studies also reported reduced calorie consumption from palatable snacks (i.e. chocolates and sweets) (Mason *et al.*, 2016; Seguias and Tapper, 2018). Thus, this resonates with our DNS cohort when they rely on portable snacks (highly salty, fatty and sugary) where and when possible between clinical cases. This finding could suggest the importance of considering external factors when improving shift workers' workplace nutrition. Overall, having sufficient space onsite for DNs during their breaks facilitates their eating and drinking opportunities and aids mindfulness eating habits (Nelson, 2017), improving their nutrition.

4.5.4 Working social and culture

Our cohort cited the benefits of working as a team where social gatherings with colleagues promoted healthier workplace nutrition, such as enjoying team camaraderie through the team's tea/ coffee breaks during their working hours. This enables DNs to have eating opportunities and peer support to help maintain their work morale (Boerjan *et al.*, 2010; Fujishiro *et al.*, 2017; Chandler, Briggs and Whitfield, 2019; Horton Dias and Dawson, 2020). Boerjan *et al.* (2010) examined the influence of workplace social support on doctors, with the survey result highlighting that the higher the level of autonomy and social support, the healthier the doctors are likely to be. Dias and Dawson (2020) further highlight the acceptability of partaking in social activities, such as sharing food with peers during team outings/ activities influencing their dietary behaviours. Thus, the benefits of team eating and activities promote positive psychological wellbeing in busy healthcare settings (Firth *et al.*, 2020), with research demonstrating its importance on DNs' interdisciplinary approach to working with other healthcare professionals and improving their clinical practices (Harrod *et al.*, 2016; Murden *et al.*, 2018; Toomer *et al.*, 2018; Walton *et al.*, 2019; Hamwey *et al.*, 2021). However, the use of cakes and sweet bakes in team activities can be a barrier to workplace nutrition as they often contain high fat and sugar, contributing to transient changes in mood (Lacasse and Leo, 2005) and feelings of sleepiness (Panossian and Veasey, 2012; Prather *et al.*, 2016; Godos *et al.*, 2021). Though previous research has not directly explored doctors' and nurses' workplace diets, our findings add to the literature and suggest that other occupational responsibilities can also impact changes in mood and sleepiness due to the lack of break opportunities. Thus, coupled with the high demands of clinical responsibilities, the lack of eating opportunities and poor eating practices during team activities could lead to DNs' poor workplace nutrition.

Workplace culture in the context of power dynamics between colleagues and job hierarchy also influences workplace nutrition. Power dynamics were a facilitator and a barrier to workplace nutrition. Our findings suggest that some senior colleagues would recognise and attempt to address the challenges, such as overly stressed and burnout junior staff (Passi and Johnson, 2016; Rich *et al.*, 2016; Hirayama and Fernando, 2018; Kinman and Teoh, 2018; Creese, Byrne and Matthews, 2021). Conversely, the power dynamic could sometimes be abused by senior colleagues in the workplace (Crowe, Clarke and Brugha, 2017). Brogan *et al.* (2021) examined nurses' barriers and enablers of healthy eating and physical activity levels through semi-structured interviews. This study used a socioecological model to understand the complexity of workplace and occupational factors. Results found that food was used as a reward when completing a night shift or experiencing difficult situations, with the importance of being accepted and fitting into the team; thus, eating discretionary food was cited as an integral part of their routine at work. Perhaps a plausible reason could be that those colleagues were hungry due to the prolonged shift with no eating or break opportunities; hence, the food provided could influence working overtime. Nevertheless, having a positive workplace culture influences the health and nutrition of shift workers.

4.5.5 Break opportunities

The lack of break opportunities in our study was a challenge more or less experienced by all of our participants and a barrier to practising healthy eating during working hours. Doctors, more than nurses, experienced little to no break opportunities due to their clinical responsibilities and often being the only doctor in the department. For example, as mentioned in the previous chapter, the unbalanced ratio between doctors and nurses (Shekelle, 2013; Hodgson, 2014) during a shift influenced the doctors' flexibility in planning their dietary intake as their break opportunities depend on available staff numbers and the clinical workload. However, because of the organisational system, there are more nurses during a shift, suggesting that they could cover each other during working hours for break opportunities and, therefore, be more able to practice healthy workplace nutrition. The European Working Time Directive (EWTD) is The Working Time Regulation 1998 applicable across the UK, where employees working a maximum of 48 hours per week must have a 20-minute rest break when working more than six hours a day. This regulation generally applies to everyone to ensure workplace health and safety, supporting a safe and effective workforce within the healthcare sector. Though the EWTD protects all employees (British Medical Association, 2021), in reality, this does not happen for our participants. Our findings suggest the poor experiences that our doctors face – with staff shortages and the increased workload and patient expectations; doctors do not have any time to take a break. This results in doctors themselves suffering the consequences of no break opportunities, with prolonged working periods and often overtime to deliver patient-centred care around the clock in poor working conditions where healthy food options are not available and accessible.

4.5.6 Nutrition is personal

Our results noted the lack of nutrition education given to DNs and their inability to understand how to eat correctly themselves. Thus, the lack of knowledge of nutrition and education could suggest its impact on their eating practices. DNs already confirmed (in the previous qualitative result chapter) that they use night shifts to eat what they want. However, our participants presented confusion, particularly among doctors, on how to eat during night shifts. A plausible solution suggested was "flipping" their routine to fit their night working patterns and practices (i.e. eating breakfast during the night, from day to night shift). As such, one matter arising from this could be whether or not DNs lack nutrition knowledge or whether the implications of shift work contributed to their poor nutrition during shift work. Our study did not explore healthcare professionals' nutrition awareness or knowledge when considering workplace nutrition but instead explored their dietary habits during shift work. The result from an earlier chapter (Chapter 3) indicated that DNs would choose healthier dietary options if available, indicating some evidence to justify that they have some nutrition knowledge but raising the question of whether work patterns have influenced their nutrition/ diet. Previous literature indicated the importance of doctors' knowledge of nutrition. It is not about having the skills to provide nutrition care to patients to improve their dietary behaviours, but resonating with our current study, the need for DNs to understand how to improve their workplace nutrition when faced with occupational and clinical challenges (Sunguya *et al.*, 2013; Schoettler *et al.*, 2015; Crowley, Ball and Hiddink, 2019; Grammatikopoulou *et al.*, 2019; Carter *et al.*, 2022; Jones *et al.*, 2022). Moreover, cited as essential across different countries (i.e. USA, New Zealand, Australia, Greece, and the UK), nutrition implementation within the medical education programme with access to evidence-based nutrition information will improve medical assessment opportunities (Schoettler *et al.*, 2015; Grammatikopoulou *et al.*, 2019; Carter *et al.*, 2022; Jones *et al.*, 2022). Considering the significance of nutrition education and knowledge and its contribution to DNs' workplace nutrition and dietary practices, it is necessary to explore whether DNs' health and nutrition are influenced by their limited nutrition knowledge or shift work patterns.

Nutrition has been identified as a "personal thing" by our participants, depending on the individual to make proactive changes instead of waiting for their "employer to look out" for them. Here it could suggest how the role of the employers and the employees regarding workplace nutrition remains unclear, as the priority within the healthcare system is often the delivery of quality patient – rather than staff - care. Previous literature does not explicitly look at workplace nutrition in the healthcare setting. Nevertheless, it has indicated that the perceptions surrounding the importance of healthy employees and the employers' responsibilities (i.e. leadership and management) and beliefs in promoting a healthy workplace should contribute to influencing positive workplace health (Gabel *et al.*, 2009; Pescud *et al.*, 2015; Shearer, Graham and Skinner, 2016). For example, nutra-ergonomic strategies such as improving employment standards, workers' safety and performance will enhance the workplace environment and the health and wellbeing of workers (Shearer, Graham and Skinner, 2016). Likewise, influencing employees' workplace health and wellbeing is not just ensuring workplace occupational health and safety but rather addressing the multifaceted factors, including education and training to ensure employees have the satisfactory skills and knowledge to understand how to deal with workplace challenges (Pescud *et al.*, 2015). While our study has cited that nutrition is personal and individual, the responsibility and role of workplace nutrition nevertheless should be shared between the employers and employees, ensuring that nutrition knowledge is embedded within the training curriculum and practiced within the workplace to support a good workplace nutrition.

4.5.7 Workplace regulations

Workplace regulations further restrict DNs' health and nutrition by impacting their choice of food and opportunities to eat during their shifts. Hospital guidelines prevent possible risks to personnel, and eating or drinking by staff was thought to be viewed as unprofessional by patients (Weinbroum *et al.*, 2007; Callahan and Seifi, 2016; Bartek, Verdial and Dellinger, 2017; Loison *et al.*, 2017; Kokkinos *et al.*, 2020). One example shared by our doctors was the inconvenience of wearing hospital scrubs when wanting to go out of the operating theatres for food. Surgical scrubs are easily seen as a representation of those working either as nurses or doctors and are associated with the risks of biological hazards in their working area (Callahan and Seifi, 2016). However, debates on infections and cross-contaminations about the respectability of this conduct have previously been discussed, with DNs often seen outside their clinical areas in the hospital canteen and or travelling to and from work (Weinbroum *et al.*, 2007; Tziner *et al.*, 2015; Bartek, Verdial and Dellinger, 2017). Our results indicate how such regulations impact their eating practices and behaviour towards following the rules – for example, those who chose to break the rules because of the time needed to change. Perhaps following the rules can be cumbersome. Our results demonstrate whether doctors' choices were influenced by their attitudes or behaviour because they wanted to access food quickly and with less burden. Conceivably, our cohort could suggest a lack of awareness and knowledge of the regulation, which may explain the inconsistency of regulation compliance and impact their workplace dietary behaviours. Nevertheless, workplace regulations demonstrate barriers to good nutrition and that hospitals should look at the food provisions in the vicinity, for example, in operating theatres, to remove barriers to shift workers' access to food when needed.

4.6 Conclusion

In conclusion, this chapter consolidates the key findings regarding the impact of occupational factors on doctors' and nurses' workplace nutrition during shift work. It also addresses the current state of food provisions and facilities affecting their workplace health and nutrition, proposing potential strategies for improvement. Three overarching areas were identified: the workplace environment (i.e., working within the workplace and where their workplace is situated in the community), the workplace culture, and the regulations (i.e., break opportunities and accessibilities and availabilities to water intake). These factors significantly influence the workplace nutrition of doctors and nurses, as demonstrated by our findings. Barriers in these areas not only influence their eating opportunities but also impede the basic necessity for DNs to have access to during their shifts. Addressing these factors requires organisational management at the Trust level to prioritise workplace nutrition. Thus, our results indicate the need to highlight the lack of sufficient support that doctors and nurses receive from the organisation in ensuring the mental and physical wellbeing of doctors and nurses, highlighting the need to go beyond peer support. As a result, our participants also suggested strategies to enhance workplace nutrition during shifts.

The overall dietary practices of DNs, therefore, remain suboptimal. Challenging working environments with limited break opportunities, poor food choices influenced by workplace culture, and inadequate access to healthier food options contribute to DNs' irregular eating patterns. As such, this study demonstrates the importance of considering other workplace facilities and provisions related to diet and nutrition to support the workplace nutrition of DNs. Considering this, our result emphasised the necessity of having sufficient, available, and easily accessible food provisions and facilities within their immediate working areas to ensure DNs have opportunities to eat and drink when breaks are limited. However, our results also highlight that workplace factors, such as clinical workload, could suggest an association with barriers to food purchasing onsite. For example, the workplace canteen is only available at certain times during the day, with DNs unable to leave their clinical duties to purchase hot food at the canteen. Thus, it is essential to consider the occupational and workplace environmental factors when investigating how best to support and improve DNs' workplace nutrition during shift work, adopting a flexible approach to food provisions. Therefore, this study highlights the need for a more comprehensive approach that ensures food facilities and provisions are available and accessible around the clock, considering the demands of their work environment and occupational factors, to enhance DNs' workplace nutrition.

CHAPTER 5: UK BIOBANK QUANTITATIVE STUDY RESULT 1

Doctors and nurses have poor dietary intake and nutrition behaviour during shift work (see Qualitative Study, Chapter 3 – 4). For example, poor workplace nutrition has influenced DNs to opt for caffeine and high snack consumption at work due to clinical workload and facility accessibilities. Furthermore, DNs encounter occupational challenges to healthy workplace eating, hindering their compliance with dietary recommendations such as the Eatwell Guide (Public Health England, 2016) aimed to mitigate risks of poor health outcomes. Based on our earlier findings and existing literature, there remains a limited understanding of the overall workplace diet of DNs across UK healthcare professionals and its alignment with dietary recommendations. As a result, this chapter aims to explore the dietary intake of DNs during their shift work. Furthermore, to understand the characteristics of DNs' dietary intake/ quality, for example, the current intake amount in different food groups at work. The UK Biobank dataset, therefore, provided a cross-sectional understanding of the DNs with shift work. As described in the methods chapter (see Chapter 2), this chapter will explore the different features such as the food groups (i.e., fruits and vegetables, meat and fish, dairy food, and fluid intake) and the dietary quality scores such as the Healthy Diet Score and the Partial Fibre Score available from the UK Biobank – see Chapter 2 (Methodology Chapter). The selected features will then be analysed using SPSS and a Mann-Whitney U test to determine the significant results between doctors and nurses. Following this, a discussion will focus on whether the cohort adheres to dietary recommendations, aiming to determine the impact of shift work on DNs' dietary intake and nutritional behaviour.

5.1 Descriptive statistics

5.1.1 Demographics (Table 9)

There was no statistically significant difference in participants' age between DNs ($p=0.889$). The average age of the total cohort at the time of participation (time 0) was 68.9 years (SD 7.591), with doctors slightly younger than nurses (68.88 years ± 7.955

vs 68.91 years ± 7.398, respectively). The age ranged from 52 – 85 years, consistent across both groups.

There was an imbalance of gender in the sample (Table 10 and Figure 11), with 80.4% female and 19.6% male overall. However, separating doctors from nurses, the ratio of male vs female doctors was more similar (50.7% vs 49.3%, respectively) compared to nurses, where there were more females than males (95.6% vs 4.4%, respectively).

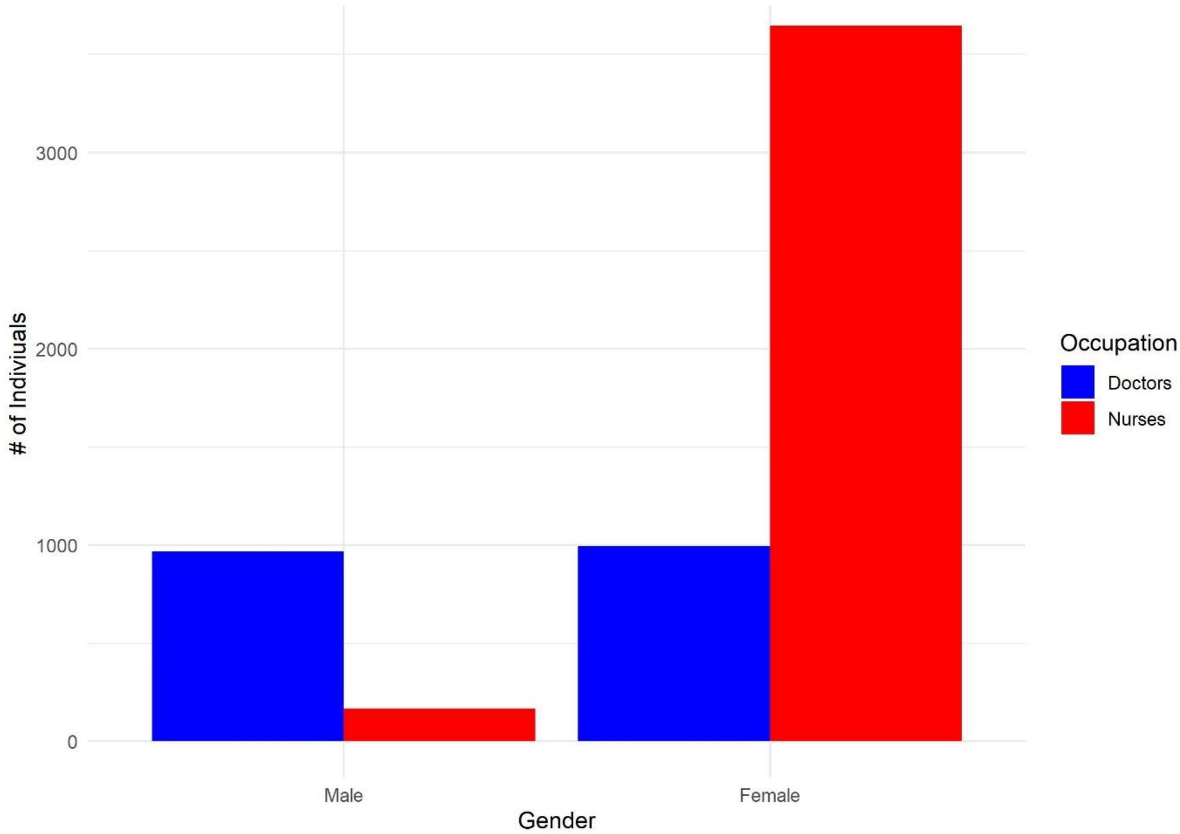

Figure 11: Gender of doctors and nurses from the UK Biobank dataset

The ethnicity distribution in the total sample was statistically significant (p<0.001) within the total sample, doctors and nurses. Most participants were from a White British background (87.5% of the total, 83.3% of doctors, and 89.6% of nurses), followed by ‘any other white background’ ((4.5% of the total, 6.6% of doctors, 3.4% of nurses) and Irish participants (3.2% of the total, 2.9% of doctors, and 3.4% of nurses)). Other ethnic groups were underrepresented.

The Body Mass Index (BMI) (Figure 12) between DNs was statistically significant ($p<0.001$) between the groups, with nurses having a higher mean BMI than doctors (26.82 kg/m^2 ±5.08 vs 25.32 kg/m^2 ± 3.82 kg/m^2, respectively), with the overall mean being 26.31 kg/m^2. However, the overall BMI ranged from 14.68 – 56.09kg/m^2 (SD 4.739 kg/m^2) across the total sample. Results from DNs reporting similar findings separately (14.91 – 56.09kg/m^2 ± 3.818kg/m^2 and 14.68 – 53.73kg/m^2 ± 5.076kg/m^2, respectively). Categorising the BMI results, most fell into the 'healthy' group (45.7% of the total, 51.9% of doctors, and 42.5% of nurses), followed by 'overweight' (35.6% of the total, 36.6% of doctors, and 35% of nurses). A small proportion of participants reported being 'underweight' (0.6% of the total, doctors and nurses).

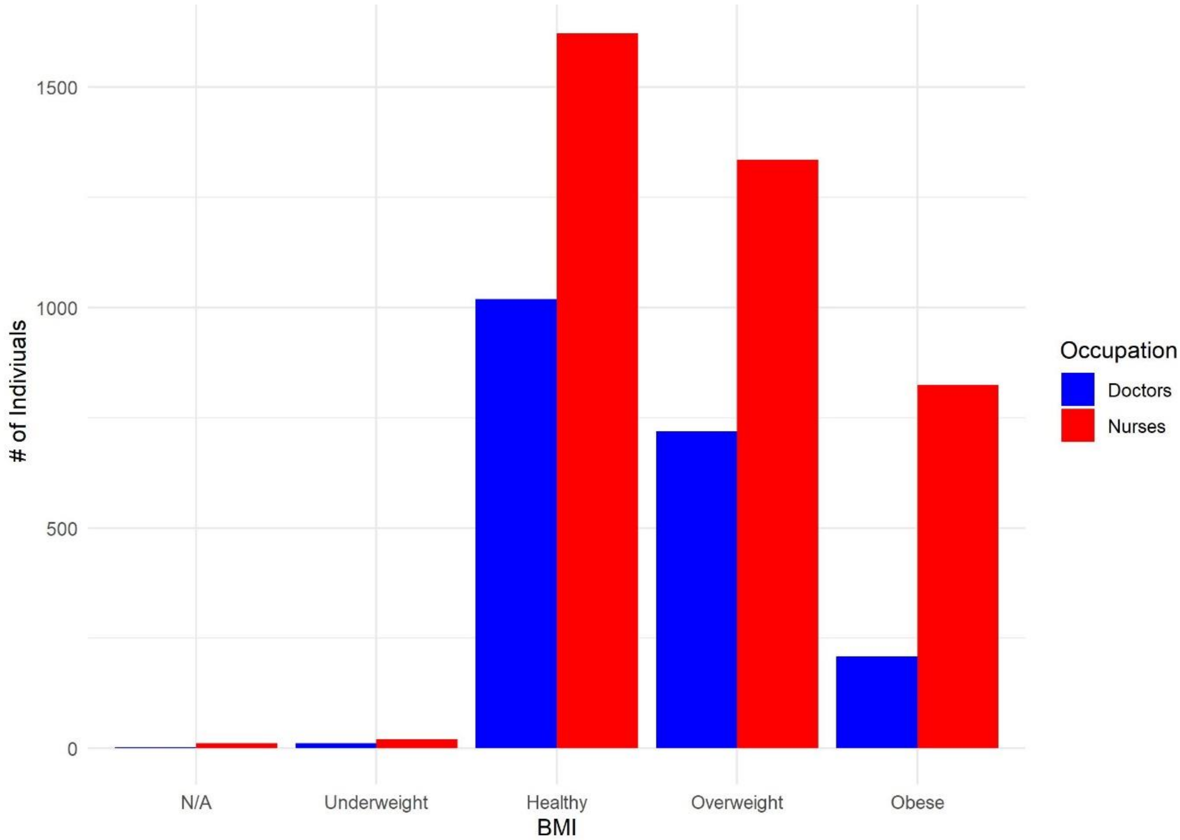

Figure 12: BMI of doctors and nurses from the UK Biobank dataset

Table 9: Age, Ethnicity and BMI of doctors and nurses from the UK Biobank dataset (descriptors with a measure of central tendency)

Descriptor	Measures	Total n (%)	Doctors n (%)	Nurses n (%)

Participants		5777 (100)	1962 (33.96)	3815 (66.04)
Age	Mean	68.90	68.88	68.91
	Median	69.00	69.00	69.00
	Minimum	52.00	53	52
	Maximum	85.00	85	85
	Standard Deviation	7.59	7.96	7.40
	Mann-Whitney U	3750850.50		
	Standard Error	59992.71		
	Asymptotic Sig.(2-sided test)	0.889		
Ethnicity	Prefer not to answer	8 (0.1)	3 (2.0)	5 (0.1)
	Do not know	1 (0.0)	0 (0.0)	1 (0.0)
	White	1 (0.0)	0 (0.0)	1 (0.0)
	Mixed	1 (0.0)	0 (0.0)	1 (0.0)
	Chinese	29 (0.5)	10 (0.5)	19 (0.5)
	Other ethnic groups	56 (1.0)	29 (1.5)	27 (0.7)
	British	5054 (87.5)	1635 (83.3)	3419 (89.6)
	Irish	187 (3.2)	57 (2.9)	130 (3.4)
	Any other white background	258 (4.5)	129 (6.6)	129 (3.4)
	White and Black Caribbean	5 (0.1)	1 (0.1)	4 (0.1)
	White and Black African	2 (0.0)	1 (0.1)	1 (0.0)
	White and Asian	8 (0.1)	4 (0.2)	4 (0.1)
	Any other mixed background	11 (0.2)	7 (0.4)	4 (0.1)
	Indian	67 (1.2)	50 (2.5)	17 (0.4)
	Pakistani	13 (0.2)	9 (0.5)	4 (0.1)
	Any other Asian background	19 (0.3)	10 (0.5)	9 (0.2)

	Caribbean	23 (0.4)	3 (0.2)	20 (0.5)
	African	32 (0.6)	12 (0.6)	20 (0.5)
	Mann-Whitney U	3553048.50		
	Standard Error	34442.49		
	Asymptotic Sig.(2-sided test)	<.001		
BMI	N/A	15 (0.3)	3 (0.2)	12 (0.3)
	Underweight	33 (0.6)	12 (0.6)	21 (0.6)
	Healthy	2641 (45.7)	1019 (51.9)	1622 (42.5)
	Overweight	2054 (35.6)	719 (36.6)	1335 (35.0)
	Obese	1034 (17.9)	209 (10.7)	825 (21.6)
	Mean	26.31	25.32	26.82
	Median	25.38	24.81	25.82
	Minimum	14.68	14.91	14.68
	Maximum	56.09	56.09	53.73
	Standard deviation	4.74	3.82	5.08
	Mann-Whitney U	4312627.50		
	Standard Error	59815.54		
	Asymptotic Sig.(2-sided test)	.000		

Table 10: Gender and Education of doctors and nurses from the UK Biobank dataset (descriptors with a measure of central tendency)

Descriptor	**Total n (%)**	**Doctors n (%)**	**Nurses n (%)**
Gender			
Male	1134 (19.60)	967 (49.30)	167 (4.40)
Female	4643 (80.40)	995 (50.70)	3648 (95.60)

Education			
A levels/ AS levels or equivalent	718 (12.4)	2 (0.1)	716(18.8)
College or university degree	3265 (56.5)	1923 (98.0)	1342 (35.2)
CSEs or equivalent	63 (1.1)	0 (0.0)	63 (1.7)
NA	37 (0.6)	19 (1.0)	18 (0.5)
None of the above	19 (0.3)	1 (0.1)	18 (0.5)
NVQ or HND or HNC or equivalent	34 (0.6)	1 (0.1)	33 (0.9)
O Levels/ GCSEs or equivalent	799 (13.8)	3 (0.)	796 (20.9)
Other professional qualifications	842 (14.6)	13 (0.7)	829 (21.7)

5.1.2 Characteristics of dietary consumption

Total fruit and vegetable intake (Table 11)

There was statistical significance between the DNs in their fruit intake ($p<0.001$). Doctors had a higher maximum number of daily fruit servings than nurses (30.5 vs 22, respectively) (Figure 13). Across both groups, including the total fruit intake, most participants had 2.0 – 2.9 servings of fruits per day (27.2% of total participants, 26.7% of doctors, and 27.4% of nurses) with nurses having a higher mean intake than doctors (2.840 ± 2.489 vs 2.657 ± 2.796). The distribution between DNs was similar for the total vegetable intake yet had a statistically significant difference ($p<0.001$) (Figure 14). However, nurses reported a higher vegetable intake overall than doctors (2.415 ± 2.036 vs 2.349 ± 2.104). Overall, 37.5% of all participants had 3 – 3.9 servings of vegetables daily, yet when separating DNs, 37% had 2 – 2.9 servings of vegetables daily across both groups. Considering the Eatwell Guide (Public Health England, 2016) of consuming at least five portions of various fruits and vegetables daily, our overall cohort was on the borderline of meeting the recommendation (2 – 2.9 servings of fruit and 3 – 3.9 servings of vegetables).

Table 11: Total fruit and vegetable intake per day for doctors and nurses from the UK Biobank dataset

Descriptor	Measures	Total	Doctors	Nurses

		n (%)	n (%)	n (%)
Total fruit intake	Participants	5777 (100)	1960 (33.93)	3815 (66.04)
	Mean (servings)	2.78	2.66	2.84
	Median (servings)	2.50	2.50	3.00
	Maximum	30.50	30.5	22.00
	Standard deviation	2.59	2.79	2.49
	Mann-Whitney U	3950379.50		
	Standard Error	59600.17		
	Asymptotic Sig.(2-sided test)	<.001		
Category	<2.0 servings	1286 (22.3)	490 (25.0)	796 (20.9)
	2.0 – 2.9 servings	1570 (27.2)	524 (26.7)	1046 (27.4)
	3.0 – 3.9 servings	1347 (23.3)	449 (22.9)	898 (23.5)
	>4.0 servings	1510 (26.1)	471 (24.0)	1039 (27.2)
	N/A	62 1.1)	26 (1.3)	36 (0.9)
	Mann-Whitney U	3950379.50		
	Standard Error	59600.17		
	Asymptotic Sig.(2-sided test)	<.001		
Total vegetable intake	Mean (servings)	2.39	2.35	2.42
	Median (servings)	2.00	2.00	2.00
	Maximum	40.5	30.00	40.50
	Standard deviation	2.06	2.10	2.04
	Mann-Whitney U	4022532.00		
	Standard Error	59253.97		

	Asymptotic Sig.(2-sided test)	<.001		
Category	<2.0 servings	1821 (31.5)	691 (35.2)	1130 (29.6)
	2.0 – 2.9 servings	722 (12.5)	743 (37.9)	1426 (37.4)
	3.0 – 3.9 servings	2169 (37.5)	290 (14.8)	748 (19.6)
	>4.0 servings	1038(18.0)	228 (11.6)	494 (12.9)
	N/A	25 (0.4)		

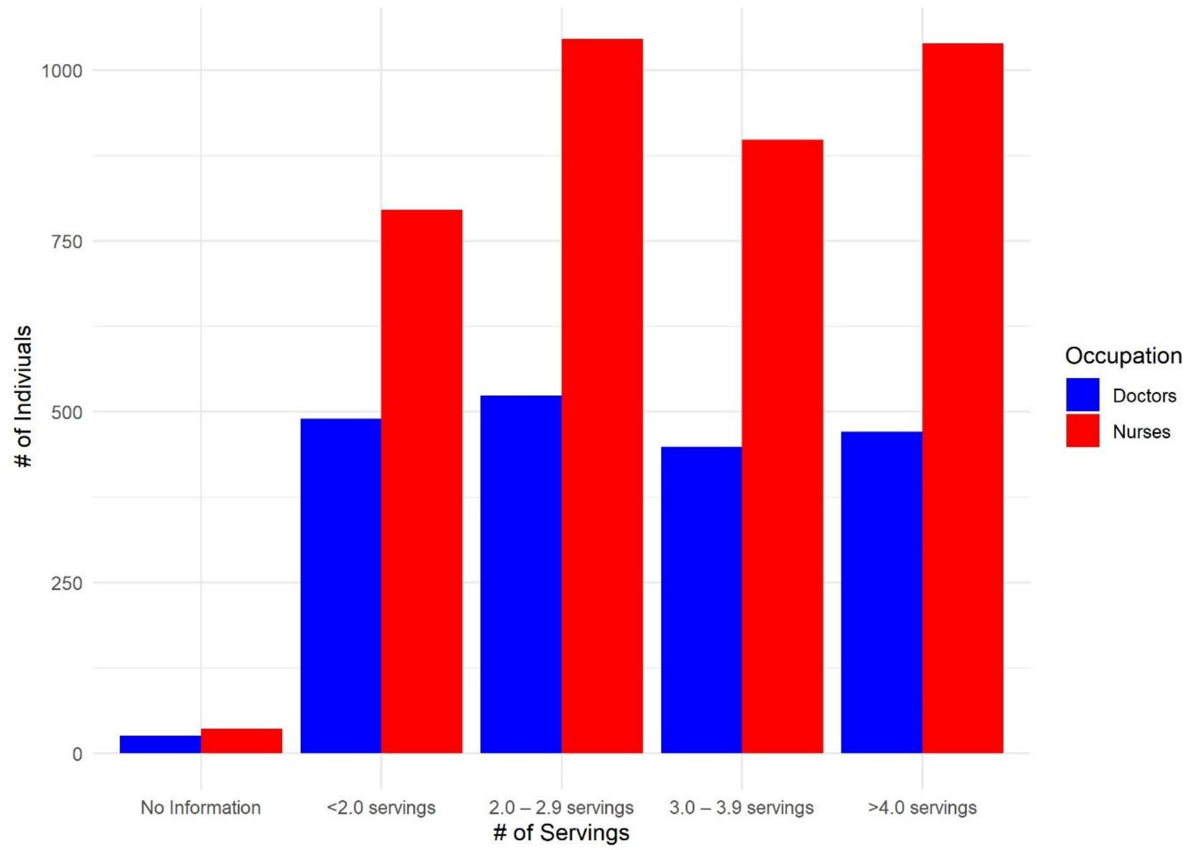

Figure 13: Fruit intake of doctors and nurses from the UK Biobank dataset

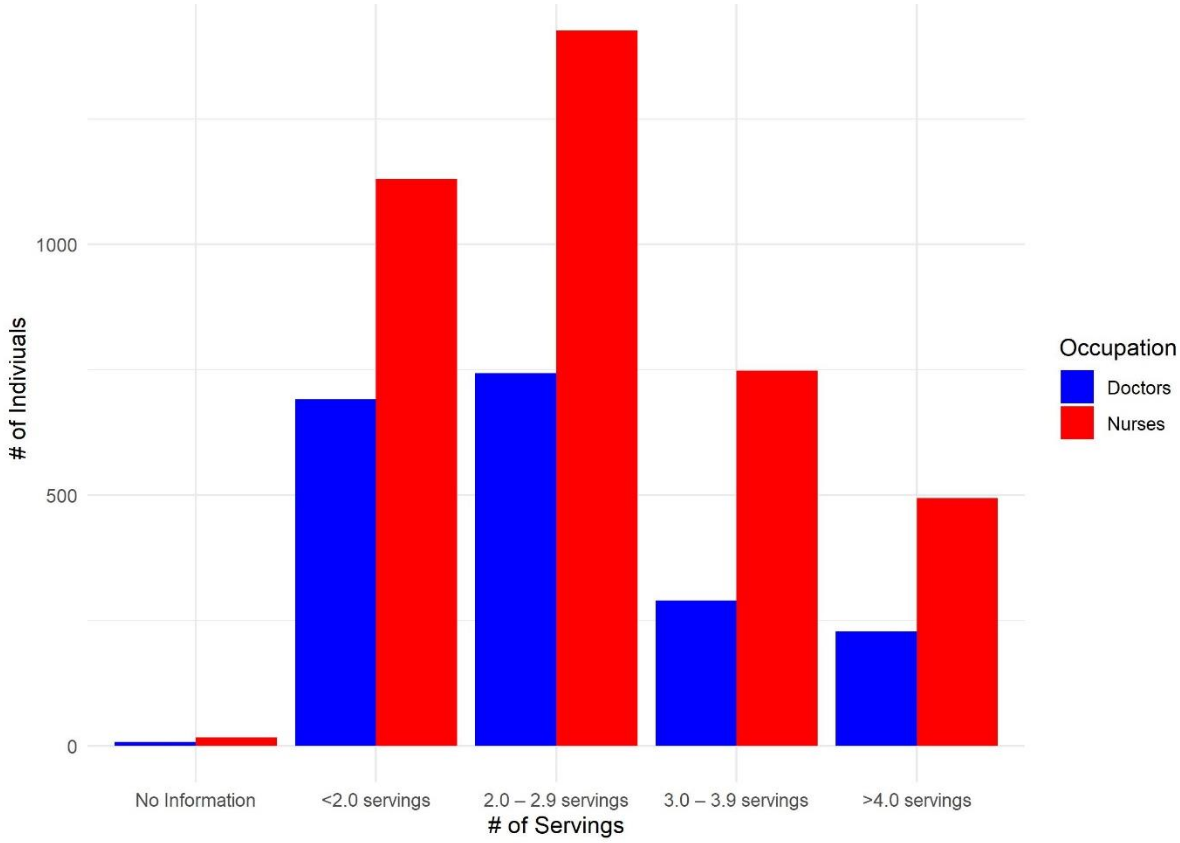

Figure 14: Vegetable intake of doctors and nurses from the UK Biobank dataset

Total meat, unprocessed red meat and fish intake (Table 12)

There was a statistical significance in DNs' meat intake (p=0.005), with doctors consuming more than nurses, on average, per week (5.350 ± 2.793 vs 5.093 ± 2.621). Across both groups, most participants consumed more than seven servings of meat per week (24% of total, 26.7% of doctors, 23.1% of nurses) (Figure 15).

Table 12 highlighted a statistical significance in unprocessed red meat intake per week between DNs (p<0.001). On average, doctors had a higher mean serving than nurses per week (2.176 ± 1.429 vs 2.053 ± 1.443). Across all groups, most participants had between 1.0 – 1.9 servings of unprocessed red meat per week (40.5% of total participants, 40.1% of doctors, and 40.8% of nurses) (Figure 16).

Fish intake (Table 12) showed no statistical significance (p=0.247) between DNs. However, doctors consumed more than nurses per week (2.339 ± 1.534 vs 2.277 ±

1.489). Overall, most participants would consume fish 1.0 – 1.9 times per week, with a higher proportion of doctors doing so than nurses (all participants = 40.2%, doctors = 42.3% and nurses = 39.1%) (Figure 17).

Table 12: Total meat, unprocessed red meat and fish intake per week for doctors and nurses from the UK Biobank dataset

Descriptor	Measures	Total n (%)	Doctors n (%)	Nurses n (%)
Total meat intake	Participants	5777 (100)	1962 (34)	3815 (66)
	Mean (servings)	5.18	5.35	5.09
	Median (servings)	5.00	5.00	5.00
	Maximum	22.50	22.50	20.50
	Standard deviation	2.68	2.79	2.62
	Mann-Whitney U	3574121.50		
	Standard Error	59885.01		
	Asymptotic Sig.(2-sided test)	.005		
Category	<3.0 servings	863 (14.9)	283 (14.4)	580 (15.2)
	3.0 – 3.9 servings	966 (16.7)	345 (17.6)	621 (16.3)
	4.0 – 4.9 servings	640 (11.1)	195 (9.9)	445 (11.7)
	5.0 – 5.9 servings	1210 (20.9)	359 (18.3)	851 (22.3)
	6.0 – 6.9 servings	692 (12.0)	257 (13.1)	435 (11.4)
	>7.0 servings	1406 (24.3)	523 (26.7)	883 (23.1)

Total unprocessed red meat intake	Mean (servings)	2.09	2.18	2.05
	Median (servings)	1.50	2.00	1.50
	Maximum	14.0	11.50	14.0
	Standard deviation	1.44	1.43	1.44
	Mann-Whitney U	3500259.00		
	Standard Error	58678.64		
	Asymptotic Sig.(2-sided test)	<.001		
Category	<1.0 servings	597 (10.3)	161 (8.2)	436 (11.4)
	1.0 – 1.9 servings	2341 (40.5)	786 (40.1)	1555 (40.8)
	2.0 – 2.9 servings	1636 (28.3)	583 (29.7)	1053 (27.6)
	3.0 – 3.9 servings	456 (7.9)	177 (9.0)	279 (7.3)
	>4 servings	747 (12.9)	255 (13.0)	492 (12.9)
Total fish intake	Mean (servings)	2.29	2.34	2.28
	Median (servings)	2.00	1.50	2.00
	Maximum	11.00	11.00	10.00
	Standard deviation	1.51	1.53	1.48
	Mann-Whitney U	3674305.50		
	Standard Error	58875.71		
	Asymptotic Sig.(2-sided test)	.247		
Category	<1.0 servings	318 (5.5)	77 (3.9)	241 (6.3)
	1.0 – 1.9 servings	2322 (40.2)	830 (42.3)	1492 (39.1)

	2.0 – 2.9 servings	1449 (25.1)	474 (24.2)	975 (25.6)
	>3 servings	1688 (29.2)	581 (29.6)	1107 (29.0)

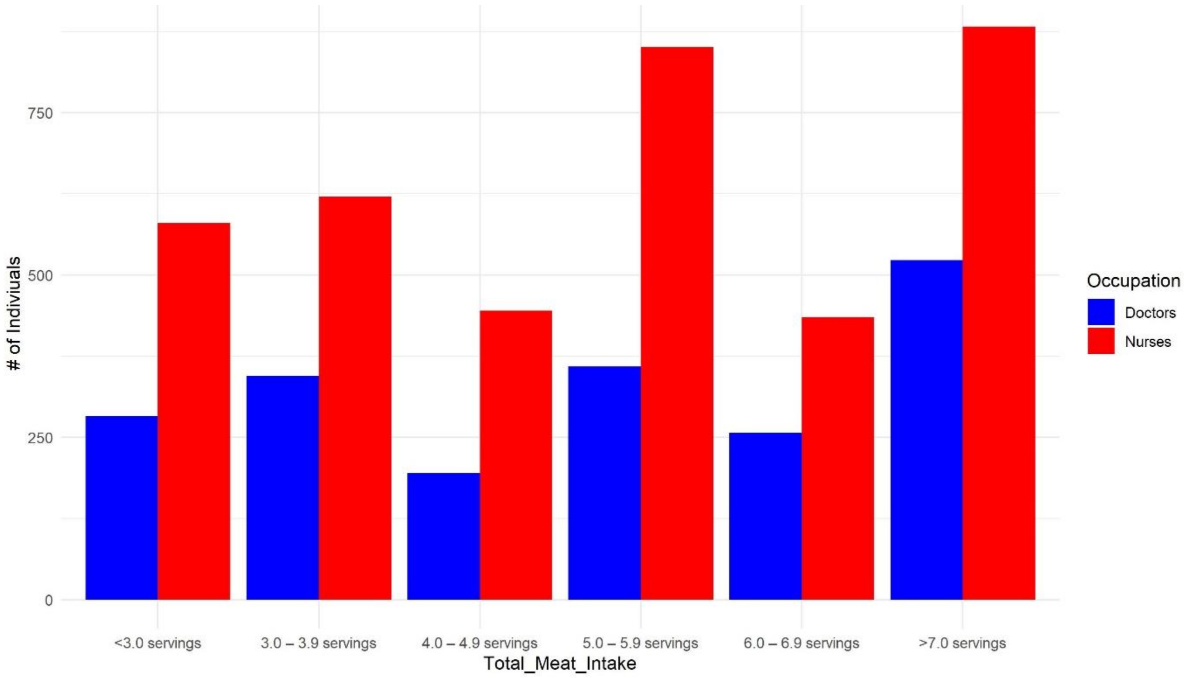

Figure 15: Meat intake of doctors and nurses from the UK Biobank dataset

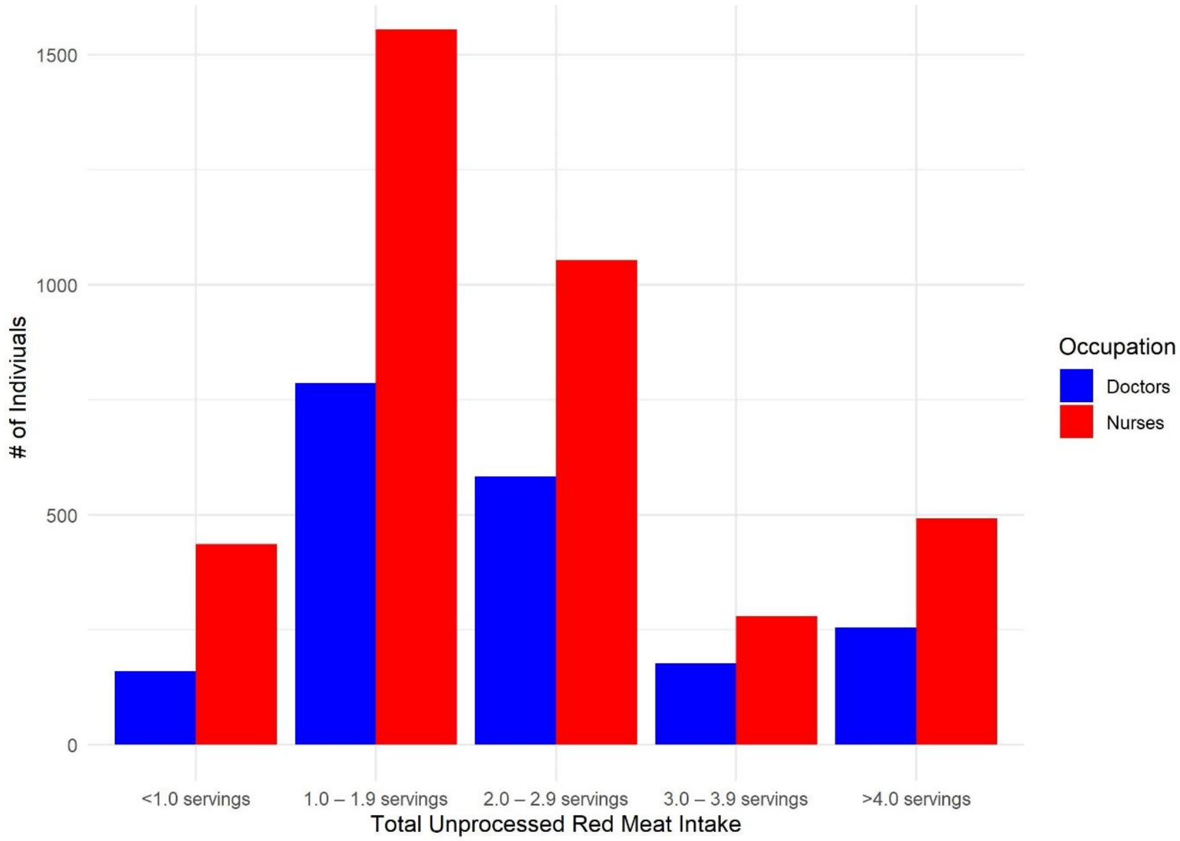

Figure 17: Unprocessed red meat intake of doctors and nurses from the UK Biobank dataset

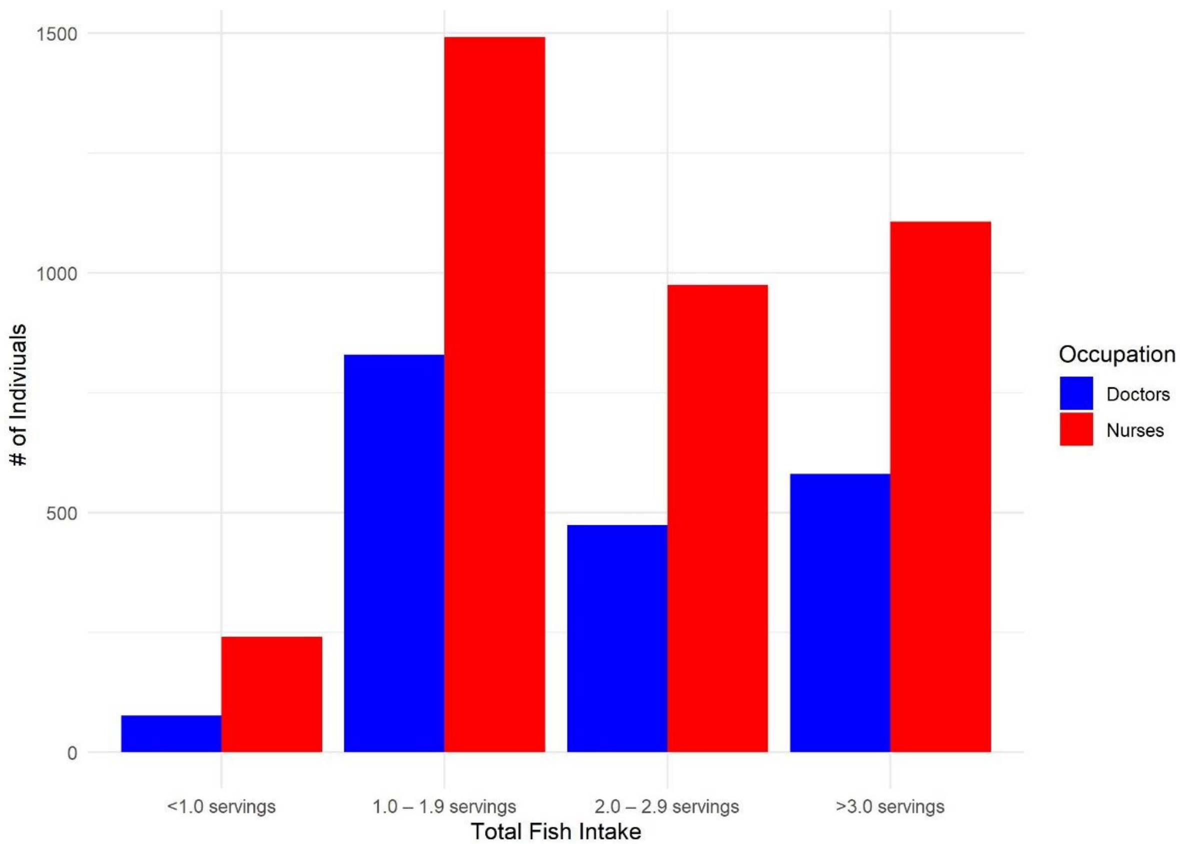

Figure 16: Fish intake of doctors and nurses from the UK Biobank dataset

Milk and cheese intake (Table 13)

No statistical significance was found in milk intake between DNs (p=0.941). Despite also no differences in the daily mean intake between DNs (91.434ml ± 41.603 vs 91.121ml ± 42.079), the maximum milk intake was higher in doctors than nurses per day (335ml vs 235.71ml, respectively, with an overall SD of 41.91ml). Overall, 97% of participants would consume less than 150ml of milk daily (Figure 18).

There was a significant difference (p<0.001) between DNs for cheese intake. Doctors consumed more cheese than nurses per week (2.96 ± 1.041 vs 2.59 ± 1.074) compared to the cohort's mean of 2.72 (SD 1.077). Considering all participants, most of the cohort would consume cheese 2.0 – 4.9 times per week (77.4% of all participants, 80.9% of doctors, 75.6% of nurses) (Figure 19).

Table 13: Milk and cheese intake in doctors and nurses from the UK Biobank dataset

Descriptor	Measures	Total n (%)	Doctors n (%)	Nurses n (%)
Total milk intake	Participants	5777 (100)	1962 (34)	3815 (66)
	Mean (ml)	91.23	91.43	91.12
	Median (ml)	102.86	103.56	102.86
	Maximum	335.00	335.00	235.71
	Standard deviation	41.91	41.60	42.08
	Mann-Whitney U	3738098.00		
	Standard Error	60030.73		
	Asymptotic Sig.(2-sided test)	.941		
Category	<150ml	5606 (97.0)	1900 (96.8)	3706 (97.1)
	150 – 299ml	170 (2.9)	1 (0.1)	109 (2.9)

	>300ml	1 (0.0)	61 (3.1)	0 (0.0)
Total cheese intake	Participants	5686 (98.424)	1937 (33.529)	3749 (64.895)
	Mean (times)	2.72	2.96	2.59
	Median (times)	3.00	3.00	3.00
	Maximum	5	5	5
	Standard deviation	1.077	1.041	1.074
	Mann-Whitney U	2947971.00		
	Standard Error	55068.65		
	Asymptotic Sig.(2-sided test)	.000		
Category	<1	82 (1.4)	18 (0.9)	64 (1.7)
	1.0-2.9	828 (14.3)	182 (9.3)	646 (16.9)
	2.0-4.9	4473 (77.4)	1587 (80.9)	2886 (75.6)
	>5	302 (5.2)	150 (7.6)	152 (4.0)
	Do not know	1 (0.0)	0 (0.0)	1 (0.00

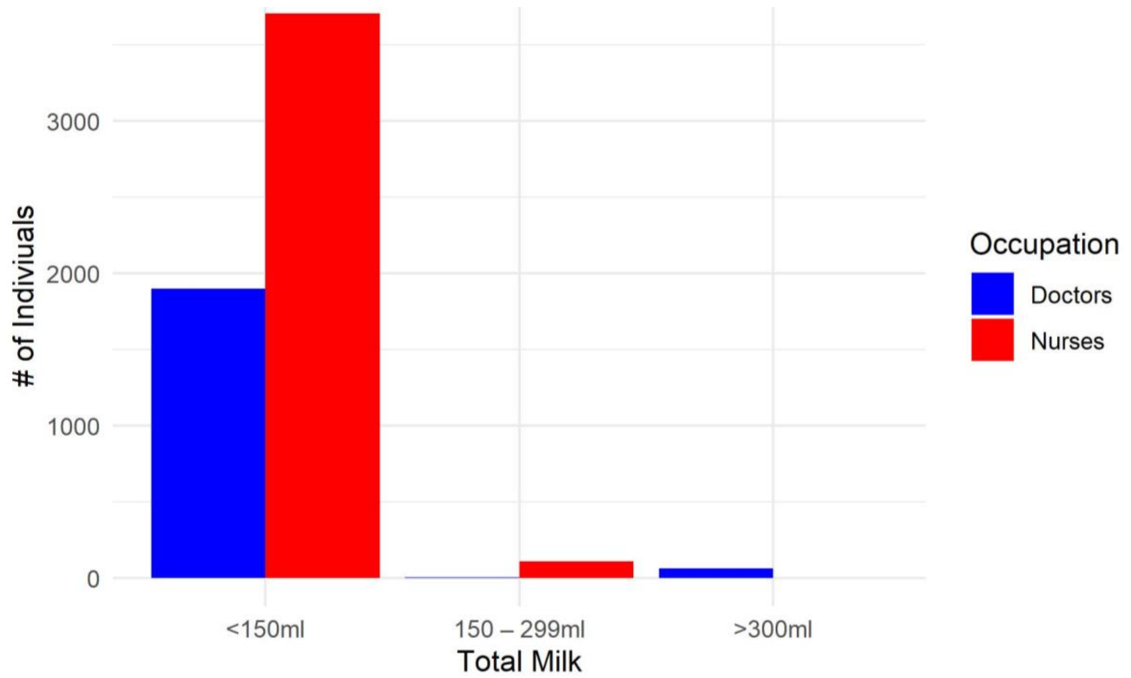

Figure 18: Milk intake of doctors and nurses from the UK Biobank dataset

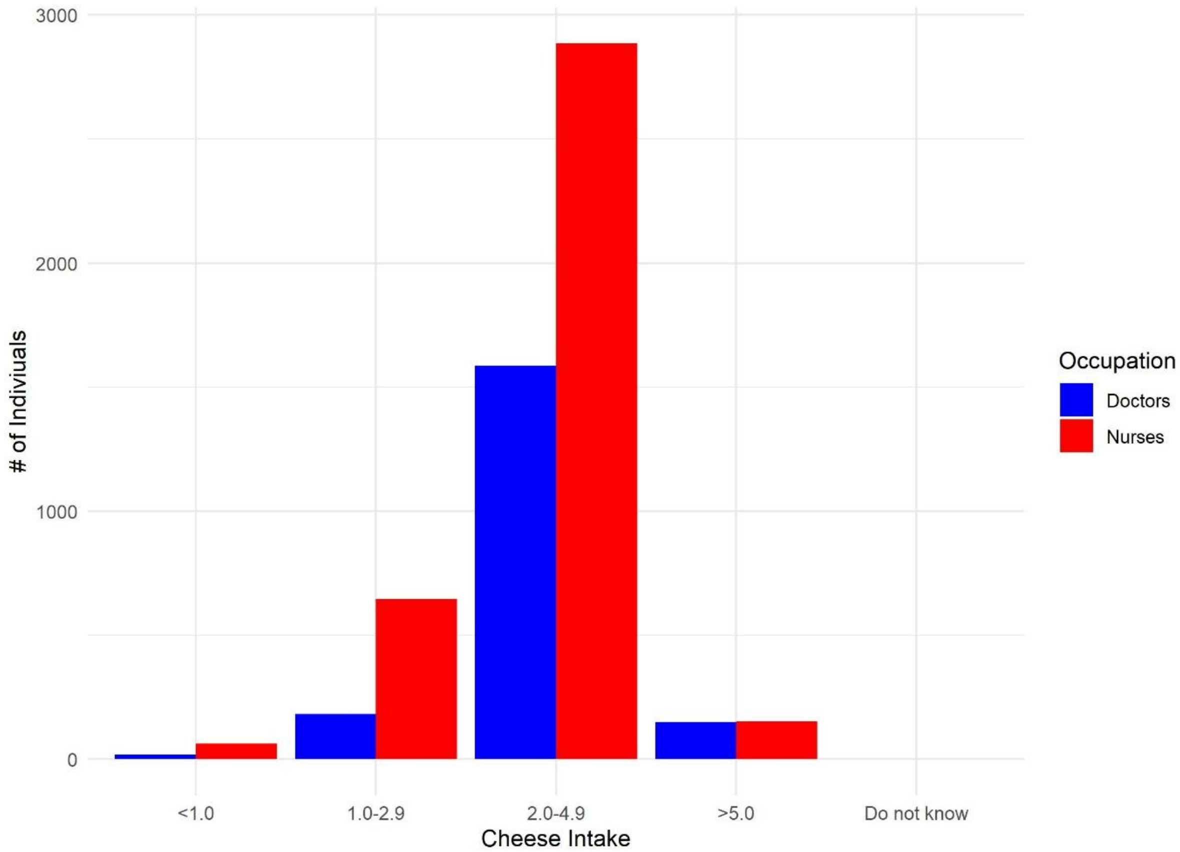

Figure 19: Cheese intake of doctors and nurses from the UK Biobank dataset

Tea and coffee intake (Table 14)

A significant difference was found in DNs' daily tea intake ($p<0.001$). Nurses consumed more cups of tea than doctors per day (3.14 ± 3.560 vs 2.18 ± 3.972), with the total cohort drinking a mean of 2.82 cups daily (SD 3.732). Overall, most participants consume between 2.0 – 3.9 cups of tea per day (29.7% of the total cohort, 34.3% of doctors, and 27.3% of nurses). Interestingly, nurses reported drinking more than 6 cups of tea per day more than doctors (20.9% vs 11.2%, respectively) (Figure 20).

In contrast, doctors consumed more cups of coffee than nurses per day (1.57 ± 3.859 vs 1.30 ± 3.60), with a statistical difference between them ($p<0.001$). The total cohort's average coffee intake was 1.39 cups (SD 3.796), with most participants reporting having more than 3 cups of coffee daily, with more doctors in this category than nurses (36% of the total cohort, 41.2% of doctors, 33.3% of nurses) (Figure 21).

Table 14: Tea and coffee intake per day in doctors and nurses from the UK Biobank dataset.

Descriptor	Measures	Total n (%)	Doctors n (%)	Nurses n (%)
Total tea intake	Participants	5775 (99.965)	1960 (33.928)	3815 (66.038)
	Mean (cups)	2.82	2.18	3.14
	Median (cups)	3.00	2.00	3.00
	Maximum	35	21	35
	Standard deviation	3.73	3.97	3.56
	Mann-Whitney U	4322530.50		
	Standard Error	59538.99		
	Asymptotic Sig.(2-sided test)	.000		
Category	<2.0 cups	1604 (27.8)	634 (32.3)	970 (25.4)
	2.0 to 3.9 cups	1715 (29.7)	673 (34.3)	1042 (27.3)
	4.0 to 5.9 cups	1435 (24.8)	434 (22.1)	1001 (26.2)
	>6 cups	1017 (17.6)	220 (11.2)	797 (20.9)
	Don’t know	6 (0.1)	1 (0.1)	5 (0.1)
Total coffee intake	Participants	5775 (99.967)	1960 (33.927)	3815 (66.037)
	Mean (cups)	1.39	1.57	1.30
	Median (cups)	2.00	2.00	2.00
	Maximum	18	18	15
	Standard deviation	3.796	3.859	3.760
	Mann-Whitney U	3317876.50		

	Standard Error	59229.78		
	Asymptotic Sig.(2-sided test)	<.001		
Category	0	1360 (23.5)	342 (17.4)	1018 (26.7)
	0.5 – 1.9	1159 (20.1)	372 (19.0)	787 (20.6)
	2.0 – 2.9	1178 (20.4)	438 (22.3)	740 (19.4)
	>3	2078 (36.0)	809 (41.2)	1269 (33.3)
	Don't know	2 (0.0)	1 (0.1)	1 (0.0)

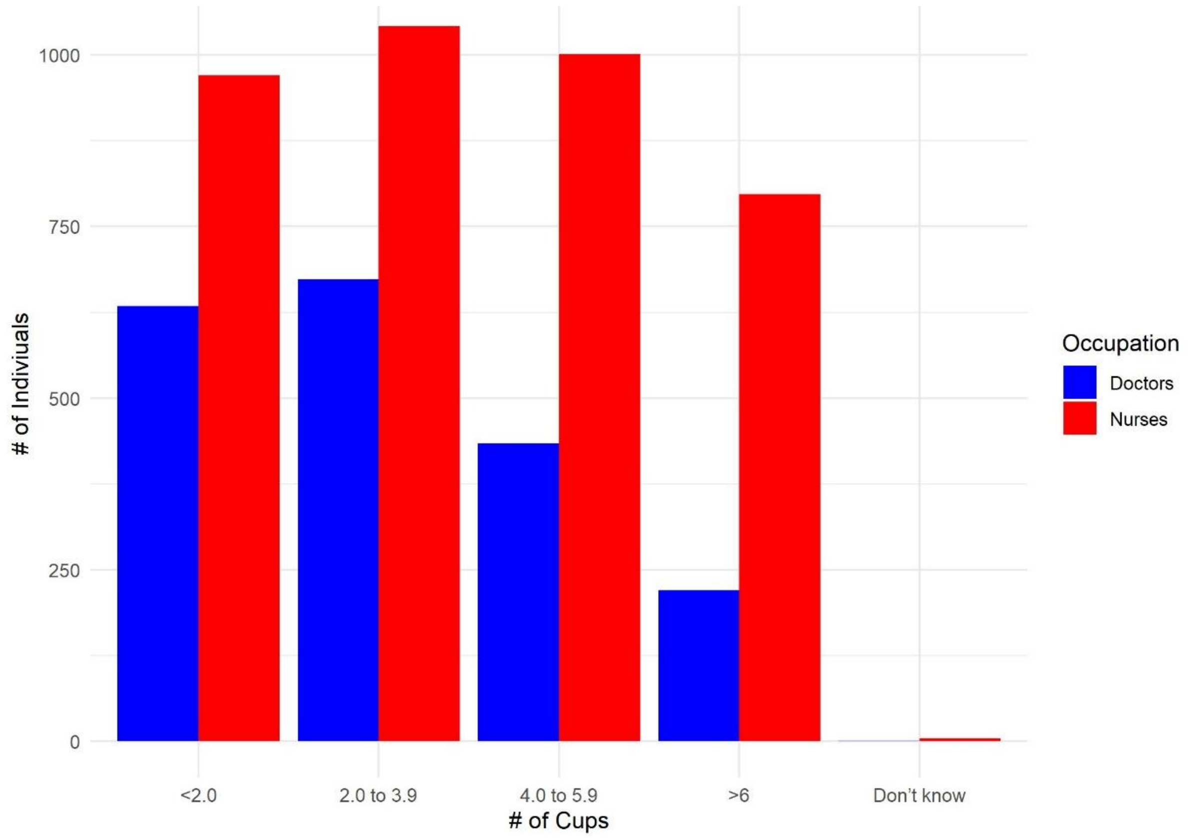

Figure 20: Tea intake of doctors and nurses from the UK Biobank dataset

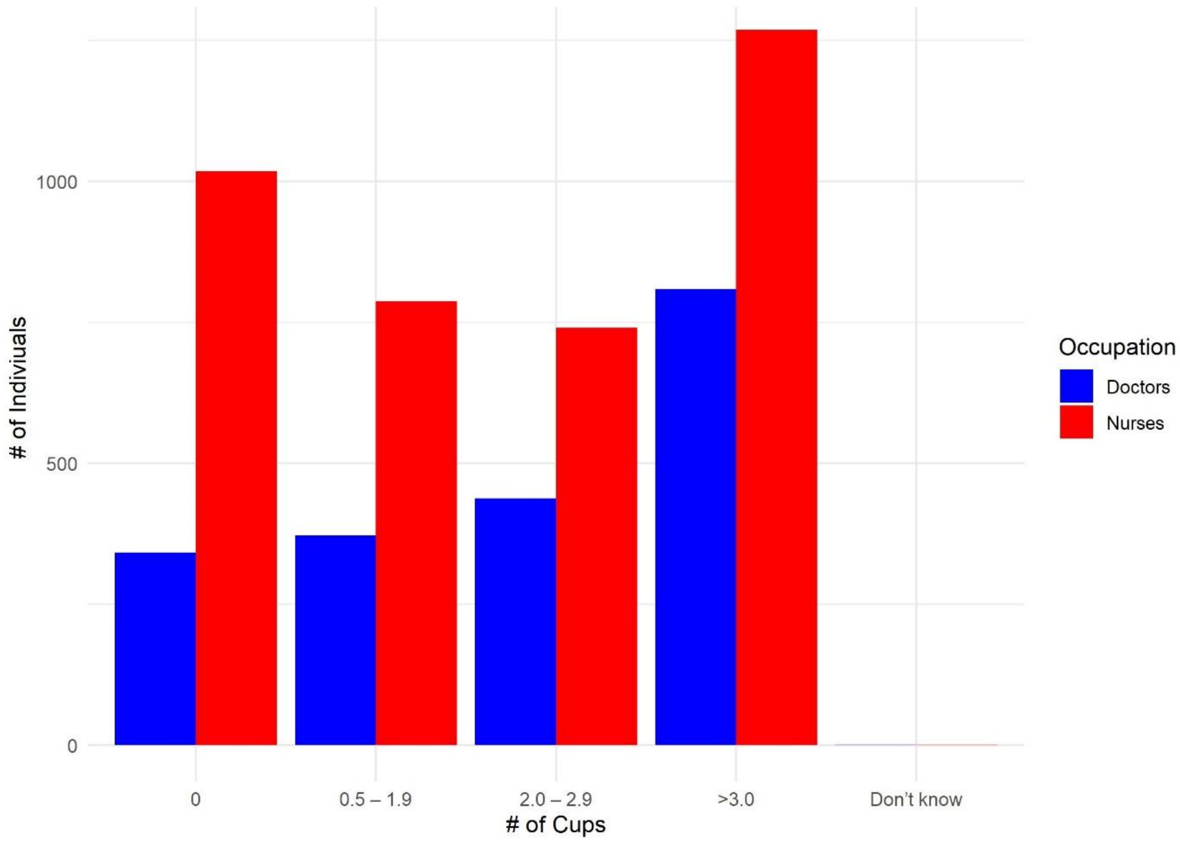

Figure 21: Coffee intake in doctors and nurses from the UK Biobank dataset

Water intake (Table 15)

Water intake demonstrated a significant result between DNs ($p<0.001$). On average, nurses drank more glasses of water than doctors (2.60 ± 3.568 vs 1.40 ± 4.229) per day, despite the maximum glasses of water per day being 20 for both groups (overall SD 3.85). Across the cohort, most participants (24% of the population, doctors and nurses) would consume two glasses of water daily. However, only a small proportion of participants consumed more than eight glasses of water (2% overall, 1.1% of doctors, and 2.5% of nurses) (Figure 22).

Table 15: Water intake per day for doctors and nurses from the UK Biobank dataset

Descriptor	Measures	Total n (%)	Doctors n (%)	Nurses n (%)

Total water intake	Participants	5777 (100)	1960 (33.927)	3815 (66.037)
	Mean (glass)	2.87	1.40	2.60
	Median (glass)	3.21	2.00	3.00
	Minimum	0	0	0
	Maximum	20	20	20
	Standard deviation	3.85	4.23	3.57
	Mann-Whitney U	4414570.00		
	Standard Error	59205.07		
	Asymptotic Sig.(2-sided test)	.000		
Category	<1	377 (6.5)	196 (10.0)	181 (4.7)
	0	283 (4.9)	122 (6.2)	161 (4.2)
	1	968 (16.8)	385 (19.6)	583 (15.3)
	2	1393 (24.1)	478 (24.4)	915 (24.0)
	3	952 (16.5)	318 (16.2)	634 (16.6)
	4	717 (12.4)	207 (10.6)	510 (13.4)
	5	399 (6.9)	110 (5.6)	289 (7.6)
	6	338 (5.9)	81 (4.1)	257 (6.7)
	7	67 (1.2)	16 (0.8)	51 (1.3)
	8	155 (2.7)	24 (1.2)	131 (3.4)
	>8	116 (2.0)	21 (1.1)	95 (2.5)

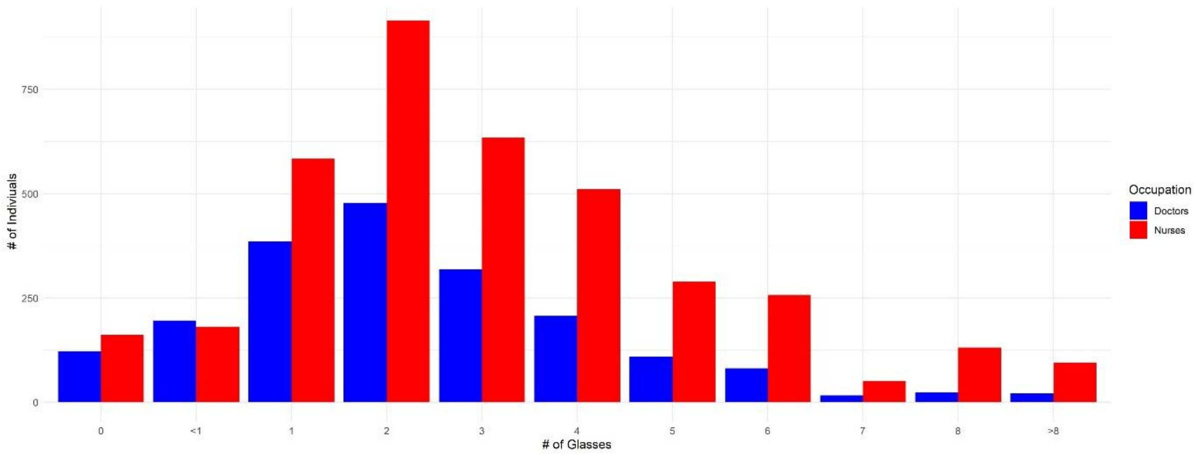

Figure 22: Water intake in doctors and nurses from the UK Biobank dataset

Alcohol intake (Table 16)

A statistically significant difference was reported in the frequency of alcohol consumption between DNs (p<0.001), with most participants reported as current alcohol drinkers (93.7% of the total cohort, 95.3% of doctors and 92.9% of nurses). Across the whole cohort, our dataset indicated that most participants consume alcohol 3-4 times weekly (93.7% of the total cohort, 95.3% of doctors, and 92.3% of nurses). There was a further statistical significance of the overall average weekly and monthly alcohol consumption across the cohort (p<0.001). Doctors reported having a higher average weekly intake than nurses (63.146g ± 48.570 vs 40.261g ± 48.242) despite nurses reaching a higher maximum intake than doctors (512g vs 435.20g, ± 54.05).

Alcohol intake in the dataset was converted from 1 glass containing 8g of pure alcohol. Across the different types of alcohol, results highlighted a statistical significance in average weekly red wine intake (p<0.001), average weekly champagne plus white wine (p<0.001), average weekly beer plus cider (p<0.001), and average weekly spirits intake (p<0.001). However, nurses only had a higher weekly red wine intake than doctors (18.20ml ± 30.864 vs 28.52ml ± 38.570). Conversely, doctors had a higher weekly intake than nurses on champagne (24.65ml ± 35.403 vs 17.52ml ± 31.442), beer (9.332 ± 22.442 vs 4.093ml ± 16.028), and spirit (0.624ml ± 1.979 vs 0.428ml ± 1.549). For other types of wines, there was no statistical significance in the average fortified wine intake (p=1.000) and other alcoholic drinks (p=0.832) between DNs.

Table 16: Average weekly alcoholic intake in doctors and nurses from the UK Biobank

Descriptor	**Measures**	**Total n (%)**	**Doctors n (%)**	**Nurses n (%)**
Alcohol drinker status	Participants	5777 (100)	1962 (33.962)	3815 (66.038)
	Prefer not to answer	4 (0.1)	0 (0.0)	4 (0.1)

	Never	211 (3.7)	64 (3.3)	147 (3.9)
	Previous	150 (2.6)	29 (1.5)	121 (3.2)
	Current	5412 (93.7)	1869 (95.3)	3543 (92.9)
Alcohol intake frequency	Mean	1.90	1.92	1.89
	Median	2.00	2.00	2.00
	Maximum	2	2	2
	Standard Deviation	0.42	0.37	0.45
	Mann-Whitney U	3647160.000		
	Standard Error	25232.739		
	Asymptotic Sig.(2-sided test)	<.001		
	Never	209 (3.6)	62 (3.2)	147 (3.9)
	Daily or almost daily	150 (2.6)	29 (1.5)	121 (3.2)
	3-4 times a week	5412 (93.7)	1869 (95.3)	3543 (92.9)
	Prefer not to answer	209 (3.6)	0 (0.0)	4 (1.0)
Average weekly red wine intake	Mean	21.70	28.52	18.20
	Median	8.00	16.00	0.00
	Maximum	336	320	336
	Standard deviation	34.03	38.57	30.86

	Mann-Whitney U	2955512.00		
	Standard Error	56873.04		
	Asymptotic Sig.(2-sided test)	.000		
Average weekly champagne plus white wine	Mean	19.94	24.65	17.52
	Median	8.00	0	.00
	Maximum	336	336	336
	Standard deviation	33.01	35.40	31.44
	Mann-Whitney U	3014079.00		
	Standard Error	56761.85		
	Asymptotic Sig.(2-sided test)	.000		
Average weekly beer plus cider	Mean	5.87	9.33	4.09
	Median	0	0	0
	Maximum	512	286.72	512
	Standard deviation	18.62	22.44	16.03
	Mann-Whitney U	3068802.50		
	Standard Error	43844.53		

	Asymptotic Sig.(2-sided test)	.000		
Average weekly spirits intake	Mean	0.49	0.62	0.43
	Median	0	0	0
	Maximum	42.75	42.75	42.75
	Standard deviation	1.71	1.98	1.55
	Mann-Whitney U	3459153.50		
	Standard Error	45139.49		
	Asymptotic Sig.(2-sided test)	<.001		
Average weekly fortified wine intake	Mean	0	0	0
	Median	0	0	0
	Maximum	0	0	0
	Standard deviation	0	0	0
	Mann-Whitney U	3742515.00		
	Standard Error	0.000		
	Asymptotic Sig.(2-sided test)	1.000		
Average weekly intake of other alcoholic drinks	Mean	0.02	0.02	0.02

	Median	0.00	0.00	0.00
	Maximum	48	24	48
	Standard deviation	0.79	0.68	0.85
	Mann-Whitney U	3741696.000		
	Standard Error	3866.772		
	Asymptotic Sig.(2-sided test)	0.832		
Overall average weekly intake	Mean	48.03	63.15	40.26
	Median	34.24	48.57	30.19
	Maximum	512	435.20	512.00
	Standard deviation	54.05	61.08	48.24
	Mann-Whitney U	2794619.000		
	Standard Error	59378.177		
	Asymptotic Sig.(2-sided test)	.000		

5.1.3 Characteristics of Dietary Quality Scores

Healthy Diet Score (Table 17)

A statistical significance was found between DNs in the Healthy Diet Score ($p<0.001$). Nurses had a higher mean Healthy Diet Score than doctors (4.19 vs 4.02). Most participants across the total sample, doctors and nurses, all reported having an overall Healthy Diet Score of 4 out of 7 (26%, 25.2%, and 26.4%, respectively) after including all six groups of food items for calculation. Here, the higher the score, the healthier the diet participants consumed.

Table 17:Healthy Diet Score of doctors and nurses from the UK Biobank dataset.

	Total n (%)	Doctors n (%)	Nurses n (%)
Participants	5777 (100)	1962 (33.962)	3815 (66.038)
Healthy Diet Score			
Mean	4.13	4.02	4.19
Median	4.00	4.00	4.00
Maximum	7	7	7
Standard deviation	1.42	1.45	1.40
0	36 (0.6)	18 (0.9)	18 (0.5)
1	152 (2.6)	70 (3.6)	82 (2.1)
2	545 (9.4)	202 (10.3)	343 (9.0)
3	1152 (19.9)	406 (20.7)	746 (19.6)
4	1502 (26.0)	494 (25.2)	1008 (26.4)
5	1384 (24.0)	473 (24.1)	911 (23.9)
6	799 (13.8)	235 (12.0)	564 (14.8)
7	207 (3.6)	64 (3.3)	143 (3.7)
Mann-Whitney U	3967390.50		
Standard Error	58734.76		
Asymptotic Sig.(2-sided test)	<.001		

Partial Fibre Score (Table 18)

No statistically significant difference was found in DNs' partial fibre score (p=0.954). Across the sample (total, doctors and nurses), there was a mean intake of 15g per day, with a maximum intake of 72.76g for doctors, 95.23g for nurses and an overall maximum of 95.23g (SD 5.90). Results were categorised based on quintile splits. Across the whole sample, most participants had a low/ medium fibre intake (60.5%). However, when separating DNs, both groups fell into the low, medium and high partial fibre intake categories relatively equally, based on the quintile splits within the groups (ranging between 20% - 20.1%).

Table 18: Partial fibre score for doctors and nurses from the UK Biobank dataset

	Total **n (%)**	**Doctors** **n (%)**	**Nurses** **n (%)**
Participants	5777 (100)	1962 (33.962)	3815 (66.038)
Partial Fibre Score			
Mean	15.03	15.07	15.01
Median	14.52	14.56	14.52
Maximum	95.23	72.76	95.23
Standard deviation	5.90	6.09	5.80
Quintiles (accordingly)			
Low	1156 (22.0)	394 (20.1)	766 (20.1)
Low/ Medium	3497 (60.5)	391 (19.9)	760 (19.9)
Medium	0 (0.0)	393 (20.0)	766 (20.1)
Medium/ High	0 (0.0	391 (19.9)	760 (19.9)
High	1124 (19.5)	393 (20.0)	763 (20.0)
Mann-Whitney U	3745985.50		
Standard Error	60033.65		
Asymptotic Sig.(2-sided test)	0.954		

<u>5.2 Discussion</u>

This chapter investigated the dietary intake of DNs with shift work. The result indicated dietary intake differences between DNs in several nutritional areas. Our cross-sectional data observed that doctors consume more meat, coffee and alcohol than nurses, whereas nurses drink more tea and water. Caffeine consumption as a means to stay awake during shift work was prevalent among both groups, highlighting the potential impact of shift work on dietary behaviour. Furthermore, the whole cohort displayed significant patterns of limited fruit and vegetables, fish and dietary fibre, with a preference for cheese across the week. These results reinforce our early study's findings (see qualitative Chapters 3 – 4), indicating that while DNs intend to eat healthily, clinical workload and limited food accessibility and availability persist as barriers during working hours. Additionally, our study highlights that DNs generally lead relatively healthy lifestyles based on the Health Diet Score. Despite these positive results, our findings conclude that DNs' eating practices remain sub-optimal and do not consume the dietary intake as recommended by the Eatwell Guide (Public Health England, 2016; Buttriss, 2017).

The Eatwell Guide gives the UK public a more accessible approach to understanding food and drink choices, outlining the recommended proportions (Buttriss, 2016, 2017; Public Health England, 2016; Scarborough *et al.*, 2016) and further adopting the dietary recommendations made by the Scientific Advisory Committee on Nutrition (SACN) (SACN, 2015), visually representing a healthy balanced diet. The guide categorises into five areas: fruit and vegetables; potatoes, bread, rice, pasta and other starchy carbohydrates; beans, pulses, fish, eggs, meat and other proteins; dairy and alternatives; and oils and spreads. Furthermore, it targets the general population regardless of dietary preferences, weight, or ethnicity. However, it excludes children (those under two years) due to their different nutritional needs (Buttriss, 2016). Thus, these findings evidenced the essential nutrition support that DNs need. However, significant findings from this chapter show that DNs' preferred diet during shifts largely consists of meat, caffeine, and alcohol, highlighting its potential as a workplace strategy for better workplace dietary behaviours and nutrition.

DNs' fibre intake was sub-optimal and did not meet the UK recommendation of 30g of dietary fibre per day for its health benefits (SACN (Scientific Advisory Committee on Nutrition), 2015; Public Health England, 2016). Dietary fibre, mainly found in fruits and vegetables, is essential in glucose and lipid regulations, insulin sensitivity, gut motility, and cardiovascular disease (Barber *et al.*, 2020; Evans, 2020; Koç *et al.*, 2020; Davis *et al.*, 2021). Our cohort's mean intake was 15.03g per day, with no significant result between DNs (15.07g and 15.01g, respectively). Considering fibre intake was half of its recommendation, DNs are at health risk due to their irregular meal consumption at work (see Qualitative Result, Chapter 3). Insufficient fibre intake has been associated with increased risks of diverticular disease (Aune *et al.*, 2020), affecting the effectiveness of the digestive system, particularly more prevalent in the Westernised culture with low fibre intake and higher risk of overweight and obesity (Mimura, Emanuel and Kamm, 2002; Piscopo and Ellul, 2020). Concerning our cohort's Western lifestyle, as participants were all UK-based, and the high clinical workload contributed to limited break opportunities (see Qualitative Result, Chapter 3 – 4) (Mota *et al.*, 2013; Peplonska, Kaluzny and Trafalska, 2019; Souza *et al.*, 2019b; Horton Dias and Dawson, 2020), this could suggest the inadequate fibre intake in our cohort and may increase gastrointestinal symptoms. For example, a double-blinded clinical randomised controlled trial demonstrated that a fermentable oligosaccharides, disaccharides, monosaccharides and polyols (FODMAP) diet (cutting out certain carbohydrates for a while reduces gastrointestinal symptoms) in patients improves gastrointestinal function, sleep and mental health (Yan *et al.*, 2020). Elsewhere, epidemiological evidence has also shown that increased fibre intake reduces type 2 diabetes risks by 6% per 7g of fibre (Greenwood *et al.*, 2013) and cardiovascular disease risk by 9% per 7g of fibre (Threapleton *et al.*, 2013). Thus, poor fibre intake contributes to bowel problems and related health outcomes such as sleep, type 2 diabetes and cardiovascular diseases, highlighting DNs' poor nutritional practices (see Qualitative Study Result, Chapters 3 – 4). As a result, shift work contributes greatly to poor dietary fibre intake during working hours. Considering the health benefits of dietary fibre, there is a greater need to support increasing fibre intake during shift work to promote better health outcomes.

Our result indicated that DNs just about met the fruit and vegetable intake recommendation of 5 pieces per day (Public Health England, 2016; Buttriss, 2017), with nurses consuming more fruits and vegetables than doctors. Consuming fruits and vegetables has its health benefits, including lowering risks of cardiovascular heart disease, pancreatic disease, and cancer and preventing mental and psychological disorders (Pem and Jeewon, 2015; Fulton *et al.*, 2016; Angelino *et al.*, 2019; Yip, Chan and Fielding, 2019; Zurbau *et al.*, 2020). Moreover, it can positively influence mental health, preventing depressive symptoms and improving behaviours (Pem and Jeewon, 2015; Głąbska *et al.*, 2020), especially in healthcare where doctors face occupational stress impacting their mental health (Cheshire *et al.*, 2017; Kinman and Teoh, 2018). For example, a cross-sectional study of adults demonstrated that higher fruit and vegetable intake was associated with better mental health outcomes such as positive mood, life satisfaction and flourishing (Brookie, Best and Conner, 2018). Considering these positive impacts, this can suggest the need for DNs to consume adequate fruits and vegetables to promote healthy eating, improve work behaviours and cope with occupational stress, as indicated by our earlier results (see Qualitative Result Chapter 3). However, fruit and vegetable intake can have negative health consequences. Florindo *et al.* (2015) examined the fruit and vegetable intake and the nutritional behaviour of health workers (i.e. including doctors). This finding revealed the association between limited awareness of dietary guidelines and their health benefits, leading to insufficient consumption of fruits and vegetables. However, the cross-sectional nature of Florindo *et al.'s* (2015) study limited the ability to determine the impact of other contributing factors, such as the environment and behaviour changes during shift work, on fruit and vegetable intake. Our previous study (see Qualitative Result, Chapter 3) further indicates DNs' poor dietary intake and low adherence to dietary recommendations, resulting in fatigue. A plausible reason for the difference in intake in fruit and vegetable intake between DNs could be the extra time nurses have for meal planning (i.e., if bringing home-cooked food to work) or more opportunities to consider healthy food choices during their shifts (i.e. more break opportunities) (see Qualitative Result, Chapter 3). Though the literature remains unclear on the comparison between DNs' fruits and vegetable intake, our result indicates the need for health promotion interventions to address the importance of consuming fruits and vegetables, encouraging improved dietary behaviours among healthcare professionals. Thus, though our cohort collectively met the recommendation of 5 pieces of fruit and vegetable per day intake, a higher consumption in this food group is highly recommended.

Our cohort exhibited high weekly meat consumption, with doctors consuming more than nurses and surpassing the recommended intake of 70g per day (Public Health England, 2016). Meat is a source of protein, and its benefits contribute to the essentials for the body's growth and maintenance (Shang, Chaplot and Wu, 2018). Further, it can also aid weight management (Leidy *et al.*, 2015) and contribute to overall health and longevity, which is particularly important for older individuals as muscle mass declines with age (Lonnie *et al.*, 2018; Kitada *et al.*, 2019; Nunes *et al.*, 2022). Given that our cohort skews toward the older age (mean of 68.9 years old, between 52 – 85 years) and their long working hours and years of service (see Quantitative Method, Chapter 5), insufficient protein intake could result in DNs experiencing physical health problems associated with ageing. For example, multimorbidities such as diabetes, osteoporosis, high blood pressure and anxiety (Singer *et al.*, 2019) are common among older adults, with obesity and ageing also sharing similar phenotypes (Tam, Morais and Santosa, 2020). Therefore, adequate meat consumption can support our cohort's work efficiency during shifts, particularly older DNs, when sufficient energy is required during their long shifts with limited eating opportunities.

However, our result indicates that excessive meat consumption among doctors raises health concerns. This could be attributed to the Western cultural lifestyles and their influences prevalent in the UK Biobank participants (Godfray *et al.*, 2018; Milford *et al.*, 2019), such as economic, social, cultural and environmental factors. For example, Milford *et al.* (2019) highlighted how Western countries generally have a higher economy, thus increasing the total amount of food consumed per capita. This could imply that greater availability of modern technologies may result in heightened marketing and advertising efforts influenced by global trends. These factors, in turn, point to additional significant factors contributing to the growing prevalence of animal-based diets. Yet, high levels of saturated fat found in certain meat are associated with elevated low-density lipoprotein and total cholesterol, contributing to obesity, type 2 diabetes, cancer, cardiovascular disease and mortality (Valsta, Tapanainen and Männistö, 2005; Ospina-E *et al.*, 2012; O'Sullivan *et al.*, 2013; Bergeron *et al.*, 2019; Marinova and Bogueva, 2019). Shift workers, including DNs, have a higher prevalence of overweight and obese (Solovieva, Lallukka, Virtanen, and Viikari-Juntura, 2013; Wang *et al.*, 2014; Sun *et al.*, 2017; Saulle *et al.*, 2018; Lauren *et al.*, 2020; Sooriyaarachchi *et al.*, 2022) consistent with our early findings (see Qualitative Results, Chapter 3 – 4). For example, a systematic review and meta-analysis suggest that rotating shift work has been associated with an increased risk of abdominal obesity (Sun *et al.*, 2017), suggesting that shift work contributes to DNs' dietary patterns, including a higher meat intake. Alternatively, processed meats, commonly present in DNs' onsite food purchases/ or snacks, such as sandwiches, contribute to their meat consumption. Our previous study highlighted the frequent purchase of cold food and meal deals, including sandwiches, due to limited access, unavailability of hot food (i.e. long queues) or canteen closure after hours (see Qualitative Result Chapters

3 – 4). Though this study did not explore the type of processed meat consumption, our result could assume that DNs' meat consumption was based on food availability during their shifts. While meat consumption provides health benefits, it is crucial to align consumption with recommended guidelines to avoid health risks caused by poor nutrition from shift work factors.

Dairy consumption was mixed amongst our DNs cohort, with less than 150ml of milk daily and a majority consuming a high amount of cheese weekly. Dairy provides protein, vitamins and calcium (Public Health England, 2016; Buttriss, 2017). However, it is also recommended to minimise dairy consumption by 21% (Scarborough et al., 2016) due to its high fat and sugar content. Our current study did not examine specific milk and cheese types or analyse the impact of high dairy intake on weight and metabolic syndrome risk among DNs. However, regular dairy consumption supports benefits such as peak bone mass and reduced osteoporosis risks in ageing, attributed to the calcium typically found in milk and cheese, which are easily absorbed, accessible, and affordable, making regular consumption viable (Rozenberg *et al.*, 2016; Hodges *et al.*, 2019; Malmir, Larijani and Esmaillzadeh, 2020; Bourne *et al.*, 2021). Further evidence has suggested that ageing is associated with an increased risk of osteoporosis (Aspray and Hill, 2019; Coll *et al.*, 2021). Considering our DNs are of the older age group with shift work and spend significant time on their feet, inadequate calcium intake may lead to osteoporosis over time, thus increasing the risks of bone fractures if accidents occur. This can result in hospitalisation and the inability to work, impacting patient care delivery. Osteoporosis is also associated with a sub-optimal level of vitamin D (Rozenberg *et al.*, 2016; Hodges *et al.*, 2019), a concern for DNs with limited sunlight exposure during indoor work. To prevent adverse health effects, it is, therefore, crucial for DNs to moderate their dairy consumption according to dietary recommendations, considering the existing nutritional challenges posed by shift work.

Our result highlights inadequate hydration practices among DNs during their shift work. Our DNs consume only two glasses of water daily, sufficiently lower than the six to eight glasses recommendations. Hydration or fluid intake can include water, lower-fat milk and sugar-free drinks such as tea and coffee, as recommended by the Eatwell Guide (Public Health England, 2016; Buttriss, 2017). Water intake offers health benefits for shift workers, enhancing their cognitive performance, mood, kidney and metabolic functions (Lemaire *et al.*, 2010; Masento *et al.*, 2014; El-Sharkawy *et al.*, 2016; D'Annibale *et al.*, 2021; Perrier *et al.*, 2021). Considering the long and unpredictable hours of DNs' clinical workload (see Qualitative Results, Chapter 3 – 4) and the impact of sleep deprivation from shift work, it is important for DNs to remain alert in providing safe patient care (Hamidi, Boggild and Cheung, 2016; Hamidi *et al.*, 2019). Thus, despite the benefits of hydration, limited water intake could be attributed to occupational factors such as inadequate water accessibility in the workplace, as suggested by our earlier results (see Qualitative Results, Chapters 3 – 4). Conversely, water intake restrictions could depend on limited bathroom and break opportunities due to clinical cases, as observed in earlier studies on DNs (Bae, Hwang and Lee, 2018; Ojo *et al.*, 2019). Our findings indicate the importance of reevaluating shift work conditions to promote hydration among DNs, addressing the lack of water and break facilities and emphasising the benefits of water consumption for optimal cognitive performance in patient care delivery.

Tea and coffee consumption was also significant amongst our DNs, with nurses consuming more cups of tea than doctors, whereas doctors favoured more cups of coffee. However, the overall fluid intake, like water, was below the recommended guidelines (Public Health England, 2016). Thus, dehydration could influence their mood and cognitive performance (Adan, 2012; Masento *et al.*, 2014; Kase *et al.*, 2022). As discussed in an earlier study (Chapters 3 – 4), DNs must sustain their energy for long working hours. Yet, our findings suggest that DNs rely on tea and coffee for hydration due to the benefits of caffeine intake over water. Although other caffeine-based beverages like energy drinks were not examined in this study, which could affect our findings as tea and coffee were more easily accessible, the accessibility and preference for tea and coffee influenced DNs' beverage choices to stay alert during their shifts. As the data was extracted from a large quantitative database, results could not justify why DNs opted for a particular caffeine beverage over others. However, a plausible justification could be that the individual's preference or cultural differences influenced tea or coffee consumption (Grigg, 2002; Mikołajczyk-Stecyna *et al.*, 2021). Concerning DNs, the lack of break opportunities (see Chapter 4) poses barriers to staying hydrated, with suggestions of its impact on their energy levels and cognitive performance in delivering patient care, particularly when sleep disruptions are already experienced. Therefore, barriers to fluid access remain the central challenge for DNs during working hours (see Chapter 4). As a result, the challenge of limited fluid access is essential to support DNs' hydration levels and prevent excessive reliance on tea and coffee. Further, it considers the health consequences of excessive caffeine consumption when continuous access to food and drink facilities is neither accessible nor available around the clock.

Alcohol consumption was prevalent across our cohort, with most identifying as regular alcoholic drinkers, consuming 3 – 4 times per week. Doctors consumed more alcohol across different types than nurses. However, our cohort exceeded the UK recommended amount of 14 units per week (Department of Health & Social Care, 2021). Previous literature has highlighted the consequences of alcohol consumption, including an increased risk of alcoholic cirrhosis (Whitfield *et al.*, 2022), dementia (Rehm *et al.*, 2019), ischemic attack, strokes and other related cardiovascular diseases (Grønbaek, 2009; Chiva-Blanch and Badimon, 2019). Considering our DNs, it is plausible that high alcohol intake could be a coping strategy to manage high occupational stress. Shift workers, in particular, frequently opt for alcohol after working hours to cope with emotional shifts (Dorrian *et al.*, 2017; Booker *et al.*, 2019; Sayre, Grandey and Chi, 2019; Richter *et al.*, 2020a) (see also Qualitative Result, Chapter 3). However, using alcohol as a coping strategy could negatively impact DNs' health. Habitual alcohol intake is associated with non-communicable diseases, such as increased risks of diabetes, obesity, and cardiovascular disease (Peasey *et al.*, 2006; Biddinger *et al.*, 2022). Mittal *et al.* (2018) found that higher alcohol consumption among NHS hospital staff was associated with being overweight and obese. Likewise, Buchvold *et al.* (2019) 6-year follow-up study on nurses with shift work confirmed the association between high alcohol consumption and poor health outcomes. Conversely, alcohol has also been indicated as a sleep aid for shift workers experiencing disrupted circadian rhythm due to irregular sleeping and eating patterns, as discussed in our earlier findings (see Qualitative Result, Chapter 3). In our present study, doctors had a higher alcohol intake than nurses, which could suggest that they experience more emotional challenges at work or struggle with sleep quality. This notion can be confirmed where previous literature among doctors indicated that occupational distress increases health problems with several poor behaviours, including binge drinking alcohol, due to coping with stress due to work factors (Medisauskaite and

Kamau, 2019). However, this present study did not explore these associations; thus, causation cannot be determined. Yet, when developing strategies to enhance DNs' workplace health, it is important to consider other confounding factors. Thus, efforts should be made to ensure that alcohol consumption aligns with recommendations and to mitigate the associated health consequences if consumed excessively.

Our DNs exhibited poor nutrition and dietary practices during shift work (see Qualitative Result, Chapter 3). Most of our cohort falls into the healthy and overweight/ obese categories (Table 9). Nurses have a higher BMI than doctors (26.82kg/m^2 ± 5.08 vs 25.32kg/m^2 ± 3.82), with the cohort's BMI 26.31kg/m^2 ± 4.74). Thus, it is important to consider the dietary needs of DNs and the implications of shift work on their nutrition and dietary practices (see also Qualitative Result, Chapters 3 – 4). Existing literature supports our findings, demonstrating the association of overweight and obese with shift work among DNs (Hulsegge *et al.*, 2016; Kyle, Neall and Atherton, 2016; Liu *et al.*, 2018; Saulle *et al.*, 2018; Fradkin, Raz and Boaz, 2019; Jaradat, Lahlouh and Mustafa, 2020). Systematic reviews of epidemiological studies highlighted the unhealthy dietary practices within shift work (Liu *et al.*, 2018; Saulle *et al.*, 2018) (see also Qualitative Result, Chapter 3), with poor nutritional behaviours contributing to negative health outcomes such as cardiovascular impairments and circadian disruption due to irregular and poor sleep practices resulting from shift work (Morris *et al.*, 2015; Mohd Azmi *et al.*, 2020). For example, Fradkin *et al.* (2019) indicated that nurses with rotating shift work consumed more calories on shift work days, particularly during night shifts. This can be attributed to sleep deprivation during night shifts, altering an individual's appetite. In line with our previous findings on disrupted circadian rhythms during shift work, DNs often resort to easily accessible, high-calorie-dense snacks to stay awake and "keep themselves busy" (see Qualitative Result, Chapter 3 – 4). This poor nutritional practice and high consumption of unhealthy snacks can lead to excessive calorie intake, contributing to overweight and obesity (Kyle *et al.*, 2017b; Fradkin, Raz and Boaz, 2019). Jaradat *et al.* (2020) found that hospital doctors engaged in shift work experienced fatigue, anxiety and depression, and those who were also smokers were overweight and obese. This evidence strengthens our findings, confirming the impact of shift work on health issues such as increased fast-food consumption or large, irregular, infrequent meals leading to weight gain. Therefore, significant efforts are necessary to promote lifestyle changes and improve dietary habits, address nutrition intake, and prevent weight gain associated with shift work.

5.2.1 Strengths and limitations

The main strength of this study was to provide an overall understanding of the DNs' dietary practices with shift work from the UK Biobank database consisting of 5,777 participants, where the current knowledge within the literature is unclear. In addition, the dataset of DNs from across the UK who had shift work enabled an investigation of the dietary needs to determine their nutritional intake, its impact from shift work, and whether there was any significance between the two professions, and it complemented the dietary recommendations.

However, there were several limitations to this study. First, the study cannot fully understand DNs' dietary needs over time and whether they meet the recommended guidelines. For example, this study used a cross-sectional approach and only used baseline assessment data to determine the dietary intakes of DNs. Thus, choosing to analyse the baseline data limited the opportunity to understand whether DNs' dietary intake changed over time and whether their knowledge towards nutrition was practised at repeated measures. A second limitation was the misreporting of the data due to participants self-reporting their dietary intake through a series of touch screen questionnaires, such as a detailed diet recall. As the baseline assessment process lasted between 2 – 3 hours with five data collection parts, individuals recalling what they ate via a 24-hour dietary recall could be difficult when this data collection method was based on the individual's memory. Using 24-hour dietary recall may provide detailed data leading to the estimation of the total dietary intake in the short term. However, this method cannot measure distant past meals or irregularly consumed food. On the other hand, food frequency can provide a longer-term estimation of usual food intake. However, this cannot be accurately reported when the questionnaire is restricted to only the list of food items within the tool (Saravia *et al.*, 2022). Previous literature highlighted the challenges of collecting valid and reliable dietary intake (Picó *et al.*, 2019; Ravelli and Schoeller, 2020), with evidence strongly suggesting the subjectiveness of using surveys and questionnaires with the combinations of factors relying on the individual's memory or their willingness to share their true dietary consumption would limit the opportunity to assess food consumption and its association to health outcomes. As a result, it has been suggested that clinical biomarkers can provide a more reliable analysis of the metabolites and help understand the food-metabolite association concerning diet-induced disease and health risks (Garcia-Aloy *et al.*, 2019; Picó *et al.*, 2019; Langenau *et al.*, 2020).

Our study included a sample size of 5,777 DNs, with the UK Biobank volunteers being a voluntary database. Despite this limitation, our findings provide insight into DNs' diets and opportunities to further explore their habitual diets during shift work and be generalisable to the whole DNs population in the field.

Occupational factors have previously been highlighted as predictors of nutritional practices (Nabe-Nielsen *et al.*, 2016; Bonnell *et al.*, 2017; Gibson, 2018; Heath, Dorrian and Coates, 2019; Souza *et al.*, 2019a). For example, the environmental factors (such as food facilities and provisions and their availabilities), the challenges of shift work (such as clinical workload and its impacts on dietary intake) (see Qualitative Result Chapter 4), and the shift work patterns (such as the work hours, the types of shifts) are factors that could influence DNs' nutritional behaviours during shift work. Nevertheless, this study provides a foundation knowledge of DNs' current diet and the need to explore other variables to better understand how shift work influences DNs' diet at work.

5.3 Conclusion

This study examined the dietary intake of DNs with shift work using the UK Biobank. Despite the limitations of the cross-sectional data, our overall findings suggest that DNs are meat eaters, lack dietary fibre and water, prefer dairy, specifically cheese, and heavily rely on caffeine and alcohol, which has yet to be researched by previous literature. Compared to UK dietary recommendations, DNs' nutritional intake remains sub-optimal and does not fully fill the required nutrients, thus contributing to poor workplace nutrition and overall health. Though this study predominately looked at what DNs currently eat without the direct comparison against each different working pattern, our findings highlighted the importance of researching DNs' eating practices to provide the knowledge needed to support them best. Considering previous literature on their occupational role, it could be assumed that DNs' diet and nutrition largely depend on their clinical responsibilities and the time available during their shifts. DNs' diets are sub-optimal across all areas in this study. Thus, there is a further need to understand DNs' diet during their working hours, address the similarities and differences in different shift patterns, and feed our understanding of the barriers and facilitators to improve their workplace nutrition when designing workplace interventions.

CHAPTER 6: UK BIOBANK QUANTITATIVE STUDY RESULT 2

6.1 Introduction

Shift work has demonstrated its impact on physiological and psychological health, such as poor mental health and cardiovascular diseases (Torquati *et al.*, 2018; Zhao *et al.*, 2019). Our earlier chapters (see Chapters 3 – 4) indicated that shift work affects health professions, including doctors' and nurses' eating patterns, leading to poor dietary habits, obesity and reliance on high-calorie food due to limited accessibility during outside standard working hours, mainly due to clinical responsibilities (Reeves, Newling-Ward and Gissane, 2004; Fradkin, Raz and Boaz, 2019; Heath, Dorrian and Coates, 2019; Souza *et al.*, 2019b). Other occupational factors also contribute to DNs' nutritional practices, such as workplace facilities (Leedo *et al.*, 2017; Lima *et al.*, 2021; Lucia *et al.*, 2021; Horton Dias *et al.*, 2022) and the shift work patterns, including the number of working hours, the types of shifts and the length of shifts (Fradkin, Raz and Boaz, 2019; Phoi and Keogh, 2019; D'Annibale *et al.*, 2021) (see Chapter 4). Therefore, DNs' dietary intake can be influenced by several barriers to workplace healthy eating, highlighting the need to address the different variables contributing to DNs' overall workplace nutrition and health.

To our knowledge, limited evidence exists regarding the impact of various shift work patterns on DNs' nutritional intake with shift work. In addition to our earlier findings (see Chapter 5), there is the opportunity to understand if and how different shift work characteristics influence DNs' dietary behaviours. Thus, this chapter aims to explore the dietary intake of DNs during their shifts using the UK Biobank dataset. Furthermore, it examines the impact of various working patterns, such as night and day shifts, and how they impact DNs' dietary intake and diet quality. By analysing different types of shift work patterns, we aim to gain insights into how these working patterns influence the food choices and dietary habits of DNs.

6.2 Descriptive statistics

6.2.1 Demographics

Descriptive analysis was conducted in MySQL to determine the demographics of DNs with different shift work patterns (Table 19). The UK Biobank dataset study included 5777 eligible participants, with the majority of 66.04% being nurses (n=3815) and the rest being doctors (33.96%, n=1962). Results indicated that 89.91% of doctors worked 40 hours a week (n=1764), whereas most nurses (63.33%) worked between 30-40 hours a week (Field ID 22604) (Figure 23).

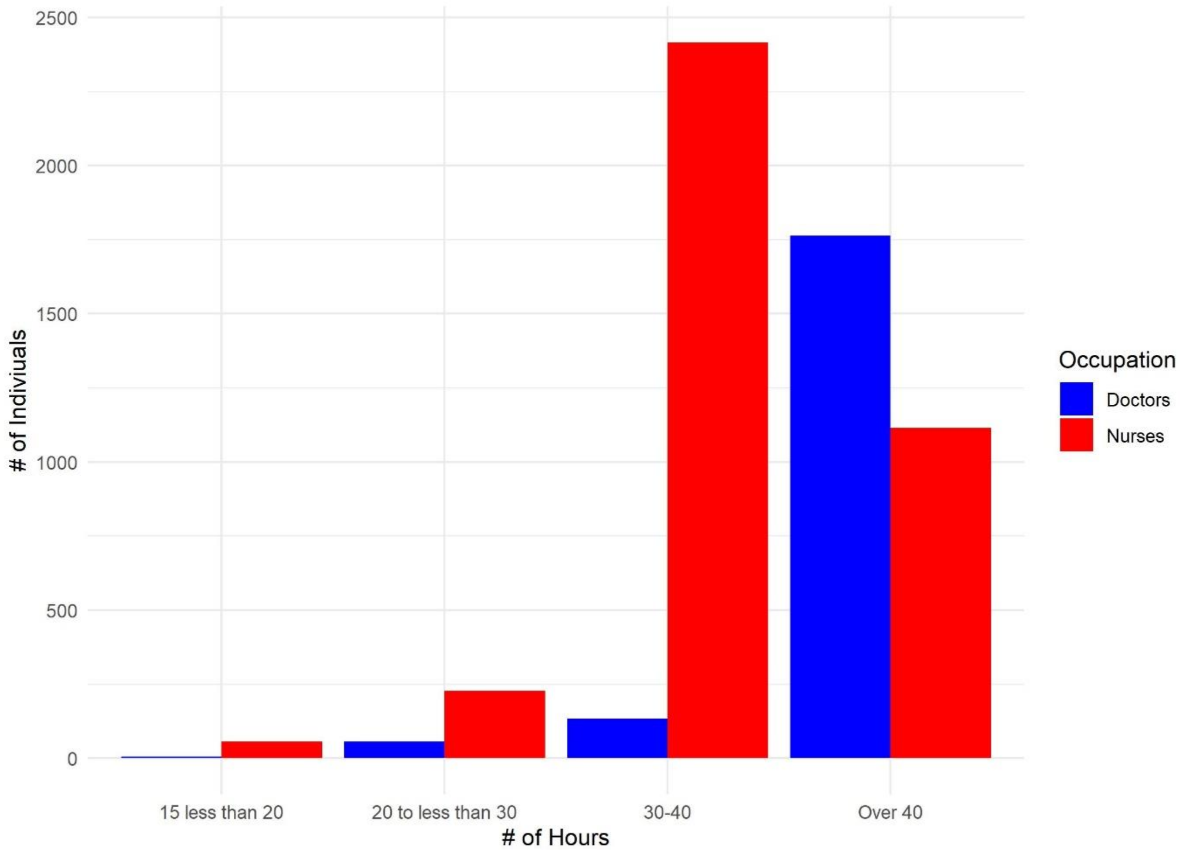

Figure 23: Number of hours worked per week in doctors and nurses from the UK Biobank dataset

Considering DNs with shift work and the number of hours worked per week, the 'job involved shift work' (Field ID 22620) and work hours per week (Field ID 22605) features were used. From the total cohort, 65.50% of doctors had shift work (n=1285) compared to 90.43% of total nurses. Most doctors (90.21%) cited working over 40 hours, compared to 63.65% of nurses working 30-40 hours with shift work. The mean hours worked were 51.92 hours for the cohort, 75.22 hours for doctors, and 38.64 hours for nurses (Figure 24).

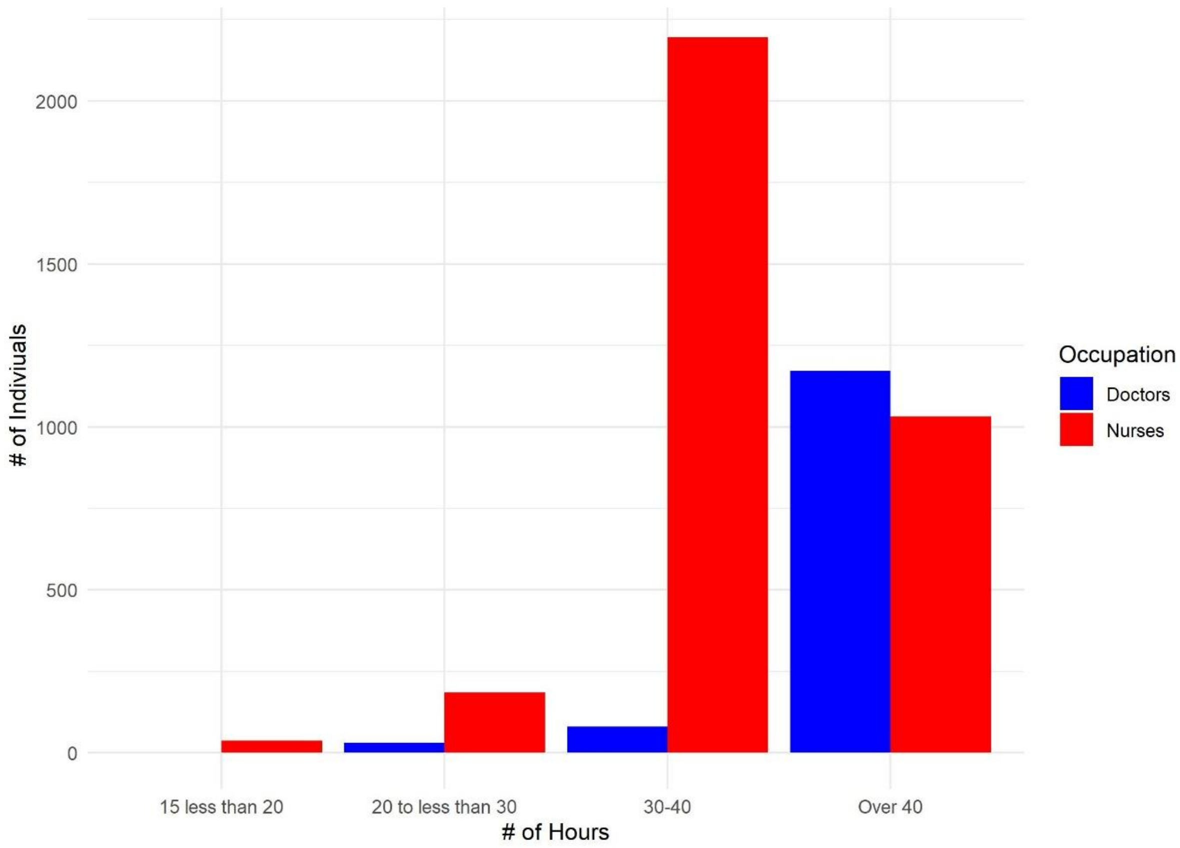

Figure 24: Number of working hours per week in doctors and nurses with shift work from the UK Biobank dataset

When measuring DNs with a mix of day and night shifts (Field ID 22640), both DNs cited that their "whole job" consists of a mix of day and night shifts (63.74% and 57.97%, respectively). In addition, those with this shift type predominately worked for 1 – 5 years, with 13% of doctors and 14.90% of nurses falling in this category.

DNs reported working similar lengths of night shifts (Field ID 22642) with an average of 11 – 15 hours (cohort's average length = 11.71 hours), with doctors working more than nurses (13.80 vs 10.84 hours) (Figure 25). DNs reported working 6 – 10 night shifts per month (54.63% and 33.57%, respectively) (Field ID 22643) (Figure 26), with consecutive night shifts of 1 – 5 nights per cycle, and most doctors (84.67% with an average of 2.38 consecutive night shifts) falling into this category (Figure 27). Conversely, nurses worked 1 – 5 night shifts (43.33%) or 6 – 10 night shifts (40.78%), with an overall average of 5.38 consecutive night shifts.

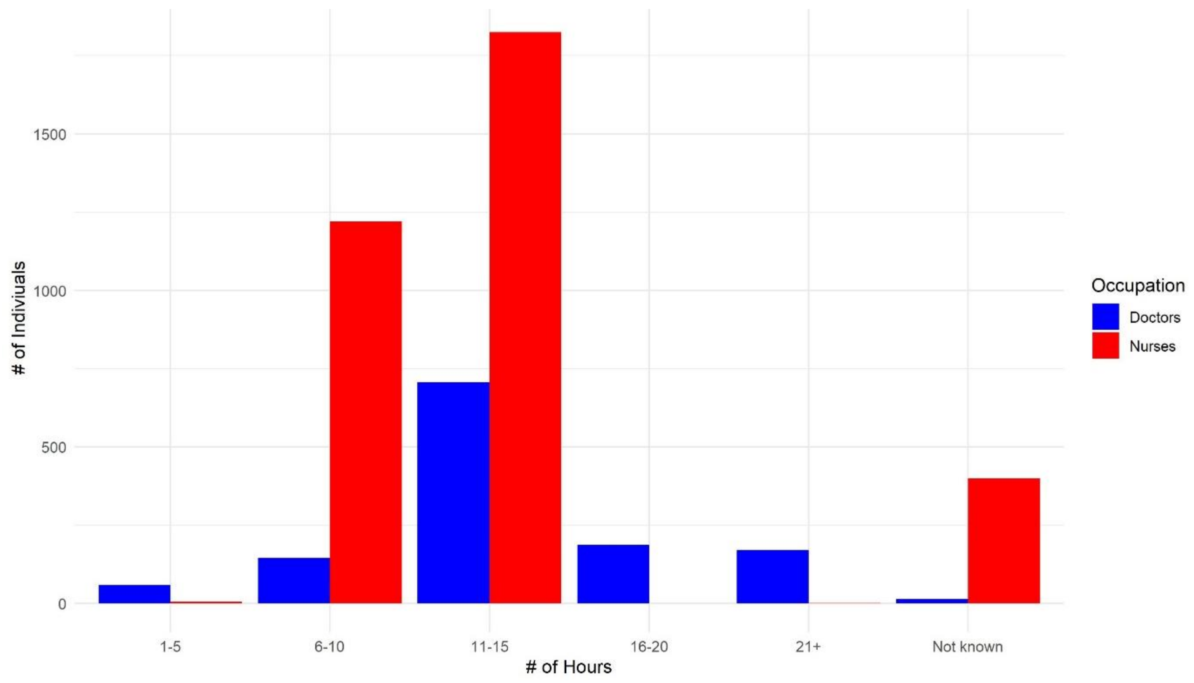

Figure 26: Number of average hours of night shifts in doctors and nurses from the UK Biobank dataset

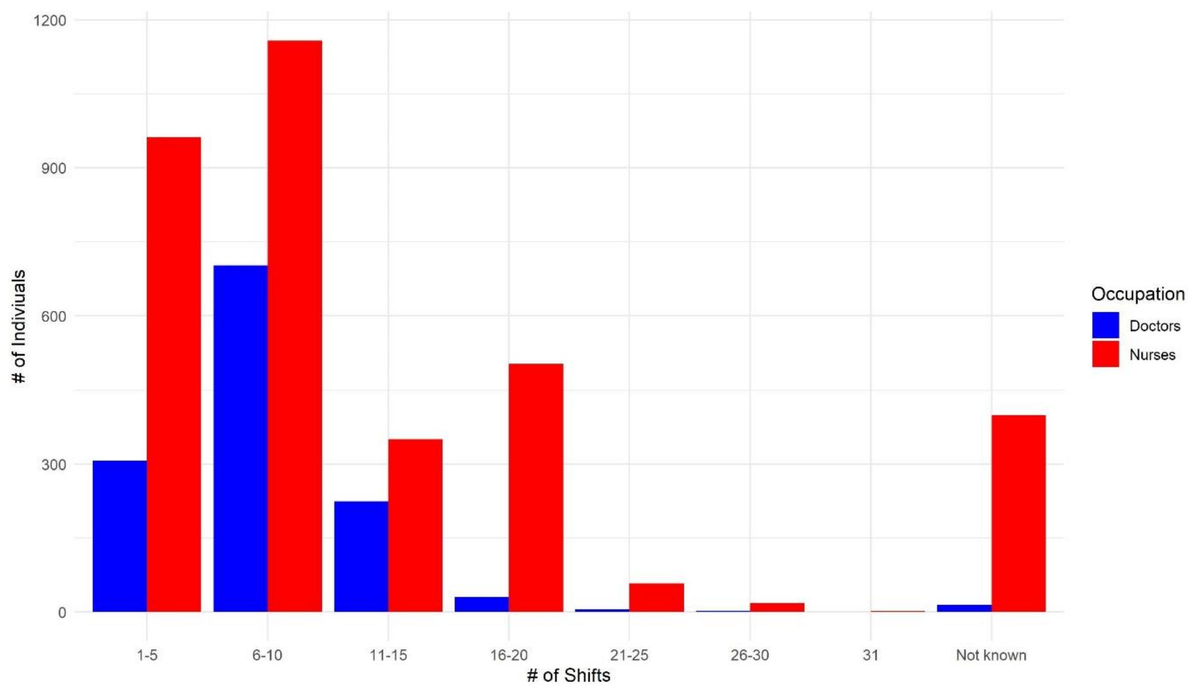

Figure 25: Number of night shifts per month in doctors and nurses from the UK Biobank dataset

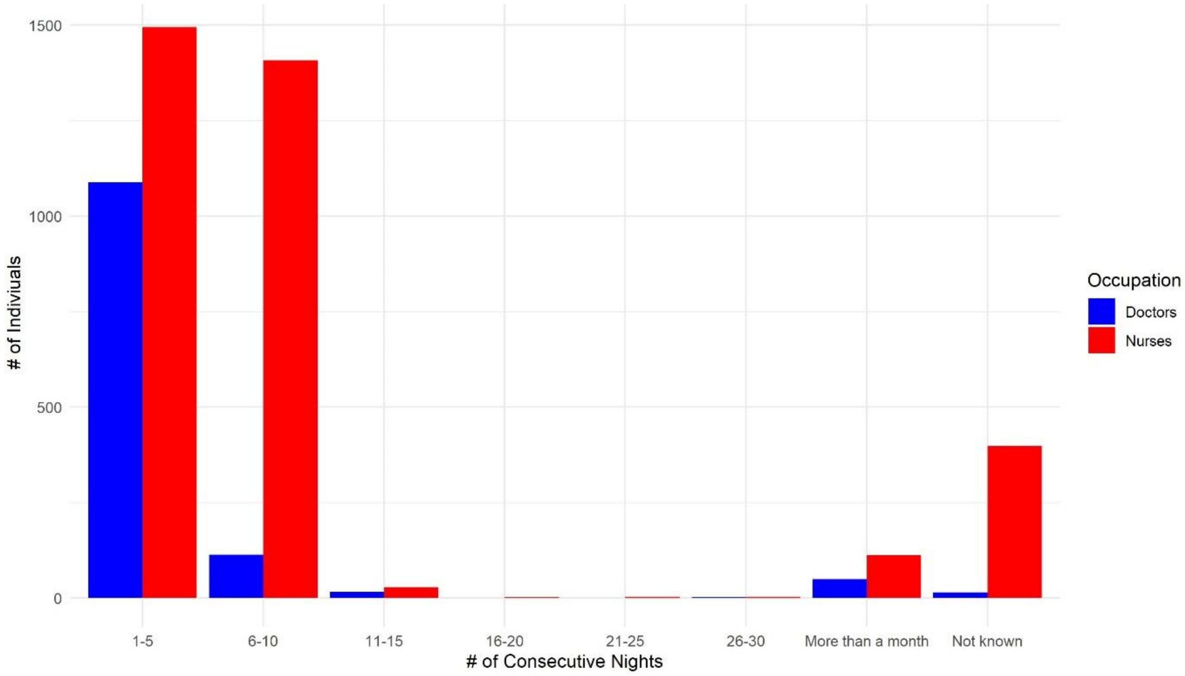

Figure 27: Number of consecutive night shifts in doctors and nurses from the UK Biobank dataset

Lastly, the number of rest days during their shift cycles was similar for both DNs, with the majority having '1 – 5 days' of rest days per work cycle (27.24% and 72.72%, respectively). The average was 3.42 days, with 2.06 days for doctors and 3.60 for nurses.

Table 19: Demographics of doctors and nurses in different shift work patterns

Variable	n (%)
Total number of participants	
Total number of nurses	3815 (66.04)
Total number of doctors	1962 (33.96)
Total number of doctors and nurses	5777
Doctors and work hours per week	
15 less than 20 hours	6 (0.31)
20 to less than 30 hours	57 (2.91)
30-40 hours	135 (6.88)
Over 40 hours	1764 (89.91)
Total	1962
Nurses and work hours per week	

15 less than 20 hours	57 (1.49)
20 to less than 30 hours	227 (5.95)
30-40 hours	2416 (63.33)
Over 40 hours	1115 (29.23)
Total	3815
Doctors and nurses with shift work	
Out of 1962 doctors	1285 (65.50)
Out of 3815 nurses	3450 (90.43)
Doctors with shift work and how many hours per week	
15 to less than 20 hours	1 (0.08)
20 to less than 30 hours	32 (2.49)
30-40 hours	81 (6.30)
Over 40 hours	1172 (91.21)
Total	1285
Nurses with shift work and how many hours per week	
15 to less than 20 hours	37 (1.07)
20 to less than 30 hours	185 (5.36)
30-40 hours	2196 (63.65)
Over 40 hours	1032 (29.91)
Total	3450
Doctors with a mix of day and night shifts	
Some but not all of job	451 (35.10)
Whole of job	819 (63.74)
Not worked during job	15 (1.17)
Total	1285
Nurses with a mix of day and night shifts	
Some but not all of job	1051 (30.46)
Whole of job	2000 (57.97)
Not worked during job	399 (11.57)
Total	3450

Doctors with a period spent working mix day and night shift	
Less than 1 year	66 (5.14)
1-5 years	167 (13.00)
5-10 years	105 (8.17)
10-20 years	68 (5.29)
20-30 years	39 (3.04)
30+ years	6 (0.47)
Not known	834 (64.90)
Total	1285
Nurses with a period spent working mix day and night shift	
Less than 1 year	195 (5.65)
1-5 years	514 (14.90)
5-10 years	162 (4.70)
10-20 years	136 (3.94)
20-30 years	36 (1.04)
30+ years	8 (0.23)
Not known	2399 (69.54)
Total	3450
Doctors and usual length of night shift	
1-5 hours	59 (4.59)
6-10 hours	146 (11.36)
11-15 hours	707 (55.02)
16-20 hours	187 (14.55)
21+ hours	171 (13.31)
Not known	15 (1.17)
Total	1285
Nurses and usual length of night shift	
1-5 hours	5 (0.14)
6-10 hours	1219 (35.33)
11-15 hours	1825 (52.90)
16-20 hours	0 (0.00)
21+ hours	2 (0.06)

Not known	399 (11.57)
Total	3450
Doctors and number of night shifts worked monthly	
1-5 night shifts	306 (23.81)
6-10 night shifts	702 (54.63)
11-15 night shifts	224 (17.43)
16-20 night shifts	30 (2.33)
21-25 night shifts	5 (0.39)
26-30 night shifts	3 (0.23)
Not known	15 (1.17)
Total	1285
Nurses and number of night shifts worked monthly	
1-5 night shifts	962 (27.88)
6-10 night shifts	1158 (33.57)
11-15 night shifts	350 (10.14)
16-20 night shifts	503 (14.58)
21-25 night shifts	58 (1.68)
26-30 night shifts	18 (0.52)
31+ night shifts	2 (0.06)
Not known	399 (11.57)
Total	3450
Doctors and consecutive night shifts during mixed shift periods	
1-5 night shifts	1088 (84.67)
6-10 night shifts	114 (8.87)
11-15 night shifts	16 (1.25)
16-20 night shifts	0 (0.00)
21-25 night shifts	0 (0.00)
26-30 night shifts	2 (0.16)
More than a month	50 (3.89)
Not known	15 (1.17)

Total	1285
Nurses and consecutive night shifts during mixed shift periods	
1-5 night shifts	1495 (43.33)
6-10 night shifts	1407 (40.78)
11-15 night shifts	29 (0.84)
16-20 night shifts	2 (0.06)
21-25 night shifts	3 (0.09)
26-30 night shifts	3 (0.09)
More than a month	112 (3.25)
Not known	399 (11.57)
Total	3450
Doctors and rest days during mixed shift periods	
1-5 days	350 (27.24)
6-10 days	28 (2.18)
11-15 days	1 (0.08)
16-20 days	0 (0.00)
21-25 days	0 (0.00)
26-30 days	1 (0.08)
More than a month	8 (0.62)
Not known	897 (69.81)
Total	1285
Nurses and rest days during mixed shift periods	
1-5 days	2509 (72.72)
6-10 days	480 (13.91)
11-15 days	10 (0.29)
16-20 days	1 (0.03)
21-25 days	2 (0.06)
26-30 days	0 (0.00)
More than a month	29 (0.84)
Not known	419 (12.14)
Total	3450

For subsequent results, a Kruskal-Wallis test determined the difference between DNs' demographics and dietary intakes across the different working pattern characteristics.

6.2.2 Participants’ demographics against different working shift patterns

Age

Age was significant against all the working patterns and characteristics between DNs (Table 20), except for the "mix of day and night shifts worked" ($p=0.969$). The total cohort (52 – 85 years) had a mean age of 69.30 years (SD 7.615), with nurses slightly older than doctors (69.34 ± 7.371 vs 69.21 ± 8.090). Older participants worked more hours; for example, those with 15 – 19.9 hours had a mean age of 68.21 (SD 7.400) vs those working 40+ hours per week, aged 70.35 (SD 7.825). This trend was similar in nurses – those working 15 – 19.9 hours had a mean age of 67.35 (SD 9.072), vs 40+ hours aged 72.51 (SD 6.743). However, this was the opposite in doctors, where the fewer hours worked, the older they were: 15 – 19.9 hours, a mean age of 74.83 (SD 6.998) vs 40+ hours, an age of 69.22 (SD 8.1120).

The number of shift work years worked was significant when measured against the age group ($p<0.001$). The cohort reported a mean age of 68.39 (SD 7.552), with nurses older than doctors (69.05 years ± 7.567 vs 66.86 years ± 7.299) due to more service years.

The length of the night shifts was significant when measured against the age group ($p<0.001$). Nurses were older than doctors (68.76 years ± 7.422 vs 67.42 years ± 7.689), with the total cohort age 68.36 (SD 7.525). However, our participants reported that the younger they were, the longer their night shifts worked.

The number of night shifts per month was significant when measured against the age group ($p<0.001$). Our cohort had a mean age of 68.36 (SD 7.525), with nurses older than doctors (68.76 years ± 7.422 vs 67.42 ± 7.689). The overall trend demonstrated that the older the participants were, the fewer night shifts per month. However, the mean age increases when working 15 or more night shifts. In contrast, the older the doctors, the more night shifts worked per month. Meanwhile, for nurses, the more night shifts worked, the younger they were.

There was a significant difference between the number of consecutive night shifts worked and the age groups (p<0.001). Nurses were older than doctors (68.75 ± 7.422 vs 67.42 ± 7.689). However, the overall cohort showed that the more consecutive night shifts, the younger they were (mean age: 68.36 ± 7.525).

The rest days between shift cycles were significant in DNs when tested against the age groups (p<0.001). The overall mean age was 68.56 years (SD 7.554), with nurses being older than doctors (68.75 years ± 7.429 vs 67.09 ± 8.337). There was a trend where the more rest days were taken, the younger the participants were. This also applies when looking at DNs separately.

BMI

Our results reported a significant difference between BMI and the number of hours worked (p=0.004) (Table 20). Nurses had a higher BMI than doctors (26.808kg/m^2 ± 5.058 vs 25.209kg/m^2 ± 3.707), with the total cohort's BMI being 26.279kg/m^2 (SD 4.716). In the total cohort, those working longer hours per week had a higher BMI. For example, working 15 – 19.9 hours had a BMI of 22.734kg/m^2 (SD 2.499) compared to a mean BMI of 25.324kg/m^2 (SD 3.741) when working more than 40 hours. This was the same when looking at DNs separately.

The number of mixed days and night shifts worked was significant when measured against age groups (p=0.037). Nurses had a higher BMI than doctors (26.822kg/m^2 ± 5.0858 vs 25.249kg/m^2 ± 3.829), with the total cohort's BMI measured at 26.394kg/m^2 (SD 4.827). Conversely, those with a mixture of day and night shifts had a lower BMI than those without (26.391kg/m^2 ± 4.841 vs 26.934kg/m^2 ± 4.827). This trend resonated with the nurses; however, doctors were the opposite – for example, those without a mixture of shifts had a lower BMI than those with a mixed shift combination (25.163kg/m^2 ± 2.349 vs 25.376kg/m^2 ± 3.858, respectively).

The length of night shifts was significant when tested against the age groups ($p<0.001$). Nurses had a higher BMI than doctors (28.799kg/m^2 ± 5.087 vs 25.250kg/m^2 ± 3.843), with the total cohort's BMI being 26.343kg/m^2 (SD 4.806). Most of the cohort who worked 8 – 12 hours per night shift had a BMI between 25.923 – 26.434kg/m^2, suggesting that the longer the night shifts worked, the higher the BMI. Similarly, most nurses working 10 – 12 hours had a BMI between 26.419 – 26.994kg/m^2. Conversely, most doctors worked longer, 12 – 16 hours per night shift, with a lower BMI between 24.402 – 25.393kg/m^2.

A significant difference was found between the number of monthly night shifts and BMI ($p<0.001$). Nurses had a higher BMI than doctors (26.799kg/m^2 ± 5.087 vs 25.250kg/m^2 ± 3.843), with the total cohort's BMI being 26.343kg/m^2 (SD 4.806). Overall, there was no trend, but most DNs (n=827, 19.175%) worked 7-night shifts per month, with a BMI of 26.248kg/m^2 (SD 4.762). When looking at the DNs separately, nurses reported a similar finding, with the majority (n=693, 22.774%) having 7-night shifts per month with a BMI of 26.398kg/m^2 (SD 4.826). Doctors conversely had more night shifts, 10 per month (n=300, 23.622%), with a BMI of 25.186kg/m^2. Overall, nurses worked fewer night shifts than doctors per month but had a higher BMI.

The consecutive night shifts reported a significant difference within DNs when tested against the BMI ($p<0.001$). Nurses had a higher mean BMI than doctors (26.799kg/m^2, ± 5.078 vs 25.250kg/m^2 ± 3.8432), with the total cohort's BMI of 26.343kg/m^2 (SD 4.807). No overall trend in the cohort was found, but most DNs (n=950, 22.026%) worked seven consecutive night shifts with a mean BMI of 26.221kg/m^2 (SD 4.838). Separating DNs, nurses reported similar findings, where the majority (n=850, 27.932%) worked for seven consecutive night shifts, with a BMI of 26.337kg/m^2 (SD 4.879). Conversely, most doctors (n=574, 45.197%) work for one consecutive night shift, reporting a lower mean BMI of 25.075kg/m^2 (SD 3.684). Thus, nurses work more consecutive night shifts and have a higher BMI than doctors.

Table 20: Summary of the Kruskal-Wallis' significant results in doctors and nurses on age and BMI, when measured against the different working patterns characteristics

	Working Patterns						
Other variables	Work hours categories	Mix of day and night shifts worked	Mix of day and night shifts worked in years	Length of night shifts	Number of night shifts worked monthly	Consecutive night shifts	Rest days between shift cycles
Age	**<0.001**	0.969	**<0.001**	**0.000**	**0.000**	**0.000**	**0.000**
BMI	**0.004**	**0.037**	0.190	**<0.001**	**<0.001**	**<0.001**	0.166

6.2.3 Characteristics of dietary consumption against different working shift patterns (Table 21)

Total fruit intake (per day)

Total fruit intake was significant between DNs in the work hours categories (p=0.037), with doctors presenting a lower mean intake (2.700) than nurses (2.859) per day (total mean fruit intake = 2.806). However, the fruit intake data ranged between 0 and 22 pieces per day (SD 2.5715 overall). Our result found a higher proportion of DNs consuming more fruits when working over 30 hours per week (n=3,778, 92.34%) compared to those working 15-29.9 hours (n=313, 7.65%).

The number of night shifts worked per month to fruit intake was significant in DNs (p=0.048), with a mean intake of 2.796 (SD 2.488) and nurses consuming more than doctors (2.854 vs 2.655, respectively). Similarly, fruit intake ranged between 0 and 22 pieces per day, with nurses reaching a higher maximum intake than doctors (maximum intake was 15 per day). Overall, most of the cohort worked seven-night shifts per month (n=828, 19.17%), with participants in this category consuming 2.0 fruits per day on average.

Consecutive night shifts in our cohort demonstrated a significant difference in total fruit intake (p=0.020), with a mean intake of 2.796 (SD 2.488). Nurses had a higher mean fruit (2.854 vs 2.655, respectively) and a maximum intake (22 vs 15, respectively) than doctors. Fruit intake also ranged between 0 and 22 pieces of fruit per day, with nurses reaching 22 pieces compared to doctors (15). Most of the cohort worked seven consecutive night shifts (n=951, 22.02%), with participants consuming a mean of 2.0 fruit intake.

The total fruit intake with rest days was significant between DNs (p=0.023). DNs consumed a mean of 2.817 fruits (SD 2.476), with doctors consuming more than nurses daily (2.500 vs 1.957 days, respectively). However, the total fruit intake ranged between 0 and 22, with nurses reaching a higher maximum than doctors (22 vs. 10, respectively). Most of the cohort had three rest days between shift cycles (n=838, 24.51%), with participants consuming 2.0 pieces of fruit daily.

Total vegetable intake (per day)

There was a significant difference in DNs' vegetable intake when measured against the consecutive night shifts worked (p=0.004). DNs consumed an average of 5.157 vegetables daily (SD 2.671), ranging between 0 – 22.5 portions during consecutive night shifts. DNs presented a similar intake (5.326 for doctors and 5.087 for nurses), though doctors had a higher maximum vegetable consumption (22.5 portions) than nurses (20.5 portions). Most of the cohort worked seven consecutive night shifts (n=951, 22.02%), with a mean vegetable intake of 2.0 portions a day.

Total meat, unprocessed red meat and fish intake (per week)

There was a significant difference in DNs' total meat intake when measured against consecutive night shifts worked (p=0.004). DNs consumed an average of 5.157 portions of meat per week (SD 2.6713), with a higher doctor intake than nurses (5.326 vs 5.087, respectively). Likewise, doctors' maximum weekly meat portion was higher than nurses' (22.5 vs 20.5). Those with more consecutive night shifts consumed less total meat across the week – for example, those working 0 – 8 consecutive night shifts ranged between 0 – 22 meat portions a day. However, most of the cohort cited working for seven consecutive night shifts (n=951, 22.01%), with this group consuming 5 – 5.5 meat portions a week (21.56%).

Though there was no significant difference in our cohort's meat intake against the number of working hours, DNs demonstrated that those working more hours per week consumed less meat. For example, those between 15-19.9 hours a week (n=52, 1.27%) of the total cohort consumed a mean of 2.808 portions compared to those working between 30-39.9 and 40+ hours a week (n=1996, 48.79% and n=1782, 43.56% respectively) consumed 1.383 and 2.446 meat portions weekly.

Total unprocessed red meat consumption demonstrated significant differences in the 'work hours categories'. When measured against the work hour categories, DNs consumed 2.088 mean portions of unprocessed red meat per week, with the majority (n=1782, 43.56%) of the cohort working more than 40 hours per week. Most of this group (n=611, 34.29%) consumed 1.5 weekly portions. However, when compared against the lowest work hours category of 15 – 19.9 hours per week (n=52, 1.27%), most of that group (n=15, 28.85%) also consumed 1.5 portions per week. Between DNs, there was a significant difference (p=0.03), with results highlighting that doctors consumed more unprocessed red meat than nurses (2.163 ±1.4209 vs 2.052 ±1.4469, respectively) when measured against the number of working hours. Nevertheless, overall, the more hours worked, the more unprocessed meat consumed.

A significant difference was found between DNs in unprocessed meat and the number of 'rest days' taken (p=0.029). A mean portion of 2.086 (SD ± 1.4812) unprocessed red meat was consumed; however, doctors consumed more than nurses (2.285 ± 1.579 vs 2.060 ± 1.466). Across the total cohort, results highlighted that the more rest days taken, the less unprocessed meat consumed. For example, most DNs had three rest days (n=838, 24.51%), with the majority consuming between 1.0 – 2.9 portions per week (n=577, 86.85%). However, those with more rest days (i.e. 8 – 27 days) consumed 0 – 1.9 weekly portions.

Fish intake significantly differed between DNs when assessed against monthly night shift frequencies (p=0.008). Doctors reported a higher mean intake than nurses (2.317 ±1.523 vs 2.292 ± 1.491, respectively). Across the cohort, most DNs worked 7-night shifts per month (n=828, 16.16%), with the majority consuming 1.5 – 2.0 portions of fish per week (n=420, 50.72%). Separating DNs, doctors worked more night shifts than nurses (an average of 10 vs 7-night shifts per month, respectively). However, most DNs in those groups (n=300, 23.62% and n=694, 22.74%, respectively) consumed similar fish portions per week (1.0 – 1.9 portions) despite differences in the number of night shifts per month.

Milk and cheese intake

Milk intake per day in DNs significantly correlated with average night shift length (p<0.001). A mean intake of 91.685ml of milk per day was consumed, with doctors consuming more than nurses (91.897ml ± 41.530 vs 91.576ml ± 41.717, respectively). However, a large range of milk was also consumed (between 0 – 335.0mls per day), with the doctors having a higher maximum intake than nurses (335ml vs 235.714ml). In addition, most of the total cohort worked, on average, 12 hours per night shift (n=1699, 39.32%), with the majority consuming <150ml of milk per day (n=1649, 97.06%). Overall, DNs worked 12 hours per night shift (n=547, 37.29% for doctors and n=1152, 40.36% for nurses), with most of this group consuming <150mls of milk daily.

There were no significant differences in DNs for cheese intake when measured against the various working patterns (Table 21).

Tea and coffee intake (per day)

Tea intake in DNs was significantly associated with the variable 'work hour categories' (p<0.001). On average, 2.84 cups of tea were consumed daily (SD 3.582), with nurses consuming more than doctors (3.16 cups ± 3.408 vs 2.20 cups ± 3.831). Doctors working fewer hours consumed more tea: 3.83 cups between 15 – 19.9 hours vs 2.15 cups when working more than 40 hours per week. Conversely, tea consumption for nurses was equally split across all working hours, between 3.02 – 3.22 cups. Nevertheless, our total cohort consumed more tea if they worked more weekly hours. For example, most participants worked more than 30 hours per week (n=3778, 92.35%), consumed 2.45 – 3.15 cups of tea daily and reached a maximum of 20 cups. Meanwhile, those working fewer hours, 15 – 19.9 hours per week, consumed 3.27 cups of tea daily.

Tea consumption significantly correlated with the number of consecutive night shifts worked (p<0.001). A mean of 2.88 cups of tea was consumed daily (SD 3.768), with nurses consuming more than doctors (3.14 cups ± 3.578 vs 2.26 cups ± 2.26) and reaching a higher amount also (35 vs 21 cups). Overall, most of the cohort (n=951, 22.02%) worked seven consecutive night shifts and consumed an average of 3.17 cups of tea in that group. Between DNs, doctors with more consecutive night shifts consumed more tea than those with fewer shifts. For example, those working nine shifts drank 5.00 cups, while those working 2 – 4 night shifts consumed 2.00 – 2.83 cups of tea, highlighting nearly double the amount. This was also similar when comparing those working more or fewer than 10 consecutive night shifts (4.25 – 10.0 vs 2.98 – 3.38 cups, respectively).

Coffee intake significantly differed between DNs concerning the 'work hours categories' variable ($p<0.001$). The average intake was 1.39 cups of coffee (SD 3.791), with doctors consuming more than nurses (1.56 cups ± 3.861 vs 1.31 cups ± 3.754). However, those working for more hours drank fewer cups of coffee. For instance, individuals working over 40 hours consumed 1.47 cups of coffee, while those between 15 - 19.9 hours had an average intake of 1.65 cups. Between DNs, doctors working more hours per week consumed a larger range of cups of coffee (0 – 18 cups per day when working 40 or more hours) compared to those working fewer hours, 0 – 4 cups when working 15 – 19.9 hours. Nurses were also similar, where those working 15 – 19.9 hours per week consumed a smaller range of cups of coffee than those working for more than 30 hours (ranges between 0 – 8 cups vs 0 – 15 cups). Overall, coffee consumption increased as the hours worked increased, with doctors consuming more than nurses.

There was a significant difference between DNs when measuring coffee consumption against the consecutive night shifts ($p=0.018$). Doctors had a higher mean intake than nurses (1.48 cups ± 3.896 vs 1.33 cups ± 3.733 cups), with the overall cohort consuming 1.38 cups (SD 3.782) daily. Most of the cohort worked seven consecutive night shifts (n=951, 22.01%), consuming more than 3 cups of coffee daily, with the maximum reaching 15 cups. Similarly, among doctors, 40.55% consumed over three cups of coffee regardless of the number of consecutive night shifts worked (the other 59.37% consumed between 0 – 2.9 cups across the groups). Likewise, most nurses worked seven consecutive night shifts (n=851, 27.89%), with most of the group (33.84%) reporting drinking more than three cups of coffee. Overall, consuming over three cups of coffee per day was common regardless of the number of consecutive night shifts worked, with doctors having a higher consumption than nurses.

Water intake (per day)

Water intake significantly differed between DNs based on the 'work hours categories' variable ($p<0.001$). The total mean water consumption was 2.26 glasses per day (SD 3.757), with nurses drinking more than doctors (2.64 glasses ± 3.473 vs 1.50 glasses ± 4.175). Both groups reached a maximum of 20 glasses per day. Those working 30 - 30.9 hours had the highest water intake (mean of 2.61 glasses, SD 3.44) compared to other working hours, with a similar distribution across categories and a mean intake between 1.92 - 1.95 glasses per day. This finding was also similar when separating DNs. Doctors working 30 – 39.9 drank the most (an average of 2.31 glasses per day, SD 3.885), with those working fewer hours (15 – 29.9 hours) drinking less than one glass of water per day (0.50 – 0.92 glasses, ± 5.320 – 5.793). Conversely, nurses working more weekly hours had higher water intake than those with fewer hours. For example, those with more than 40 hours per week drank an average of 2.84 glasses (SD 3.459) compared to 2.11 glasses (SD 3.659), between 15 – 19.9 hours.

Significant differences in water intake were observed among DNs based on the average length of the night shift ($p=0.002$). The total cohort drank 2.36 glasses of water (SD 3.70), with doctors drinking less than nurses across all night shift lengths (1.62 glasses ± 4.018 vs 2.67 glasses ± 3.514). Most of the cohort (n=1699, 39.32%) worked 12 hours of night shifts, with 25.90% of DNs drinking two glasses of water. Doctors were also similar, with the majority (n=495, 38.98%) working an average of 12 hours and drinking 1.83 (SD 3.826) glasses per day. Nurses also presented similar findings, with most working 12 hours of night shift (n=1204, 39.46%) and drinking 2.71 glasses of water (SD 3.449). Interestingly, working over 12 hours showed a negative correlation with water consumption. DNs exhibited reduced water intake as the night shift exceeded 12 hours, with a peak at 24 hours, where the majority (23.26%) consumed an average of three glasses of water per day. This finding was consistent when separating DNs, with nurses decreasing water consumption when working more than 12 hours instead of peaking at 24 hours. Overall, nurses presented to consume more glasses of water per day than doctors.

Significant findings were observed between consecutive night shifts and water intake in DNs ($p<0.001$). Nurses consumed more water than doctors (2.67 glasses ± 3.514 vs 1.62 glasses ± 4.018), with the total cohort drinking 2.36 glasses (SD 3.700). Nurses reached a maximum of 30 glasses compared to 15 glasses for doctors. Most of the cohort (n=951, 22.01%) worked seven consecutive night shifts per month, with 23.34% of participants drinking, on average, 2.64 (SD 3.744) glasses of water daily. Most doctors (n=574, 45.20%) reported having one consecutive night shift and drank an average of 1.56 glasses of water in this group. Conversely, most nurses reported working seven consecutive night shifts (n=851, 27.89%) with a higher mean intake of 2.75 glasses of water. Nurses had a higher water intake and worked more consecutive night shifts than doctors.

Alcohol (frequency per week)

Our cohort reported a significant difference in alcohol consumption frequency based on the number of monthly night shifts ($p=0.020$). DNs reported drinking alcohol between "daily or almost daily" and "3-4 times a week", with doctors more likely to consume 3-4 times a week than nurses. Most of the cohort (n=828, 19.17%) worked seven consecutive night shifts, and the majority (n=777, 93.84%) of this category consumed alcohol 3-4 times a week. For doctors, most (n=299, 23.58%) worked 10-night shifts per month, with this group consuming alcohol 3-4 times a week. Conversely, most nurses (n=694, 22.75%) had an average of 7-night shifts per month, with this group (n=650, 93.66%) consuming alcohol 3-4 times a week. Overall, there was no trend between alcohol consumption frequency and the number of monthly night shifts.

Results reveal a significant difference in alcohol consumption frequency between DNs based on consecutive night shifts per cycle ($p=0.050$). Doctors were more likely to consume alcohol 3-4 times a week than nurses (1.92 vs 1.89: 1 represents "daily or almost daily" and 2 represents 3-4 times a week). Most of the cohort (n=951, 22.02%) worked seven consecutive night shifts, with 93.69% (n= 891) of this group consuming alcohol 3-4 times per week. In the total cohort, there was a sudden decrease in alcohol consumption frequency, with fewer participants (n=55, 1.27%) working more than 11 consecutive night shifts. Most doctors work for one consecutive night shift (n=573, 45.19%), with 95.29% of this group (n=546) consuming alcohol 3-4 times a week. Similar to the total cohort, there was a sudden decrease in doctors working for more than eight or more consecutive night shifts. However, these participants (n=23, 1.81%) still consumed 3-4 times alcohol per week. For nurses, the majority of 27.89% (n=851) worked seven consecutive night shifts, with 94.12% (n=801) of this category consuming alcohol 3-4 times per week. Like the overall DN cohort and doctors, fewer nurses work more than 10 consecutive night shifts (n=37, 1.21%) and consume alcohol 3-4 times per week. Overall, no trend was observed between alcohol consumption frequency and the number of consecutive night shifts.

Total weekly alcohol consumption significantly differed among DNs based on the 'work hours categories' variable ($p<0.001$). The total cohort has an average alcohol consumption of 47.507ml (SD 53.253), with doctors consuming more alcohol than nurses (61.373ml ± 58.28 vs 40.669ml ± 4.587). Among them, those working over 40 hours a week (n=1782, 43.56%) had the highest mean alcohol intake (54.586ml ± 59.161) compared to those working fewer hours, 15 - 19.9 hours (48.142ml ± 47.870). However, those working between 20 – 30.9 hours per week consumed the least 41.832 – 42.435mls per week. Similarly, doctors working over 40 hours per week exhibited a higher weekly alcohol consumption (62.818ml ± 60.628) than those working fewer hours, such as between 15 – 19.9 hours (57.140ml ± 49.811). Conversely, nurses showed different results, where the more hours worked per week, the less alcohol consumed. For example, those between 15 – 19.9 hours consumed 46.968ml (SD 48.054) compared to those working more than 40 hours per week, consuming 38.959ml (SD 52.989).

DNs exhibited a significant difference in total alcohol consumption based on the number of mixed day and night shifts worked ($p=0.006$). Those with "some" of a mixture of day and night shifts consumed the most weekly alcohol intake per week (48.039mlm ± 51.962) than those without this shift type (39.882ml ± 45.294). Similarly, in doctors, those with "some" of the mixed day and night shift in their job reported a higher weekly alcohol consumption compared to those whose “entire” job involved this shift combination (61.525ml ± 51.845 vs 60.595ml ± 62.171). Conversely, doctors without a mixture of shifts consumed the least alcohol per week (56.029ml ± 41.213).

In nurses, there was a correlation between the hours worked and the amount of alcohol consumed. Those on the fewest hours (15 – 19.9 hours) consumed the most (46.968ml ± 48.054), whereas those with more than 40 hours consumed the least alcohol (38.959ml ± 52.989).

Night shift length significantly differed among DNs concerning weekly alcohol intake ($p<0.001$). The cohort consumed an average of 46.295ml (SD 52.225), with doctors having shorter night shift lengths and drinking more than nurses (60.926ml ± 431.88 vs 40.205ml ± 47.996). Those with 3 hours of night shift consumed a mean of 73.623ml (SD 74.546), compared to most participants (n=1699, 39.319%) working 10 hours (39.861ml ± 47.060) or 12 hours consuming 46.642ml (SD 54.749). This trend was similar for doctors, where those working fewer hours at night had a higher intake; for example, working 3 hours consumed 73.623mls (SD 74.546) vs those working 12 hours consuming 59.183ml (SD 60.088). However, those working more than 12 hours increased alcohol consumption (60.295 – 71.357ml). Similarly, nurses with fewer night shift hours had a higher average alcohol intake (4 hours = 72.570ml ± 55.762) compared to those working 12 hours (41.486ml ± 51.545), which represented the majority of nurses (n=1204, 36.462%). Those working over 12 hours per night shift continue the trend of consuming less alcohol with longer night shift lengths.

The total weekly alcohol consumption of DNs showed a significant correlation with the number of consecutive night shifts worked ($p<0.001$). Doctors consumed more alcohol per week than nurses (60.926ml ± 58.694 vs 40.205ml ± 47.996), with the whole cohort consuming an average of 46.296mls (SD 52.225). Most participants (n=951, 22.008%) worked seven consecutive night shifts, consuming a mean intake of 43.088ml per week (SD 46.204). Doctors' consumption remained consistent across different night shifts, with the majority (n=574, 45.197%) working one consecutive night shift consumed 59.094ml (SD 60.597). For nurses, weekly alcohol intake remained consistent across all numbers of consecutive night shifts, ranging from 37.792 to 44.705ml. However, those with 11 consecutive night shifts had the highest alcohol intake, averaging 93.852ml (SD 109.128). Overall, doctors consumed a higher weekly alcohol intake than nurses.

Table 21: Summary of the Kruskal-Wallis' significant results in doctors and nurses on dietary intake, when measured against the different working patterns characteristics

	Working Patterns						
Food Variable/	**Work hours categories**	**Mix of day & night shifts worked**	**Mix of day & night shifts worked in years**	**Length of night shifts**	**Number of night shifts worked monthly**	**Consecutive night shifts**	**Rest days between shift cycles**
Total fruit	**0.037**	0.638	0.673	**0.193**	0.048	0.020	**0.023**
Total vegetable	0.842	0.138	0.769	0.321	0.427	**0.002**	0.333
Total meat	0.150	0.123	0.548	0.263	0.819	**0.004**	0.443
Total unprocessed red meat	**0.003**	0.136	0.777	0.252	0.072	0.086	**0.029**
Total fish	0.292	0.320	0.549	0.811	**0.008**	0.412	0.123
Total milk	0.180	0.235	0.472	**<0.001**	0.396	0.094	0.538
Total cheese	0.285	0.751	0.175	0.190	0.541	0.925	0.491
Total tea	**<0.001**	0.762	0.865	0.061	0.279	**<0.001**	0.203
Total coffee	**<0.001**	0.062	0.136	0.056	0.570	**0.018**	0.125
Water	**<0.001**	0.074	0.699	**0.002**	0.136	**<0.001**	0.079
Alcohol (frequency)	0.861	0.242	0.862	0.390	**0.020**	**0.050**	0.971
Alcohol (overall weekly intake)	**<0.001**	**0.006**	0.113	**<0.001**	00.079	**<0.001**	0.280

6.2.4 Characteristics of dietary quality scores against different working shift patterns (Table 22)

Healthy Diet Score

The Healthy Diet Score was calculated using the data collected (see previous Chapter 5). Our cohort exhibits significant differences based on the 'work hours categories' variable (p=0.026). The mean Healthy Diet Score was 4.17 out of 7 (SD 1.423), indicating a higher score corresponding to a healthier diet. Nurses had a higher mean score than doctors (4.23 ± 1.399 vs 4.05 ± 1.464). Furthermore, across the whole cohort, those working 20 - 29.9 hours had the highest mean score (4.36 ± 1.412), while those with the fewest hours scored the lowest (3.85 ± 1.420). Separating DNs, this was also similar where those working the fewest hours (15 – 19.9 hours) had the lowest score (3.50 ± 0.837, and 3.89 ± 1.479) compared to those working 20 – 29.9 hours scoring the highest (4.12 ± 1.592 and 4.42 ± 1.360).

There was a significant association between the number of night shifts worked and the Healthy Diet Score in DNs (p=0.002). The total cohort's mean score was 4.15 (SD 1.418), with nurses reporting higher scores than doctors (4.19 ± 1.408 vs 4.04 ± 1.438). The majority worked 7-night shifts per month (n=828, 19.16%), with this group reporting a healthy diet score of 4.20 (SD 1.410). Most doctors worked 10-night shifts per month (n=300, 23.62%), with a mean score of 4.06. Meanwhile, for nurses, the majority (n=694, 22.75%) worked 7-night shifts, scoring a mean of 4.25 (SD 1.406). Nurses have fewer night shifts per month and a higher Healthy Diet Score than doctors.

A significant difference was observed between DNs' Healthy Diet Score and the consecutive night shifts (p=0.006). The total cohort reported a mean score of 4.15 (SD 1.418), with nurses having a higher mean than doctors (4.19 ± 1.408 vs 4.4 ± 1.438). Most participants (n=951, 21.99%) worked for seven consecutive night shifts, scoring 4.25 (SD 1.422). Doctors mostly worked for one consecutive night shift (n=574, 45.197%), scoring 3.99 (SD 1.434). Conversely, nurses had a higher mean score of 4.28 (SD 1.401), with the majority working seven consecutive night shifts (n=851, 27.892%). Nurses have a higher healthy diet score but work more consecutive night shifts than doctors.

Partial Fibre Score

No statistical significance was found between partial fibre score and working pattern characteristics in DNs.

Table 22: Summary of the Kruskal-Wallis' significant results in doctors and nurses on Healthy Diet Score and Partial Fibre Scores, when measured against the different working patterns characteristics

	Working Patterns						
Other variables	Work hours categories	Mix of day & night shifts worked	Mix of day & night shifts worked in years	Length of night shifts	Number of night shifts worked monthly	Consecutive night shifts	Rest days between shift cycles
Healthy Diet Score	**0.026**	0.862	0.488	0.116	**0.002**	**0.006**	0.176
Partial Fibre Score	0.345	0.352	0.733	0.427	0.156	0.090	0.569

Table 23: Summary of overall trends in doctors and nurses on all variables measured, when tested against the different working patterns characteristics.

	Work hours categories			Mixture of day and night shifts worked			Mixture of day and night shifts worked in years			Length of night shifts			Number of night shifts worked monthly			Consecutive night shifts			Rest days between shift cycles		
	O	**D**	**N**	**O**	**D**	**N**	**O**	**D**	**N**	**O**	**D**	**N**	**O**	**D**	**N**	**O**	**D**	**N**	**O**	**D**	**N**
Age	↑	↓	↑	→	→	→	↑	↑	↑	↓	↓	↓	↓	↑	↓	↓	→	→	↓	↓	↓
BMI	↑	↑	↑	↓	↑	↓	→	→	→	↑	↑	↑	→	→	→	→	→	→	→	→	→
Fruit	↑	↑	↑	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	↓	↓	↓
Vegetable	→	→	→	→	→	→	↓	↓	↓	→	→	→	↓	↓	↓	↓	↓	↓	↓	↓	↓
Meat	↑	↑	↑	↑	↑	↑	↓	↓	↓	→	→	→	↓	↓	↓	↓	↓	↓	↓	↓	↓
Unprocessed red meat	↑	↑	↑	↑	↑	↑	→	→	→	→	→	→	↓	↓	↓	↓	↓	↓	↓	↓	↓
Fish	↑	↑	↑	↑	↑	↑	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→
Milk	↑	↑	↑	↑	↑	↑	→	→	→	→	→	→	→	→	→	↓	↓	↓	↓	↓	↓
Cheese	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→
Tea	↑	↑	↑	↑	↑	↑	→	→	→	→	→	→	↓	↓	↓	↑	↑	↑	→	→	→
Coffee	↑	↑	↑	↑	↑	↑	→	→	→	→	→	→	↓	↓	↓	→	→	→	↓	↓	↓

Water	→	→	→	→	→	→	→	→	→	→	→	↓	→	→	→	→	→	→	→	→	→
Alcohol (frequency)	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→
Alcohol (weekly intake)	↑	↑	↓	↑	↑	↓	→	→	→	↓	↓	↓	→	→	→	→	→	→	→	→	→
Healthy Diet Score	↑	↑	↑	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→
Partial Fibre Score	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→

Key:

↑ = the higher the number of the dependent variable (e.g. food and social factors), the higher the independent variable (working patterns) = positive correlation

↓ = the higher the number of the dependent variable, y-axis, (e.g. food and social factors), the lower the independent variable, x axis, (working patterns) = negative correlation

→ = no overall trend (may not follow if sig fig is present)

O = Overall/ total cohort

D = Doctors

N = Nurses

Note that the overall trend in the table is based on the results presented on graphs rather than the p-value when Kruskal-Wallis was run.

6.3 Discussion

This study investigated the dietary intake of DNs from the UK Biobank dataset and its impact on different working patterns. The main findings highlighted four areas impacting DNs' dietary intake. First, the total weekly work hours increased the intake of fruit, unprocessed meat, tea and coffee, water and alcohol consumption, and the overall healthy diet score. The duration of night shifts showed no overall impact on milk and alcohol consumption. Additionally, the number of night shifts worked per month showed no overall impact on fish intake and overall healthy diet score. Lastly, consecutive night shifts reduced the intake of vegetables and meat but increased tea and coffee, with no overall trend in water intake and overall healthy diet score (Table 23). As a result, this study sheds light on the influence of different working patterns on the dietary intake of DNs, providing valuable insights into the factors that affect DNs' dietary choices and can inform strategies to promote healthier eating habits in this population.

Our result suggested that working longer hours per week contributes to poor nutrition and dietary intake, leading to risks of health issues. Previous literature highlights how extended work hours can lead to overeating, increased consumption of instant food or fast food (Heerman et al., 2017; Tanaka et al., 2019) and contributing to obesity and weight gain. Tanaka *et al.* (2019) presented clear evidence suggesting that long work hours lead to poor dietary behaviours, such as skipping breakfast frequently and eating instant food, resulting in a higher likelihood of overeating or eating fast food. This was also observed in other studies and occupations, including manufacturing, where long work hours were associated with poor dietary habits like consuming cold beverages and snacks from vending machines and convenience stores, resulting in higher BMI (Escoto *et al.*, 2010). While limited research explored the association between weekly work hours and dietary behaviour, several Japanese studies nevertheless examined this (Nakanishi *et al.*, 2001; Oono *et al.*, 2021). Nakanishi *et al.* (2001) and Oono *et al.* (2021) indicated that the higher the work hours, the more unhealthy the dietary patterns among workers are, suggesting a link to poor health outcomes such as hypertension. A plausible suggestion could be attributed to the traditional working culture in the East, which emphasises respect for seniority and authority and fosters loyalty to their work (Shkoler and Kimura, 2020). Thus, employees are expected to work long hours beyond their regular responsibilities. While the Japanese studies suggested the impact of long work hours on dietary intake, a research limitation was not explicitly examining specific food groups, which aligns with our present study's aim. Nevertheless, long working hours influence poor dietary intake, and this finding applies to all professions, not just DNs.

Our overall result highlighted that those working more weekly hours consumed more fruit. Although fruits are generally considered healthy, high fruit intake accompanied by excessive sugar content can negatively affect overall health (Sadler *et al.*, 2019). Results indicate that doctors had a lower intake than nurses but remained lower than the recommended daily servings (2.57 compared to the four recommended servings) (Public Health England, 2016; World Health Organisation, 2020b). Fruit consumption offers its health benefits, such as its richness of essential vitamins, minerals, dietary fibre and natural antioxidants supporting overall health (Van Duyn and Pivonka, 2000; Ocean, Howley and Ensor, 2019; del Río-Celestino and Font, 2020; Wang *et al.*, 2021). For example, the antioxidants in fruit, such as anthocyanin, demonstrated cardiovascular-protective effects (Bakuradze *et al.*, 2019; Wang *et al.*, 2021), promoting hydration and healthy digestion. A large prospective study across European countries with a 5.8-year follow-up found that higher fruit and vegetable intake was associated with lowering risks of aerodigestive tract cancer (Boeing *et al.*, 2006). Despite these health benefits to support healthy vitality, excessive fruit consumption raises health concerns due to its naturally high sugar content (Serpen, 2012; Evans, 2017; Sadler *et al.*, 2019), which can contribute to diabetes, obesity, cardiovascular diseases and other health complications (Serpen, 2012; Wang *et al.*, 2021). Evidence suggests that increasing fruit intake can increase a 7% greater incidence of type 2 diabetes (Imamura *et al.*, 2015). Additionally, fruit can also be commercialised as juice products (i.e. sweetened beverages) and often contains a higher concentration of sugars (i.e. fructose, glucose and sucrose), contributing to high acidity, causing discomfort to sensitive stomachs or acid reflux (Picos *et al.*, 2019; Zhang *et al.*, 2021), dental caries and tooth decay developments (Serpen, 2012; Imamura *et al.*, 2015). As a result of these health consequences, dietary recommendations limit fruit juice intake to no more than 150ml per day (Public Health England, 2016). Considering these benefits and consequences, our study could suggest our participants' awareness of fruit consumption. However, the convenience and availability of unhealthy snacks during prolonged working hours could pose health risks during shifts. While consuming fruits provides added nutritional value to health, it is pertinent to communicate the importance of consuming in moderation to prevent further health risks and poor dietary behaviours.

Our results indicated a decreased vegetable intake with increased consecutive night shifts worked by DNs. As discussed in our earlier study (see Quantitative Result, Chapter 6), consuming vegetables provides health-promoting properties such as essential vitamins and minerals to promote digestive and immune systems while reducing risks of chronic diseases such as cardiovascular, diabetes and some cancers (Yip, Chan and Fielding, 2019; Zurbau *et al.*, 2020). Our current study showed that doctors consumed more vegetables than nurses, suggesting a potential difference in knowledge and intention to eat healthily. However, as discussed previously (see Qualitative Result, Chapter 3), the demanding occupational workload posed a barrier for DNs to practice and prioritise healthy workplace nutrition when limited time and access to healthy food options were prevalent. Although limited evidence explores this association between vegetable intake and consecutive night shifts among healthcare professionals, apart from our earlier study, previous evidence have shown that night shift workers tend to consume lower vegetable intake and more fast food and snacks (Wong *et al.*, 2010; Tada *et al.*, 2014; Almajwal, 2016). Here, our earlier chapters discussed the implications of DNs resorting to easily accessible snacks during night shifts (see Qualitative Results, Chapters 3 – 4). Furthermore, our research indicated that increasing clinical workload contributes to poor dietary choices, mainly when healthier food options are unavailable after regular hours (see Qualitative Result, Chapter 4). Despite the limited evidence in the literature specifically addressing the correlation between consecutive night shifts and lower vegetable intake, we can, however, consider previous evidence on the impact of night shifts on dietary habits. Consequently, we can conclude that night shifts impact vegetable intake and can assume that the more consecutive night shifts worked, the lower the vegetable intake due to barriers to accessing healthy food options during the night.

Long working hours and consecutive night shifts have increased tea and coffee consumption among shift workers. Our earlier study (see Qualitative Result, Chapter 3) emphasised that working long, irregular hours limited eating opportunities, causing

DNs to rely on caffeine to stay awake during their long shifts. Caffeine, chosen for its convenience with physiological and psychological benefits, enhances alertness, especially during long work hours (O'Callaghan, Muurlink and Reid, 2018; D'Annibale *et al.*, 2021). Other research on doctors with shift work also supports our findings, where caffeine consumption helps alleviate fatigue and improve short-term reactions, optimising performance (Buchvold *et al.*, 2019; Jaradat, Lahlouh and Mustafa, 2020; Smith, 2021). For example, Buchvold *et al.* (2019) investigated different shift work hours (i.e. short, long, etc.) and their impact on lifestyle factors, including caffeine consumption. The results of this prospective study indicated an increase in caffeine consumption regardless of the duration of work shifts. Though our result noted an overall consumption of tea and coffee, limited research has yet explicitly differentiated between tea and coffee in DNs with consecutive night shifts. Nevertheless, nurses showed a preference for tea, while doctors preferred coffee. Thus, considering previous literature and our studies' results, we can suggest that higher caffeine intake can effectively reduce sleepiness, especially for those with more hours and consecutive night shifts per week.

The study illustrated a mixed result concerning water consumption when examining the number of work hours worked per week and the consecutive night shifts. Doctors drank more water when working hours increased, whereas nurses consumed less. Adequate hydration is necessary to maintain cognitive abilities and motor function but can also increase risks of heat-related illnesses, electrolyte imbalance, urinary and kidney problems, digestive problems and skin problems (Seal *et al.*, 2019; Perrier *et al.*, 2021). For example, a UK study explored the effects of thirst and physiological status among UK adults (Patsalos and Thoma, 2020), with findings suggesting a correlation between cognitive performance, judgement, decision-making tasks, and water supplementation. This could explain why doctors consumed water to maintain their performance. However, our present study contradicts our previous findings (see Qualitative Results, Chapters 3 – 4), as it highlights those limited opportunities due to the high clinical workload for toilet breaks acted as barriers, restricting fluid intake, as indicated by the nurses who consumed less water as working hours increased per week. A plausible suggestion could be that caffeine (see earlier Quantitative Result, Chapter 6) is a popular choice for staying alert. However, our earlier results and the amount of caffeine intake suggest doctors also opt for water when caffeine is inaccessible. Thus, since our study did not specifically focus on caffeine accessibility, we cannot confirm any association. Nevertheless, considering the impact of weekly work hours, hydration remains a pertinent topic in DNs for further exploration.

An increase in alcohol consumption was associated with more hours worked per week and the duration of night shifts. Though findings were inconsistent and mixed, evidence has consistently indicated a correlation between alcohol intake and shift work (Ng and Feldman, 2008; Johnson *et al.*, 2019; Peplonska, Kaluzny and Trafalska, 2019; Richter *et al.*, 2020b; Shin and Kim, 2021). Ng and Feldman (2008) suggested that the number of hours worked per week could correlate with job stress and, thus, increased use of alcohol and drug substances. Its results showed that job complexity and high job stress contributed to higher drug and alcohol consumption on and off the job. Moreover, excessive alcohol consumption impacts the work-life balance and risks of chronic health problems, including liver cirrhosis and cardiac arrhythmia (Day and Rudd, 2019; Roerecke *et al.*, 2019). However, Ng and Feldman (2008) found that shift workers often faced pressure to work long hours due to workload demands rather than choosing to work longer out of self-motivation or positive organisational working culture.

Alcohol consumption was also correlated with the increased duration of night shifts, adversely affecting shift workers' sleeping patterns (see our earlier result in Qualitative Result, Chapter 3). Night shifts disrupt shift workers' daily lifestyle, leading to skipping meals and having irregular dietary habits that could impact the quality and quantity of sleep (Richter *et al.*, 2020b; Shin and Kim, 2021). Shin and Kim (2021) investigated the dietary patterns and lifestyle factors of hospital nurses working night shifts and their impact on sleep patterns. Its result presented that nurses with night shifts exhibited poor sleep efficiency, with higher alcohol consumption compared to non-shift workers. This higher alcohol intake could be attributed to shift workers opting for alcohol as self-medication as a coping strategy for shift-associated sleeping problems (Richter *et al.*, 2020b). For example, Dorrian *et al.* (2006) examined sleep duration and quality among hospital nurses working rotating and night shifts, finding that medical prescriptions and alcohol were commonly used as sleeping aids. This result was later confirmed by the same research group (Dorrian *et al.*, 2017), where shift workers reported less sleep ($p<0.001$) and higher alcohol intake ($p=0.04$) when working longer hours and night shifts. Furthermore, nearly one-third of participants would consume 12 or more alcoholic beverages within a 24-hour. Therefore, this observational evidence could suggest that alcohol was often employed as a sleep aid. Yet excessive alcohol consumption could contribute to poor nutritional diet among shift workers, highlighting the importance of developing strategies to support those working longer hours per week and with night shifts.

A mixed result was reported concerning DNs' Healthy Diet Score, calculated based on seven food categories (Lourida *et al.*, 2019; Hepsomali and Groeger, 2021a, 2021b; Papier *et al.*, 2021). The Healthy Diet Score reflects the overall healthiness of an individual's diet, with higher scores indicating healthier diets. In our study, the Healthy Diet Score showed significant associations among DNs when considering the number of hours worked per week, night shifts worked per month, and consecutive night shifts. Furthermore, our results indicated that the fewer consecutive night shifts worked, the higher the Healthy Diet Score. This demonstrates that DNs recognised the negative impact and consequences of working consecutive night shifts on their dietary habits. Considering the limited literature directly explores the influence of the number of consecutive night shifts on the Healthy Diet Score, we can, however, draw assumptions based on existing evidence highlighting the implications between night shift work and dietary quality and intake (Pasqua and Moreno, 2004; Wang *et al.*, 2014; Peplonska, Kaluzny and Trafalska, 2019). For example, Wang *et al.'s* (2014) meta-analysis indicated a 57% increased risk of metabolic syndrome was associated with night shift work, particularly those working between 24.00 – 06.00, which disrupts the circadian rhythm and sleep quality (Lauren *et al.*, 2020; Mohd Azmi *et al.*, 2020). Consequently, this leads to increased snacking, affecting the energy balance and influencing the consumption of carbohydrate-rich food and caffeine (see Qualitative Resul, Chapter 3).

Elsewhere, similar findings also concluded the poor nutritional quality among nurses and emergency healthcare night shift workers (Bonnell *et al.*, 2017; Peplonska, Kaluzny and Trafalska, 2019; Bouillon-Minois *et al.*, 2022). Bouillon-Minois *et al.* (2022) monitored the food intake of emergency healthcare night shift workers over 24 hours. They noted that compared to their day shift colleagues, the night shift workers consumed food with lower nutrient quality and excessive sweets and sugary drinks.

Bonnell *et al.* (2017) also identified the high snack consumption and inaccessibility to healthy food choices at night. One plausible explanation for poor diet quality during night shifts could be the lack of time, as identified in our earlier study (see Qualitative Result, Chapter 4). For example, shift workers often prefer easily accessible (i.e., out-of-hours), portable, and convenient options such as cold food or snacks. However, poor diet quality could lead to sub-optimal nutrients, including calcium and vitamin D, which has been associated with poor bone density among night shift workers (Bukowska-Damska, Skowronska-Jozwiak and Peplonska, 2019; Rizza *et al.*, 2020). Considering this, we can suggest that night shifts contribute to declining diet quality. Although no previous literature has explored the relationship between the number of consecutive night shifts and diet quality, we can suggest that fewer consecutive night shifts may lead to better diet quality amongst shift workers.

On the other hand, our result amongst the cohort contradicts previous evidence on the Healthy Diet Score regarding the relationship between the number of hours worked per week and the number of night shifts worked per month. For example, our results indicate that high Healthy Diet Scores were associated with increased hours worked and more night shifts. Yet, in contrast, the literature suggests that longer working hours and more night shifts are associated with poorer dietary habits, thus, lower scores (Hulsegge *et al.*, 2016; Bonnell *et al.*, 2017; Langenberg *et al.*, 2019; Peplonska, Kaluzny and Trafalska, 2019; Phoi and Keogh, 2019; Souza *et al.*, 2019a; Mohd Azmi *et al.*, 2020). Previous chapters have also discussed this discrepancy (see Qualitative Results, Chapters 2 – 4). However, it is important to note that nurses scored higher than doctors in our study. One possible explanation could be the sample size imbalance between nurses (n = 3815, 66%) and doctors (n=1962, 34%), skewing the data as nurses had fewer night shifts per month and fewer total working hours than doctors (see Section 7.2.2 section of this chapter).

An alternative explanation could be the difference in job satisfaction and happiness levels between DNs (Spence, 2012; Atefi *et al.*, 2014; Laurant *et al.*, 2018; McCurley *et al.*, 2019; Negri *et al.*, 2022), which may affect their diet quality. For example, Negri *et al.* (2022) surveyed a cohort of DNs (n=53 and 55, respectively) using the Eudaimonic and Hedonic Happiness Investigation (Delle Fave *et al.*, 2011) to assess job satisfaction. Although there was an equal representation from each profession, the study revealed that nurses had a higher satisfaction level (p=0.02), while no significant differences were found among doctors. Similar trends were observed when measuring job happiness. While this study, to our knowledge, remains one of the few quantitative research projects examining job satisfaction and happiness on DNs within the same study, these findings preliminarily suggest differences in job satisfaction. It is possible that nurses are more content working night shifts due to the lighter clinical workload than doctors. Our previous evidence supports that doctors are overwhelmed with their clinical workload, limiting their time to acquire food (see Qualitative Results, Chapter 2 – 4). Consequently, this can further indicate that workplace barriers such as food accessibility and availability during working hours leads to greater health risks and job dissatisfaction. McCurley *et al* (2019) confirms this assumption demonstrating that accessible and available workplace food options in hospital settings were associated with higher diet quality, as measured by the Healthy Eating Index Score, and reduced health risks such as obesity, hypertension and diabetes. Considering these evidence, it becomes evident that promoting improved workplace nutrition and providing accessible food facilities can enhance employees' satisfaction and overall health.

6.3.1 Limitations

This study, however, has its limitations. Firstly, using baseline data from the UK Biobank only provided a cross-sectional understanding of the findings at a single time, preventing the assessment of how shift work patterns may impact dietary intake over time. While the results presented that night shifts significantly contributed to DNs' poor dietary intake, we could not address what other confounding factors may have also contributed to the possible changes in habitual dietary patterns. For example, factors such as food facilities and provisions or any existing workplace health and nutrition initiatives could influence DNs' nutritional behaviour during shift work. Thus, there is scope to explore this in future research.

The data collection tools used in this study relied heavily on self-reported data, which introduces the possibility of research bias. Thus, the misreporting of shift work patterns could have impacted the reliability of the research data, such as the number of DNs with specific shift work patterns. For example, participants were asked separate questions about "Day shift worked" (Field ID 22630) and "Night shifts worked" (Field

ID 22650). However, during the data extraction process from the UK Biobank database, inconsistencies were observed between the number of participants who reported having day and night shifts separately and those who reported having a combination of both. Therefore, many missing data raised concerns when examining day and night shifts separately. A plausible assumption could be that participants misinterpreted the question, leading them to select a “mixture of day and night shifts” and discard the questions on day and night shifts separately. Considering this assumption and after discussing this issue with the author’s research team, a decision was made to rely on the data field “mixture of day and night shift” (Field ID 22640) and disregard the use of “Day shift worked” (Field ID 22630) and “Night shifts worked” (Field ID 22650) to capture as many participants as possible. While this approach introduces a potential bias into our research, it was deemed necessary to the amount of missing data when considering day and night shifts separately. Thus, this choice addressed the impact of varied shift work patterns on dietary intake in DNs.

6.4 Conclusion

In conclusion, this study examined the dietary intake of DNs from the UK Biobank and measured its impact on different working patterns. Four key working pattern variables suggested their influence on dietary intakes, such as the working hours per week, the length of night shifts, the number of night shifts per month, and the number of consecutive night shifts. The data show that longer working hours and more night shifts contribute to poorer dietary behaviour. However, the dataset had limitations in understanding DNs’ dietary intake and its changes against their working patterns. Additionally, the self-reported nature of the data collected through an online system proved difficult to accurately assess the macro and micronutrient intake to measure its nutritional quality. Thus, it could suggest the under or overestimated dietary intake, working hours, and patterns. Nonetheless, the results resonated with previous literature emphasising the impact of shift work within healthcare on dietary intake. However, the research exploring the association between different working patterns and dietary intake among DNs remains unclear and limited, preventing definitive conclusions. Nevertheless, this study highlights the significance of night shift work and its consequences on dietary intake. The overall dietary practices for DNs remain inadequate, particularly considering the challenges in accessing food during night shifts. Therefore, further research should include practical strategies to consider the diverse working patterns to improve DNs and align with public health and dietary recommendations.

CHAPTER 7: CONCLUSION AND FUTURE RECOMMENDATIONS

This thesis has explored doctors' and nurses' dietary consumption and nutritional behaviour during shift work. The research approach combines a mixed method, combining qualitative and quantitative methods to better understand DNs' dietary intake and nutrition experiences. The qualitative study involves semi-structured interviews with DNs, while the quantitative study used the UK Biobank dataset to explore how different working patterns impact their dietary intake. This final chapter summarises the key findings from each study and provides an overall interpretation of the results. The research significance, strengths and limitations, and recommendations for future research practices will also be discussed.

7.1 Thesis overview

This research was developed systematically to understand the current workplace nutrition and its influence on UK doctors and nurses undertaking shift work. Based on the overarching aim and objectives, the findings can be characterised into three areas: doctors' and nurses' workplace diet, their eating practices and behaviours towards their dietary choices during working hours, and finally, the workplace barriers and facilitators addressing those nutritional practices. Table 24 highlights the overall findings from the thesis.

In the literature review (Chapter 1), healthcare professionals, particularly doctors and nurses, play a crucial role in addressing the complex health challenges faced by this cohort (Hignett *et al.*, 2018). Doctors and nurses are the largest proportion of the wider healthcare workforce. However, much of the healthcare system faces scrutiny due to the constant demands and public health challenges. The adverse working environment and unsociable hours, such as shift work, negatively impact the workforce (Degen *et al.*, 2014; Chandler, Briggs and Whitfield, 2019). As a result, this shortage of local healthcare professionals necessitates the recruitment of overseas colleagues. To address workforce shortages and sustain the healthcare system, the literature review highlights the essentiality of prioritising the health and wellbeing of doctors and nurses, ensuring their retention and maintaining and prioritising high-quality patient care and safety without overwhelming healthcare professionals.

The review further emphasises the impact of shift work on the health and wellbeing of doctors and nurses and its health implications. Evidence has highlighted how shift work contributes to poor health and wellbeing, such as experiencing occupational burnout and stress and its impact on mental health. It also contributes to poor health outcomes from poor food choices (Nicholls *et al.*, 2016; Kyle *et al.*, 2017b). As a result, DNs are becoming overweight and obese due to poor lifestyles compared to other healthcare professionals and non-health-related jobs (Kyle *et al.*, 2017b). Given that a significant portion of their daily food intake occurs at work (Vasiljevic *et al.*, 2019), this highlights the opportunity to understand the current workplace nutrition and dietary behaviours in DNs to help improve their health and nutrition. However, to our knowledge, there is currently limited knowledge and evidence regarding the influence of shift work on the diet and nutrition of DNs in the UK. Considering this, our research aims to fill this knowledge gap with our mixed-method studies (Chapters 2 – 6).

Having established the current literature and the knowledge gap in the field, the cross-sectional qualitative study (Chapters 2 – 4) builds upon existing literature to explore doctors' and nurses' nutrition and dietary practices during shift work. The methodology, as described in Chapter 2, involved conducting individual semi-structured interviews to comprehensively understand the participants' social and lived experiences (Black *et al.*, 2018; Moser and Korstjens, 2018). By employing interviews, our research and objectives aim to capture narrative data and provide an in-depth insight into the eating behaviours and dietary practices of DNs during their shifts. The methodology (Chapter 2) was developed by incorporating previous health and wellbeing studies that used a qualitative research approach of semi-structured interviews with healthcare professionals (Cane, O'Connor and Michie, 2012; Keyworth *et al.*, 2019; Ojo *et al.*, 2019). Interview questions were aligned with the COM-B model (Michie, van Stralen and West, 2011; Michie, Atkins and West, 2014) to systematically understand participants' workplace behaviours and food choices. Snowball sampling, word of mouth, medical-related professional bodies, and social media were employed for recruitment. All data collected were anonymised, with each participant assigned a unique identifying code. A pilot interview was then conducted to ensure quality and alignment with research aims, allowing the researcher to reflect critically on the data collection process. The transcribed data were subjected to thematic analysis after being transcribed verbatim by the main researcher (Braun and Clarke, 2006) using NVivo 12 Plus (QSR International). The analysis revealed five overarching themes: self/ individual, occupation, organisation, facilities, and social/ environmental factors. Further details can be found in Chapter 2.

The qualitative approach employed in our research provided an in-depth understanding of the dietary behaviour and nutrition consumption of DNs during shift work. Following the semi-structured individual interviews, 16 participants (11 doctors and 5 nurses) were included (see Table 8 in Chapter 2). The main aim of Chapter 3 was to explore the current eating practices of DNs during their shifts, focusing on food choices and eating practices associated with the day. Findings were presented in six sections covering pre-shift, during, long, post-shifts, night, and non-working days. Additionally, the influences on DNs' eating practices were discussed, and several key findings emerged. Firstly, clinical responsibilities took precedence over eating and drinking opportunities during shifts. As a result, caffeine consumption was often used to stay awake due to its easy access and availability across the day. Secondly, the night shift contributes to poor dietary behaviour when unhealthy snacks are often consumed with limited accountability for what has been eaten. Therefore, the regularity of eating patterns during shifts was influenced by clinical workloads, especially in specific hospital environments such as operating theatres, where access to food was limited. Conversely, nurses often preferred to delay eating until their first scheduled shift break to consume what they would have eaten before work. Lastly, post-shift meals were highly valued as DNs had limited eating opportunities during their shifts, resulting in larger meals to satisfy prolonged hunger. Nevertheless, the findings from this chapter illustrate that workplace diet and nutrition of DNs remained sub-optimal. Therefore, the chapter highlighted the need for workplace intervention to improve their nutrition, considering the barriers that hinder healthy eating practices.

Chapter 4 further uses the semi-structured interviews to explore the association between shift work and different working patterns on the dietary choices and eating behaviours of DNs, focusing on identifying barriers and facilitators to workplace nutrition. The chapter also assessed existing food provisions, facilities, and prose strategies to promote healthy workplace nutrition. The results presented four areas aligned with the research objectives. Firstly, organisational factors such as the workplace environment, hospital location, and proximity to onsite shops and food facilities influenced their workplace nutrition and eating opportunities. Further, workplace culture, team activities, and occupational expectations could also act as a barrier or encouragement to good workplace nutritional behaviour, with food accessibility and availability being significant determining factors. Thirdly, workplace regulations and policies such as scheduled break opportunities and the staff-to-patient ratio impacted DNs' eating opportunities. Notably, a lack of accessible water sources near DNs' primary working area resulted in potential dehydration throughout shifts, which could affect clinical performance. Lastly, workplace nutrition, health, and wellbeing services were often limited and unavailable for DNs, as they often require referrals from their general practitioners to attend and use outside their working hours, when opening hours often clash with their shift work. This limitation, combined with services focusing more on general health and wellbeing rather than diet and nutrition, presented opportunities for future interventions and research.

The qualitative research (Chapters 2 – 4) offers valuable insights into DNs' lived experience, diet, and nutritional practices, including the health implications of their poor diet during shift work and the challenges faced. While earlier chapters identified barriers to healthy eating in the workplace, there is limited research on how different shift work patterns affect the diet and food consumption of DNs. To address this knowledge gap, the quantitative research conducted in Chapters 5 – 6 builds upon the qualitative research findings by using the UK Biobank large prospective cohort dataset, an open-access resource to examine the association between shift work and dietary intake amongst UK doctors and nurses. The methodology used to achieve this research objective is detailed in Chapter 2. Participants consisted of doctors and nurses who were working shifts. Food consumption was analysed using validated methods established in previous studies on the UK Biobank dataset (see Chapter 2 for details). Diet and working patterns were analysed via IBM SPSS Statistics 28.0, with predetermined characteristics and MySQL Database, to obtain the required variables (see Chapter 2). Considering the research aim of exploring DNs' diet amongst a large dataset, all available food items were analysed.

Chapter 5 explored the dietary intake and quality between UK doctors and nurses with shift work using the UK Biobank dataset. The analysis included 5,777 shift workers, including 1961 doctors (33.96%) and 3815 nurses (66.04%). The sample further reported gender imbalance, predominantly more female than male (80.4% vs 19.6%). Mann-Whitney U test was used to compare food consumption between doctors and nurses. The significant findings aligned with our earlier results from the qualitative chapters, revealing a sub-optimal diet from doctors and nurses. Caffeine was considerably high in both professions, with doctors preferring more coffee than nurses and nurses consuming more tea. A plausible reason for this could be the unpredictable high clinical workload during shift work; caffeine helped alleviate tiredness, considering this was more easily accessible and available during their shifts. Limited water intake was observed, with doctors and nurses only consuming two glasses of water daily, below its UK recommendation. However, alcohol consumption was high in both groups, particularly among nurses. Furthermore, fruit, vegetables, fish, and fibre were limited overall and fell short of their dietary recommendations (Public Health England, 2016; Buttriss, 2017), with fibre consumption reported to be half of its 30g recommendation. Both professions demonstrated a high weekly meat consumption, exceeding its 70g recommendation per week, with doctors consuming more than nurses. Overall, Chapter 6 highlights the poor dietary practices of DNs in the UK Biobank dataset. As a result, this chapter highlights the importance of supporting DNs' eating practices, considering the challenges and barriers they face during shift work (see Qualitative Result, Chapter 4) to improve their workplace nutrition.

Chapter 6 further uses the UK Biobank dataset to explore the impact of different shift work patterns on the dietary consumption of doctors and nurses. The main findings suggest that working night shifts and longer weekly hours are associated with poor dietary intake and overall nutrition among healthcare professionals. Longer weekly hours were associated with excessive fruit consumption, which, although rich in antioxidants, can contribute to health complications due to increased sugar intake, such as diabetes, obesity and cardiovascular diseases (Serpen, 2012; Wang *et al.*, 2021). DNs further exhibited a lack of vegetable consumption associated with the consecutive night shifts worked. A plausible reason could be the limited time and demanding workloads that likely hinder employees from accessing healthier food options, leading to increased consumption of readily available snacks in the staff room. Both doctors and nurses consumed higher amounts of tea and coffee during long and consecutive night shifts, possibly to combat sleepiness. As a result of a significant preference for caffeine consumption, particularly in night shifts, DNs reported consuming inadequate water due to its challenges similar to our earlier chapter (Qualitative Result, Chapter 4), where water accessibility proximal to DNs' primary working area was not always either available or not working. Another significant finding was the increase in alcohol consumption, which correlated with longer weekly hours and the duration of night shifts. While alcohol use might be a coping mechanism for occupational stress, its high consumption during night shifts suggests potential reliance on alcohol to manage shift-related sleep problems and disrupted circadian rhythms. Considering these main findings, this chapter underscores the poor dietary practices among doctors and nurses, particularly during night shifts and associated characteristics. As a result, the overall dietary practices for DNs remain inadequate, with opportunities to rethink how best to develop workplace interventions supporting DNs' nutrition and dietary intake in various shift work patterns. Findings from the quantitative chapter could contribute to further research focusing on the effectiveness of workplace interventions. These findings corroborated the qualitative research conducted through interviews with DNs, underscoring the prevalence of poor dietary practices during working hours, particularly during night shifts. This aligns with the overall thesis, emphasising the significant impact of the night shift on DNs' dietary habits.

Shift work is prevalent in many occupations, including healthcare and other countries, where it is essential for meeting service demands (Chapter 1). Findings from this thesis confirm that DNs exhibit sub-optimal nutrition and poor dietary behaviours, as highlighted in Table 24. However, these findings align with patterns observed in the wider UK population and other occupations with shift work. Chapters 3 – 6 indicate the inadequate consumption of fruits, vegetables, fish, and dietary fibre among DNs. Comparing these results to the recommended guidelines, it becomes evident that the UK population, including DNs, do not meet their ‘5-a-day’ as recommended in the Eatwell Guide (Public Health England, 2016; Buttriss, 2017; Gulyas and Edmondson, 2023). Research by Feng *et al.* (2022) on a UK Biobank cohort (n=399,586) demonstrates insufficient vegetable consumption across the broader population, with evidence suggesting that a higher intake of raw and cooked vegetables is associated with reduced CVD risk. Comparisons with other professions with shift work further indicate limited fruit and vegetable consumption. For example, inadequate intake levels have been reported among airline workers (Hemiö *et al.*, 2015), police force employees (Gibson *et al.*, 2018), and firefighters (Burris, Werner and Woolf, 2022).

Among DNs, increased meat consumption correlates with more frequent shift work. However, the results suggested otherwise when comparing this pattern to the UK population, as the National Diet and Nutrition Survey (NDNS) indicated. The NDNS suggests that individuals in the UK consume less red and processed meat but more white meat (Stewart *et al.*, 2021). Similar trends were also observed in other professions with shift work. For example, meat consumption was favoured among the police workforce (Kosmadopoulos *et al.*, 2020), firefighters (López-Bermudo and Gómez-Landero, 2021; Joe *et al.*, 2022), and airport workers (Bucher Della Torre *et al.*, 2020). However, these studies further indicate that shift workers are also at risk of chronic diseases due to circadian rhythm disruptions, alterations in eating habits, and inconsistent energy intake from food due to irregular shift work patterns.

Fish and dietary fibre appear to be limited among DNs. Comparatively, trends in fish intake within the broader UK population, as reported by NDNS, show little change, with fish consumption remaining low and not substituted by increased meat consumption (Stewart *et al.*, 2021; Scarborough *et al.*, 2023). Professions with shift work demonstrate similar trends in fish intake. Rotating shift workers such as police officers (Clark *et al.*, 2023), airline workers (Hemiö *et al.*, 2015), and retail and food services (O'Brien *et al.*, 2020) tend to consume less fish compared to non-shift workers. Additionally, dietary fibre intake among DNs mirrors findings in the wider UK population, where adult intake levels fall below the recommended 30g reference nutrient intake (Evans, 2020). This finding persists across various professions, irrespective of shift work status.(Nea *et al.*, 2015; D'Annibale *et al.*, 2021; Al Khatib *et al.*, 2022). Despite the slow increase in dietary fibre, overall consumption remains suboptimal across the population (Gressier and Frost, 2022).

Tea and coffee consumption among DNs, as indicated in Chapters 5 – 6, appear to be high. As discussed in Chapter 1, these beverages are often relied upon to increase alertness and alleviate sleepiness. Comparatively, caffeine intake remains prevalent in the UK population, with a consistent trend showing habitual consumption of coffee and tea (Castellana *et al.*, 2021). Similarly, in professions with shift work, caffeine consumption helps with long working hours and irregular sleep patterns. For example, high caffeine intake is observed among factory workers (Khorasaniha *et al.*, 2022), airline cabin crew (Wen *et al.*, 2020), firefighters (Berkowsky *et al.*, 2022), and military personnel (Chaudhary *et al.*, 2021). The data collected on DNs, when compared to the wider population and other shift work professions, highlights a consistent pattern of suboptimal consumption of fruits, vegetables, fish, and dietary fibre, with a preference for meat, tea, and coffee. This thesis further contributes to the existing literature by highlighting that personal choices and occupation-related factors may heavily influence these consumption patterns.

Beyond the general UK population and other occupations with shift work, this thesis can also support the literature on DNs' in other countries. While direct cross-country comparisons were unmade due to the focus of the research aim, the suboptimal nutritional patterns highlighted in this study align with prior research conducted in other countries. For example, Tables 2 – 3 from Chapter 1 summarise DNs' health and nutrition, suggesting inadequate dietary intake and increased snacking due to skipping meals and limited break opportunities when working on long irregular shifts (Han, Choi-Kwon and Kim, 2016; Bae, Hwang and Lee, 2018; Gifkins, Johnston and Loudoun, 2018b; Medisauskaite and Kamau, 2019; Zulkarnain *et al.*, 2020). While existing literature predominantly focuses on nurses' nutrition at work, this thesis furthers our understanding by providing doctors' nutrition, who often share similar work environments with nurses. Consequently, these findings offer valuable insights into DNs, not just within the UK, but also in addressing common challenges healthcare professionals face globally.

Despite DNs' sub-optimal dietary intake (Chapters 3 – 6), it could also posit the link with an increased risk of co-morbidities and their subsequent health impacts. As discussed in Chapter 1 (Section 1.4.1), shift work contributes to overall health and wellbeing such as psychological impacts (i.e. sleep, cognitive function and mental health), obesity and cardiovascular diseases (Sayre, Grandey and Chi, 2019; Cannizzaro *et al.*, 2020; Brown *et al.*, 2020; Lin *et al.*, 2020; Mohd Azmi *et al.*, 2020; Yusuf *et al.*, 2020). Moreover, studies from the wider population and DNs (Tables 2 and 3, Chapter 1) have shown that shift work correlates with higher mortality and morbidity rates. For example, the high frequency, extended durations and consecutive night shifts were found to elevate metabolic risk factors among shift workers (Streng *et al.*, 2022). The Nurses' Heath Study further demonstrates a heightened mortality rate in older individuals engaged in rotating shift work (Shi *et al.*, 2022), aligning with findings from Chapters 5 – 6, involving older UK Biobank participants working with more shifts.

Similarly, systematic and meta-analyses on shift workers highlight the association with poor chronic health conditions, including CVD, stroke, depression, and diabetes, with night workers being at risk of high risk of death due to CVD (Rivera *et al.*, 2020; Su *et al.*, 2021). Despite these health risks, research indicates that modifiable risk factors can mitigate morbidity risks, including CVD and obesity, through changes in diet, smoking habits, the quality and duration of sleep, adiposity and metabolic status, as evidenced by the UK Biobank cohort (Ho *et al.*, 2022; Li *et al.*, 2023). Considering the existing literature, findings from Chapters 3 – 6 can infer that DNs might also be susceptible to morbidities linked with shift work. However, modifying dietary practices and intake can enhance their nutrition and overall health. Nevertheless, this thesis indicates that the combination of shift work and poor diet exacerbates morbidity risks, suggesting a need for targeted interventions to support DNs in managing their nutrition and health effectively, especially at work.

While the impact of shift work on DNs' nutrition and dietary behaviour has been studied, less attention has been given to their eating behaviours when not on shift. This gap in the literature is particularly noteworthy, including this thesis, as the primary focus has been on how shift work affects dietary intake and nutrition. However, results from the qualitative chapters (Chapters 3 – 4) suggest that DNs utilise their off days as opportunities for meal preparation and enjoying food at regular intervals. These findings align with prior research, as highlighted in Table 2 of Chapter 1, indicating that during periods of being "off duty" or on "off days" (i.e. on rest days between cycles of shifts), shift workers exhibited healthier dietary practices, including regular meal times, reduced snacking, and increased consideration of food choices when not constrained by job-related factors (Sahu and Dey, 2011; Torquati *et al.*, 2016; Dias and Dawson, 2020; Lucia *et al.*, 2021; Rangel *et al.*, 2023). Thus, by integrating our findings with existing knowledge on the influence of shift work on nutrition and the risks of poor dietary behaviours and health, it can be inferred that individuals with more regular working patterns or those not subjected to shift work may have better nutrition and dietary habits. However, an opportunity remains to explore DNs' nutrition and dietary behaviours between work and off-work days for insights into the factors shaping their overall health and nutrition profiles.

The selection of a mixed-method approach for this thesis not only facilitated the achievement of the research aim and objectives but allowed for the utilisation of the mixed-method methodology as intended (see Chapter 2). Integrating qualitative and quantitative methodologies enabled the exploration of DNs' dietary intake and eating practices at work. Given the scarcity of existing literature on DNs' eating practices in shift work, the mixed-method approach provided a deeper understanding of their lived experiences and narratives, for example, unravelling the challenges encountered during shifts. This approach unveiled the intricate complexities DNs face in a demanding healthcare environment. For example, Table 24 highlights the key findings from this thesis. It reveals that DNs' diets often did not align with the recommended dietary guidelines (Public Health England, 2016), a point emphasised in the "diet at work" theme. This drew from the quantitative analysis (Chapters 5 – 6) of DNs' dietary patterns using the UK Biobank. Whereas the results under "eating practices" and "influences affecting DNs' nutrition" themes from the qualitative research (Chapters 3 – 4) delved into the reasons for underlying factors influencing DNs' eating practices, such as the influence of different shift types, for example, night shifts viewed as opportunities to eat what they want. Practical constraints such as limited food availability during certain hours were also identified as contributing factors elsewhere. Furthermore, qualitative results from Chapters 3 – 4 highlighted that being frontline workers and dealing with workplace challenges like staff shortages, organisational culture, and irregular shifts led to prioritising patient care over DNs' personal eating opportunities. As a result, adopting a mixed-method approach in this thesis corroborates findings between qualitative and quantitative results, providing a more rounded understanding of DNs' experiences during their shift work.

Overall, this current thesis explored DNs' dietary intake and nutrition behaviour during shift work to help fulfil the limited research in the literature. Previous literature has highlighted the negative impact of shift work on health and wellbeing. However, despite their significant role within the healthcare system and wider ecosystem, little attention has been given to healthcare professionals' specific diet and nutrition. The findings of this thesis contribute valuable insights into DNs' dietary habits and nutrition during shift work, emphasising the importance of promoting healthier workplace nutrition. Doctors and nurses prioritise patient care over their dietary intake during shifts, leading to suboptimal dietary patterns. Therefore, it stresses that the responsibility for improving dietary habits should not solely be the individuals themselves. Instead, it should be a collective effort involving providing adequate health and nutrition support by employers such as the NHS, the Trust and the management teams. Furthermore, sustainable strategies and effective workplace regulations and policies should be made, with clear guidelines established at the local and Trust levels and across the healthcare sector, to support and improve doctors' and nurses' nutrition during shift work.

Table 24: Summary of overall main findings of doctors and nurses

Theme	Overall findings from doctors and nurses in this thesis
Diet at work	• Doctors and nurses consume limited fruit, vegetables, fish, and fibre but prefer cheese • Relies on alternative food options such as snacks • Doctors consume more meat, coffee and alcohol than nurses • Nurses consume more tea and water than doctors • Both doctors and nurses rely heavily on caffeine • Hydration intake is minimal, such as water • Alcohol intake was excessive than recommended, with doctors consuming more than nurses
Eating practices	• Eat when and where possible rather than when DNs want/ need • Viewed night shifts as an opportunity to eat what they want, e.g., free pass or cheating • Have the intention to eat well during the shift, but clinical responsibilities were often a barrier • Nurses have regularly scheduled breaks, with more available colleagues covering each other • Values the meal after the shift the most, often as the biggest meal of the day due to lack of eating opportunities during shifts

Influences affecting DNs' nutrition	• Workplace environment – e.g., location of hospital and primary working area, including workplace facilities (staff room, canteen and other food outlets, limited hot food around the clock, vending machines, water accessibility) • Clinical responsibilities and expectations • Workplace culture (e.g., power dynamics and social gatherings) • Self – nutrition is personal • Workplace regulations (e.g., staff shortage, break opportunities, occupational uniform) • Working patterns (e.g., the number of consecutive nights, the duration of night shifts, and the total number of weekly hours) are indicated to contribute to poor dietary intake and nutrition.

7.2 Overall strengths and limitations

7.2.1 Strengths of this thesis

The projection of the global population continues to grow, so healthcare systems will face ongoing challenges in addressing public health challenges (Bashier *et al.*, 2021; Lucero-Prisno *et al.*, 2023). Considering this, the burden on healthcare professionals such as doctors and nurses will continue to be experienced unless comprehensive and effective interventions and strategies are implemented to promote healthier workplace nutrition and health. This thesis addresses a significant research gap by examining the diet and nutrition of doctors and nurses during shift work, with a particular focus on the influence of different shift work patterns. Through a mixed-method approach, this study provides essential foundational knowledge to guide future research endeavours in this area. Furthermore, it underscores the critical importance of prioritising the health and nutrition of doctors and nurses as they play a vital role in addressing the health challenges faced by the growing population. By shedding light on their dietary habits and needs, this research contributes to the broader understanding of healthcare professionals' wellbeing and capacity to tackle public health issues effectively.

Our qualitative study (Chapters 2 – 4) used evidence-based research from previous studies on healthcare professionals. Through individual semi-structured interviews conducted online, a strength of this study was capturing the raw and rich lived experiences of frontline healthcare professionals and their dietary practices, including the challenges perceived during their shifts. Doctors and nurses who have worked in similar clinical settings have similar experiences within the NHS system regardless of workplace location. As a result, results from the 16 participants reached data saturation, where similar nutritional behaviours and practices were presented in Chapters 3 – 4. The sample size was also similar to previous qualitative studies on doctors and nurses of 10 – 20 participants (see Table 3), with a notable difference in that those studies' recruitment strategies did not coincide with the public health challenge of dealing with COVID-19, where doctors and nurses were prominently required. Furthermore, the online data collection method further benefited DNs in participating regardless of geographical limitations. Considering this, the primary outcomes underline the possible future research to expand our understanding of workplace nutrition, perhaps repeating this method approach among doctors and nurses in a larger sample size.

One novel aspect of our thesis was using the UK Biobank dataset to explore DNs' dietary consumption and its influence on various shift work patterns. A key strength of this approach was the substantial sample size available (n=5777) consisting of DNs engaged in shift work. To our knowledge, there has been some other epidemiology research in the area of doctors and nurses (see Literature Review, Chapter 1) that has explored the impact of shift work on nutrition and dietary behaviour via a quantitative approach, yet evidence in this area remains sceptical. Those evidence identified the association between the impacts of shift work on health outcomes and acknowledged what and how workplace factors influence dietary behaviours. However, much of the research has predominantly focused on comparing the dietary intake between shift patterns among nurses. Furthermore, limited prior studies have focused on exploring DNs' dietary consumption using the UK Biobank, nor have they compared doctors' and nurses' diets across different shift work patterns via the UK Biobank dataset. The qualitative study conducted in this thesis provided the raw and rich lived experiences but was limited to making direct comparisons through statistical analysis. As a result, the data from the UK Biobank offers the opportunity to help quantify the dietary intake of DNs, complementing the limitations observed in the qualitative study. Considering this, our findings offer a valuable and innovative opportunity to address the existing knowledge gap and pave the way for future strategies to improve and promote DNs' workplace nutrition during shift work.

This thesis further confirms the significance of dietary behaviours when considering nutrition in the context of health. While the result chapters (Chapters 3 – 6) highlight that DNs' occupation highly influences their nutrition and dietary intake at work, it is important to acknowledge that other factors can shape dietary behaviours. As discussed in Chapter 1 (Section 1.4.2.1), dietary behaviour is complex. It encompasses a spectrum of measurable outcomes from consuming food nutrients to eating habits, preferences, eating patterns and personal health influences, addressing all the biological, physical and psychological dimensions (Figures 4 and 7 from Chapter 1) (Booth *et al.*, 2001; Marijn Stok *et al.*, 2018).

However, habitual behaviours are triggered automatically (Gardner *et al.*, 2023), posing challenges for individuals attempting to modify their behaviours when habits increase the likelihood of habitual behaviours forming in associated settings over time, even when motivation erodes (Kelly and Barker, 2016; Gardner, Rebar and Lally, 2022; Gardner *et al.*, 2023). This could indicate that DNs' dietary behaviours may extend beyond their professional domain and workplace settings. For example, economic determinants such as financial income (of their job), the cost of (available) food purchases, the physical determinants of nutrition skills, knowledge and education, the social determinants of culture and social context (including online social influences such as media channels), and their biological determinants such as personal appetites, sensory tastes, food and nutrient/ dietary requirements such as allergies and intolerances, all play significant roles in shaping health and dietary behaviours (Tapsell, 2017; Chen and Antonelli, 2020; Topolska, Florkiewicz and Filipiak-Florkiewicz, 2021). While these other influencers are previously known (de Ridder *et al.*, 2017; Tapsell, 2017; Chen and Antonelli, 2020; Ensaff, 2021; Enriquez and Archila-Godinez, 2022), findings from this thesis highlight that food choice and dietary behaviours are multifaceted (Ensaff, 2021) and emphasising the dynamic shifts in an individual's life course and their change in perspective over time. Considering the comprehensive list of factors influencing dietary habits from the wider literature, the data from DNs' suggests that occupation-related factors contribute only partially to their overall nutrition and dietary behaviours. However, findings from this thesis add valuable insights to existing knowledge, highlighting that DNs' nutrition may be uniquely impacted by how much time they spend at work compared to other demographic groups.

Overall, our research contributes to the existing literature in the field by employing a mixed-method approach that combines quantitative and qualitative methodologies. By integrating both approaches, we gained comprehensive insights into the dietary practices and experiences of DNs during shift work. Previous studies in this field have predominantly utilised qualitative or quantitative methods (see Literature Review, Chapter 1). However, our research stands out by bridging this gap and providing a more holistic understanding of the topic. The qualitative chapters offer in-depth insights into the lived experiences of DNs. At the same time, the quantitative analysis using the UK Biobank database confirms and reinforces these findings, demonstrating the generalisability of the dietary and nutritional practices among DNs with shift work to other healthcare professionals within the NHS system.

7.2.2 Limitations of this thesis

This thesis has several limitations that have been individually discussed in earlier chapters. Firstly, participant recruitment was challenging due to the unexpected COVID-19 pandemic, which resulted in high demand for doctors and nurses in their clinical roles. This impacted our recruitment period and necessitated an extension. Despite this challenge, it provided an opportunity to recognise and reflect on the significance of doctors and nurses in addressing public health challenges. Furthermore, acknowledging the importance of a healthy and sustainable workforce could deliver high-quality patient care without DNs compromising their health and wellbeing during challenging healthcare delivery situations. Recruitment of doctors and nurses posed additional challenges due to their irregular working hours and inconsistent availability during their limited off-work time when much of the "non-working" time was spent resting between shifts. This meant those DN who participated volunteered in our research in their own time. As a result, while acknowledging that the NHS workforce is diverse, other confounding factors such as the participants' demographic variables such as gender, age, gender and socioeconomic status and individual factors (i.e., motivation, attitudes and beliefs towards food choices) may further provide insights into how it might influence DNs' workplace nutrition. For example, there could be gaps in socioeconomic status between and within doctors and nurses that could influence their nutrition and dietary behaviours. However, this thesis focuses on the little and limited knowledge of DNs' diet and eating practices and their barriers to good workplace nutrition rather than comparing DNs' dietary practices against different ethnicities, ages, genders and socioeconomic statuses. Nevertheless, this provides future research opportunities in qualitative and quantitative studies (see Section 7.3 for more). Although our qualitative study was conducted and only captured the insights of 16 participants, the findings suggest that doctors and nurses have a sub-optimal diet, largely influenced by occupational challenges and barriers that hinder their ability to adopt healthier workplace nutrition behaviours.

Semi-structured interviews enabled the doctors and nurses to share their lived experiences regarding food choices and dietary behaviours during shift work. However, this approach relied on participants' ability to recall their habitual eating patterns at specific times of the day – for example, before, during and after a shift in addition to other different types of shift patterns they might have. Furthermore, it also depends on their emotional state during the interview, which could vary depending on whether they were interviewed on their non-working days or after a shift. Given the impact of shift work on physiological and psychological health, as discussed in previous chapters (see Literature review, Chapter 1 and Qualitative Results, Chapters 3 – 4), it is important to acknowledge that participants' responses may have been influenced by their current mood during the interview.

One notable limitation of the study is the temporal context in which data were collected, coinciding with the dynamic changes in the global healthcare situation during the pandemic. This factor may explain the disparity between the high number of views on the qualitative study recruitment's online page and the actual participation numbers. The evolving pandemic scenario could have influenced the heterogeneous sample, resulting in limited diversity in ethnicity, age, and gender. However, this thesis focused not on exploring dietary patterns in different socio-demographics but on doctors and nurses, addressing a gap in the current literature. Nevertheless, this could lead to future research opportunities looking more into the differences in nutrition and dietary behaviour in different socio-demographic categories, considering that the NHS is a diverse workforce.

A potential impact of conducting research amongst healthcare professionals during the pandemic could be the quality of the interview data. However, the study rigorously developed its interview topic guide using insights from previous literature and the COM-B model (Chapter 2), aligning with the research aim. Another limitation is the reliance on participants' ability to recall their eating patterns, prompting the need for question prompts to guide doctors and nurses in recalling their dietary practices. While the number of questions may seem extensive, these prompts were crucial in facilitating the interviews by aiding participants' memory recall. Not assessing the participants' psychological health and wellbeing during the interview is also a limitation that may have influenced their perceptions of how shift work affected their dietary intake and nutrition at work. Nevertheless, while our research provided a snapshot of their dietary intake, using interviews as a research method limits the detailed energy and nutrition profiles of DNs to provide a holistic understanding across each working hour. Considering this, a follow-up with the same participants using a quantitative research method could be conducted to validate their responses at different times and gain a more comprehensive understanding of their diet and nutrition during shift work.

Due to the impact of the COVID-19 pandemic, the research methods of this thesis had to be adjusted, leading to the selection of the UK Biobank dataset for analysis. The quantitative study using the UK Biobank allowed for examining DNs' dietary intake across various shift work patterns. However, there were limitations associated with using a large dataset. The data provided a snapshot view, representing a single point in time and not accounting for other confounding factors that could influence dietary patterns, such as the food facilities, provisions, or any other existing workplace health and nutrition initiatives. Another was that the UK Biobank sample was self-selected and had older participants, which could also limit the direct comparison with the qualitative results of younger participants. Despite this, the availability of the UK Biobank provided very specific data and results, which may have limited the study and its representation of the wider NHS workforce of its demographic diversity. However, in both methods, the reliability and validity of the self-reported data collected, such as through the online system (for UK Biobank), posed a challenge. As Chapter 5 (UK Biobank Result 1) discussed, participants relied on their memory and willingness to disclose accurate dietary information, which could lead to an underestimation or overestimation of their dietary intake. Thus, this limited the opportunity to explore the association between dietary intake and health outcomes. Despite this, future research opportunities are possible to analyse data of the same age group using qualitative and quantitative research methods at different time points for any associations on their dietary behaviours and shift patterns.

The self-reporting aspect could also affect the accurate reporting of shift work characteristics, such as the hours worked and the definitions of different shift work patterns when participants were from different NHS Trusts, thus may have misreported or disregarded specific details (see Chapter 6 (UK Biobank Result 2) for details). For example, participants answering the question on the number of "mixture of day and night shifts" may have discarded the questions on the number of day and night shifts separately; thus, the data of those with a combination of different shift types may be unreliable. Considering this, a decision was taken to use the data field "mixture of day and night shift" to capture as many participants as possible. The study also did not consider other potential confounding factors, such as physical activity or commuting to and from work, which could also contribute to DNs' dietary intake and food choices. Despite these limitations, the cross-sectional findings of our study indicate a sub-optimal diet among doctors and nurses.

Data analysis presented in Chapter 6 examines dietary intake and its influence on different working patterns. Non-parametric tests, specifically Mann-Whitney and Kruskal-Wallis, were employed as influential statistic analyses due to the uneven distribution of the sample. Despite the potential of regression analysis to depict variable relationships and test hypotheses, it was deemed inappropriate for this thesis. The UK Biobank data contained outliers and substantial missing data, leading to the exclusion of certain participants and datasets, consequently affecting the accuracy and reliability of regression models. Moreover, the secondary nature of the dataset posed challenges in establishing clear assumptions for reliability, further limiting the trustworthiness of regression models and their ability to capture associations between variables. Instead of predicting participants' nutrition based on shift work patterns, Mann-Whitney and Kruskal-Wallis tests were chosen to comprehend the relationship between doctors' and nurses' dietary intake. This decision was made because implying specific dietary practices based on shift patterns from a cross-sectional UK Biobank dataset lacks the depth needed to understand dietary habits over an extended period of shift work. While regression models offer insights and predictive analysis, this thesis prioritised understanding current dietary patterns over making predictions, again due to the limited understanding of DNs' nutrition in the literature using the UK Biobank data. Future research opportunities lie in exploring the longitudinal changes in doctors' and nurses' workplace nutrition through cohort or longitudinal studies. This approach would provide a more comprehensive understanding of dietary practices over an extended duration of shift work, addressing the limitations associated with the cross-sectional nature of the current dataset.

Although the research presented has limitations, this thesis successfully contributes valuable insights to the existing literature, particularly in areas with limited knowledge. While the primary focus revolves around the nutritional and dietary behaviour of DNs in the workplace, it is crucial to recognise additional confounding factors and explore the subject from various perspectives and other key influences on dietary intake and behaviours. Consequently, this thesis opens up avenues for future research, offering opportunities to expand into specific areas beyond the scope of the current presentation.

7.3 Research recommendations and future work

This thesis highlights the importance of addressing the health and nutrition of doctors and nurses during shift work. It emphasises the need to investigate further the social, environmental, and psychological factors that influence diet and nutrition at work, which this research did not explore extensively. The research findings indicate that shift work impacts dietary intake and nutrition among doctors and nurses, primarily due to heavy clinical workloads and limited access to facilities and provisions outside regular working hours, especially during night shifts. Although teamwork could facilitate eating opportunities and promote work culture and team camaraderie, leading to more eating opportunities (though the healthiness of food consumed can be questionable), the lack of support from employers and management remains a significant barrier. As a result, in response to our findings and limitations from this thesis, additional research is needed to enhance our broader understanding of workplace nutrition for DNs and develop effective, sustainable strategies to promote healthier dietary behaviours during shift work. Based on our work, the following areas have been identified for future research:

1. Increase sample size for qualitative study.

   Due to constraints in participant recruitment, including the global pandemic's impact on the availability of doctors and nurses, we could only recruit a small number of participants in a limited time. Despite the small sample size (n=16), data saturation was achieved for this thesis, allowing the exploration of the lived experiences of practising DNs regarding their diet and nutrition during shift work. Nevertheless, it is recommended that future research should include more inclusive and diverse participants concerning their occupational speciality, occupational grade, years of experience, the balance of gender, and shift work varieties as this thesis faced difficulties in providing a widespread of types of participants. With a diverse pool of participants, further analysis can help better understand whether other demographic variables such as gender, age, ethnicity and socioeconomic status influence DNs' dietary intake and nutrition practices at work.

   While debates on sample size in qualitative studies persist (Malterud, Siersma and Guassora, 2016; Vasileiou *et al.*, 2018), existing literature on healthcare professionals using interviews has reported sample sizes ranging from 16 to 55 (Lemaire *et al.*, 2010, 2011; Anstey, Tweedie and Lord, 2016; Bonnell *et al.*, 2017; Dias and Dawson, 2020). However, these sample sizes were often limited to a single occupation, unlike our thesis, which includes doctors and nurses. Therefore, it is recommended that future research endeavours recruit more participants, with a plausible solution being to collaborate with different Trusts across the UK via recruitment to increase awareness and enhance the representativeness and diversity of the sample. This would allow for a more comprehensive understanding of DNs' experiences with dietary intake and nutrition at work, considering variations in occupational roles, specialities and geographical locations.

2. Implement a follow-up from the qualitative study

   The qualitative research conducted for this study took place at a specific time, coinciding with the onset of the COVID-19 pandemic. As a result, this timing could have influenced the data collected, as doctors and nurses faced high clinical workloads and additional challenges during that period. For example, this could influence how DNs answered questions and shared their experiences when they were overworked. While it was inevitable to minimise the influence of how working in a pandemic can alter the dietary intake and nutrition behaviour in the healthcare system, having a follow-up interview with the same participants would provide valuable insights into any changes in their dietary and nutrition behaviour during shift work, as well as uncovering additional barriers and challenges they may face beyond their daily experiences.

3. Cohort or longitudinal study with clinical biomarkers from doctors and nurses

   Both the qualitative and quantitative results provided a cross-sectional understanding of doctors' and nurses' dietary intake and nutritional behaviour simultaneously. However, the nature of the research design limited the ability to establish an association between shift work and its influence on diet and nutritional behaviours. As discussed in the literature review (Chapter 1), shift work has been linked to several health and wellbeing implications, such as type 2 diabetes (Matheus *et al.*, 2013; Leon and Maddox, 2015), atherosclerosis (Sleiman, Al-Badri and Azar, 2015; Mohd Azmi *et al.*, 2020), obesity (Leon and Maddox, 2015; Liu *et al.*, 2018) and other metabolic syndromes and co-morbidities (Puttonen, Härmä and Hublin, 2010) among healthcare professionals. To further enhance our understanding in this area, it is recommended to analyse these clinical biomarkers and conduct metabolomic profiling of the DNs to provide a better nutritional assessment of their habitual diets (Jones, Park and Ziegler, 2012; Rafiq *et al.*, 2021). One research recommendation would be to conduct a cohort or longitudinal study among DNs over an extended period to address this. This study type would allow for a better understanding of the association between changing shift work patterns and corresponding changes in dietary intake and nutritional behaviour.

Additionally, incorporating the measurement of specific clinical biomarkers (e.g., type 2 diabetes, atherosclerosis, obesity, and other metabolic syndrome) experienced by DNs could provide a more reliable analysis of metabolites and help elucidate the association between diet-induced diseases, health risks, and specific food choices of doctors and nurses with shifts in greater detail.

4. Dietary assessment methods

It is recommended that multiple dietary assessment methods be employed, extending from the previous research recommendation of the limitation of understanding DNs' habitual diet via qualitative semi-structured individual interviews and the analysis of the UK Biobank dataset at a single time point. In addition to qualitative interviews and analysis of the UK Biobank dataset, incorporating tools such as the food diary and collecting clinical samples to measure relevant biomarkers, as outlined above, can provide more detailed insights into the relationship between dietary intake and shift work patterns. Given the dynamic nature of DNs' shift work cycles (see our Qualitative Result, Chapters 3 – 4), epidemiological studies (Shim, Oh and Kim, 2014; Saravia *et al.*, 2022) have highlighted the benefits of capturing dietary intake over a period of time to obtain a more accurate representation of their habitual diet. As a result, various dietary assessment methods can improve feasibility, reduce social desirability bias, and minimise reliance on participants' memory and self-reporting of food consumption. By combining data from different methods, researchers can compare and identify similarities and differences in dietary intake, enabling a holistic understanding of DNs' nutrition and facilitating the development of strategies to improve their health and nutrition.

5. Defining "shift work" and measuring its influence on doctors' and nurses' nutrition

Our result noted the lack of a standardised definition for "shift work" and its various patterns across healthcare Trusts, such as night, day, and long shifts. As a result, this could have led to participants' potential misreporting of shift work types, particularly in our quantitative research when participants are required to input the number of a specific shift work type worked. As a result, future research should establish clearer definitions, particularly regarding the different types of shift work and its characteristics. This will enable a more accurate analysis of the association between shift work and dietary intake, facilitating a better understanding of how different shift patterns influence nutrition.

6. Implement an intervention addressing the challenges and barriers experienced by doctors and nurses.

This thesis explored the dietary intake and nutritional behaviours of DNs during shift work, revealing sub-optimal dietary patterns. However, we did not include an intervention to test potential modifiable factors to improve workplace nutrition. Our findings suggest a lack of nutrition awareness among DNs, particularly regarding appropriate nutrition during night shifts, which can impact sleep quality due to disrupted circadian rhythms (Wickwire *et al.*, 2017; Brown *et al.*, 2020). Thus, to address this, workplace interventions can increase DNs' nutrition knowledge and awareness through campaigns, such as having posters on walls, short, bite-sized workshops, training courses, and collaboration with onsite catering teams to provide healthier food options around the clock. Implementing supportive workplace systems was also suggested by the participants, such as having regular nutritionist or dietitian support organised by the employer that is accessible, considering DNs' already demanding workload. Improving food provisions and extending the opening hours of food outlets can also enhance DNs' access to nutritious meals during their breaks. For example, extending opening hours could provide DNs with more food options rather than relying on widely available and accessible snacks. Further, providing DNs with food through onsite delivery at regular times during their shift could also be suggested to help improve their diet quality and nutrition. As a result, implementing an intervention that includes allowing DNs opportunities for breaks and rests in dedicated spaces could also promote better nutritional practices during working hours. Future research should address the challenges and barriers DNs face and test interventions within the workplace to develop sustainable strategies for promoting better health and nutrition. Thus, these efforts will provide valuable insights into improving workplace health and nutrition for doctors and nurses.

7. Explore other confounding factors to improve nutrition.

   This thesis predominantly explored the doctors' and nurses' dietary intake and nutrition behaviour during shift work through a mixed-method approach. However, as previously discussed (Chapter 1, Literature Review), it is important to acknowledge that the wider literature and population indicate various factors influencing health and nutrition concerning shift work. For example, Booth *et al.* (2001) and Gedrich (2003) draw on the health and nutrition determinants and their influence on health and food choices, where nutritional behaviour can be framed by factors such as the environment, social, psychological, and biological aspects affecting the dietary profile. While this thesis focuses on current dietary practices, workplace provisions, and barriers to healthy nutrition and only reports the data from the qualitative and the UK Biobank, further research is needed to understand the influence of other confounding factors. This includes exploring dietary and health behaviours before and after shifts and non-working days, those with and without shift work, individual motivation, attitudes, views toward being role models for health and beliefs, sociodemogrpahic factors (e.g. age, gender, ethnicity, education, socioeconomic status, geographical location of workplace), and other aspects such DNs' body composition (e.g. BMI, body fat percentage, muscle mass). By exploring these influences, there is the opportunity to examine how dietary habits may be influenced by other nutrition habits and choices beyond the job and or the clinical environment among doctors and nurses, and how likely these might influence morbidities or and co-morbidities that are commonly associated with shift workers.

8. Using predictive modelling for data analysis

   Current data were reported based on what was available to the studies conducted in this thesis, thus limited to Mann-Whitney and Kruskal-Wallis tests based on the disproportionate sample sizes between DNs. However, future research should extend the analysis to include other confounding factors and their impact on DNs' dietary intake using other techniques such as machine learning and predictive modelling to help explore DNs' behaviour towards their food choices at work (or at a particular shift work pattern). For example, Chapter 1 (literature review) has ascertained shift work's impacts on health. However, limited knowledge has yet ascertained the direct link between DNs' behaviour at different working patterns. As a result, machine learning and predictive modelling could suggest an alternative way to predict measures and behaviours when considering how and what interventions should be implemented to improve DNs' workplace health and nutrition.

9. Comparing data with other countries and occupations with shift work

   Globally, providing health services is essential for promoting the overall health and wellbeing of the population, as discussed in Chapter 1 (literature review). This thesis predominantly focuses on advancing our understanding of the relatively unexplored area of DNs' dietary intake, particularly utilising the UK Biobank dataset. While acknowledging the crucial role of doctors and nurses in meeting the healthcare needs of the global population, there are promising avenues for future research. This includes comparing the nutritional intake and dietary behaviours of DNs across countries and exploring disparities and similarities in dietary practices between DNs and other frontline healthcare workers, especially those engaged in shift work. By examining these aspects in the context of the UK and other countries, we can unravel the variations and commonalities in healthcare systems and their respective health and nutrition provisions.

Considering the above recommendations for future research, this would help better understand doctors' and nurses' specific nutritional requirements during shift work. This knowledge would enable the effective implementation of strategies and interventions to promote their diet and nutrition in a targeted manner.

7.4 Overall conclusion

Overall, this thesis has informed doctors and nurses' current dietary intake and nutritional behaviours during shift work. This research aimed to understand workplace nutrition and its impact on UK doctors and nurses and explore strategies for improving their health and nutrition. Findings have indicated that doctors and nurses generally have a sub-optimal diet regardless of the type of shift work they undertake. Clinical workload and limited eating opportunities were presented as significant factors affecting their dietary choices. Night shifts and the availability of caffeine and unhealthy snacks contribute to poor nutrition due to its accessibility and availability around the clock. In particular, night shifts were often viewed as a "free pass", with DNs considering this an opportunity to eat what they want. Though DNs knew the benefits of eating healthily, barriers such as work expectations and limited breaks hinder healthier eating habits. The quantitative study confirms the sub-optimal diets of doctors and nurses during shift work, particularly during night shifts when in particular, caffeine was once again acknowledged as the "go-to" alternative when no workplace facilities and initiatives are in place provided by their employers (or, in this case, by the NHS Trust). As a result, our findings contribute to the broader literature on the importance of practising good nutrition and emphasise the need for further research on the association between occupational factors, such as long-duration and consecutive night shifts, and poor nutrition among doctors and nurses.

The UK healthcare system is complex enough (Braithwaite, 2018; Dixon, 2021). Nevertheless, what is original about our findings is that changing the workplace culture and the collective attitudes towards supporting doctors' and nurses' health and nutrition is crucial for sustaining a healthy workforce and healthcare system. However, the quality of patient care is notwithstanding the core of the healthcare systems and, as such, cannot be fully measurable. Thus, to improve DNs' nutrition is to enable collaboration and integration at individual, institutional, regional, and national levels where necessary for improved communications. Making workplace changes will be difficult, especially in a national healthcare system that has been successful for the past 70 years. However, doctors' and nurses' health and nutrition must be considered to make it more successful for the next century. Thus, adapting the healthcare system to meet the needs of DNs requires understanding them as individuals and modifying environmental provisions to promote healthier eating practices and facilitate improved working culture.

Appendices

Appendix 1 – Copyright Permission

Type of Work	Chapter	Name of Work	Source of Work	Copyright holder and contact	Permission Requested	Permission Granted
Figure 2	1 – Literature Review	Figure 2: Cross-sectional survey results from Smith, Goldacre and Lambert (2017) on the adverse effects on senior UK-trained doctors' health and wellbeing.	Smith, F., Goldacre, M.J. and Lambert, T.W. (2017). Adverse effects on health and wellbeing of working as a doctor: views of the UK medical graduates of 1974 and 1977 surveyed in 2014. *Journal of the Royal Society of Medicine*, 110(5), pp.198-207.	Copyright © 2017, © SAGE Publications	25/05/2023 via RightsLink (no fee)	25/05/2023
Figure 3	1 – Literature Review	Figure 3: Pathways from shift work to cardiovascular disease (Puttonen, Härmä and Hublin, 2010)	Puttonen, S., Härmä, M. and Hublin, C. (2010). Shift work and cardiovascular disease—pathways from circadian stress to morbidity. *Scandinavian journal of work, environment & health*, pp.96-108.	Copyright © Scandinavian Journal of Work, Environment & Health	25/05/2023	25/05/2023

				Journal is Open access (CC-BY, version 4.0)		
Figure 4	1 – Literature Review	Figure 4: Conceptual analysis and taxonomy of 'dietary behaviour' (Marijn Stok et al., 2018)	Marijn Stok, F., Renner, B., Allan, J., Boeing, H., Ensenauer, R., Issanchou, S., Kiesswetter, E., Lien, N., Mazzocchi, M., Monsivais, P. and Stelmach-Mardas, M. (2018) Dietary behavior: an interdisciplinary conceptual analysis and taxonomy. *Frontiers in psychology*, 9, p.1689.	Copyright © Frontiers Journals Journal is Open access (CC-BY, version 4.0)	25/05/2023	25/05/2023
Figure 5	1 – Literature Review	Figure 5: Inter-relationship on dietary variables (Tapsell, 2017)	Tapsell, L.C. (2017). Dietary behaviour changes to improve nutritional quality and health outcomes. *Chronic diseases and translational medicine*, 3(3), pp.154-158	Copyright © Chronic Diseases and Translational Medicine	25/05/2023 via email (no fee)	25/05/2023
Figure 6	1 – Literature Review	Figure 6: Factors influencing eating practices of hospital	Monaghan, T., Dinour, L., Liou, D. and Shefchik, M. (2018). Factors influencing the eating practices of hospital nurses during their shifts.	Copyright © 2018, © SAGE Publications	25/05/2023	25/05/2023

		nurses during shift work (Monaghan et al., 2018)	*Workplace health & safety*, 66(7), pp.331-342.	Open access		
Figure 7	1 – Literature Review	Figure 7: A conceptual framework of food choice determinants from Booth et al (2001)	Booth, S.L., Sallis J.F., Ritenbaugh, C., Hill J.O., Birch .L.L., Frank, L.D., et al. Environmental and Societal Factors Affect Food Choice and Physical Activity: Rationale, Influences, and Leverage Points. *Nutr Rev*. 2001 Apr 27;59(3):S21– 36.	Oxford University Press © 2001 International Life Sciences Institute	25/05/2023 via RightsLink (no fee)	25/05/2023
Figure 10	2 – UK Biobank Methods	Figure 1: Data collected at the baseline assessment of the UK Biobank dataset (Sudlow et al., 2015)	Sudlow. C., Gallacher. J., Allen, .N, Beral, V., Burton, P., Danesh ,J., et al. (2015) UK Biobank: An Open Access Resource for Identifying the Causes of a Wide Range of Complex Diseases of Middle and Old Age. PLoS Med 12(3): e1001779.	Copyright © 2015 Sudlow et al Open access	25/05/2023 (no fee)	25/03/2023

Appendix 2 – Qualitative Study: Interview Guide

[Introduction]:

I would like to thank you for your willingness to be interviewed as a participant in our study. As mentioned, the aim of this research is to overall understand the role of workplace nutrition, nutrition-related behaviours, and mood and emotions of medical doctors during their shift work. More specifically, the purpose of the interview will enable us to explore your perceptions of your current nutrition, your biopsychosocial aspects and the possible risks of any health implications during your shift.

Our interview today will last approximately one hour which I will be asking you about your experience and perception of your nutrition consumption during your shift, any challenges you face and possible way to engage doctors like yourself to have a better approach to your own nutritional health and wellbeing.

[Consent form]

[Demographic survey]

Before we start the interview, do you have any questions you would like to ask?

If at any point during the interview you have any questions, please feel free to ask them any time. I am more than happy to answer and or clarify anything.

<u>Section 1: Your Role</u>

1. To start us off, could you please briefly outline your current role?
2. How do you try to manage your own health and wellbeing? (e.g. dieting, gym, yoga, meditation, talking therapy)

<u>Section 2: Shift Work</u>

1. Thinking about your current role, could you give me an idea about your rotating shift work experience?
2. How does the rota impact your overall lifestyle (i.e. health and wellbeing)?
3. How do you think this rota impacts on your mood and emotions?
4. When on shift, could you share your typical diet? Do you have any dietary habits?
5. How do these habits differ - if at all - when you are not on shift?
6. Thinking about your night shifts, how confident are you of eating well when on nights?
7. What are the key challenges you find during your shift relating to looking after yourself (e.g. Nutrition? Mood and emotions? Health?)
8. What are the key facilitators you find during your shift relating to looking after yourself (e.g. Nutrition? Mood and emotions? Health?)

Section 3: Nutrition

1. What influences your food choices during your working hours?
2. How important is it to eat well as a doctor?
3. Do you keep track on what you are eating – in general or when on shift?
4. Have you seen a change in your nutrition over the past year? If yes, why is that do you think?

Section 4: Mood and Emotions

1. Do you ever reflect on your feelings related to work?
2. What would you say most affects your feelings when on shift work? How is this different to being off work?

Section 5: Health

1. Are there any challenges and or barriers you feel are preventing you from being healthy?

Section 6: Facilities and Intervention

1. Thinking about your working environment, what food facilities are there available for you at your workplace?
2. Are you aware of any workplace support for your health and wellbeing?
3. What immediate and or short term workplace support would be useful for your nutrition? Health? Wellbeing?
4. What longer term support or training would be useful for your nutrition?

Before we end this interview, are there anything in your experience as a doctor that you would like to share and or discuss relating to nutritional behaviour?

[End]

[If participant is feeling uneasy after the interview, apply the Sensitivity Research Protocol – see document]

Appendix 3 – Qualitative Study: Pre-Interview Questionnaire

**this pre-interview questionnaire was presented by the online Jisc online survey platform*

Before your interview, please complete the following questions.

1. What age category do you fall into?

   - 25 – 34 years old
   - 35 – 44 years old
   - 45 – 54 years old
   - 55 – 65 years old
   - Over 66

2. What is your gender identity?

   - Male
   - Female
   - Other (please specify)
   - Prefer not to say

3. What is your ethnicity? (to specify the categories below)

   - White
   - Asian or Asian British
   - Black or Black British
   - Mixed
   - Prefer not to say
   - Other (please specify)

4. What is your current work role?

5. Which speciality of medicine are you currently working in?

- Anaesthetics
- Clinical/ medical oncology
- Radiology
- Emergency medicine
- General practice
- Intensive care medicine
- Hospital medicine (please specify)
- Obstetrics and gynaecology
- Ophthalmology
- Paediatrics and child health
- Psychiatry
- Surgical specialty (please specify)
- Others (please specify)

6. What is your current grade?

- FY1
- FY2
- Core Trainee
- GPST
- Consultant/ Trust grade
- Other (please specify)

7. How long have you been in your current role?

- < 6 months
- 6 months – 1 year
- 2 year – 5 years
- 6 years – 10 years
- 11 years – 20 years
- 21 years+

8. What is your current work rota/ cycle? (an outline including the time you start finish if possible)

9. How long is your typical rota? (weeks?)

   - What’s the frequency of nights do you have per rota?

   - What’s the frequency of long days do you have per rota?

   - What’s the frequency of short days do you have per rota?

   - What’s the frequency of weekend shifts do you have per rota?

   - Could you upload your rota if possible?

10. Have you worked a different rota in the past 6 months?

    - Yes
    - No

11. Which NHS Trust are you predominantly based at? (please specific/ highlight below)

    - Trust:
    - Prefer not to say

Thank you for completing the short survey. Please enter your email address where you will be contacted to schedule an online interview.

<u>Your email address:</u>

[End]

Appendix 4 – Qualitative Study: Consent Form

Title of Study: Healing the healer: a qualitative study exploring doctors and nurses' workplace nutritional behaviour on their health and wellbeing.

Lead researcher: Kiu Sum

I have been given the Participation Information Sheet and/or had its contents explained to me.	Yes	❒	No	❒
I have had an opportunity to ask any questions and I am satisfied with the answers given.	Yes	❒	No	❒
I understand I have a right to withdraw from the research at any time and I do not have to provide a reason.	Yes	❒	No	❒
I understand that if I withdraw from the research any data included in the results will be removed if that is practicable (I understand that once anonymised data has been collated into other datasets it may not be possible to remove that data).	Yes	❒	No	❒
I confirm I am willing to be a participant in the above research study.	Yes	❒	No	❒
I note the data collected may be retained in an anonymised archive and I am happy for my data to be reused as part of future research activities. I note my data will be fully anonymised (if applicable), and only short quotes will be used in any reporting.	Yes	❒	No	❒

Participant's Name: ____________________________

Signature: ____________________________ **Date:** ______________

This consent form will be stored separately from any data you provide so that your responses remain anonymous. The duty of confidentiality is not absolute and in exceptional circumstances this may be overridden by more compelling duties such as to protect individuals from harm.

I confirm I have provided a copy of the Participant Information Sheet approved by the Research Ethics Committee to the participant and fully explained its contents. I have given the participant an opportunity to ask questions, which have been answered.

Researcher's Name: ___________________________

Signature: _________________________ Date: _______________

Appendix 5 – Qualitative Study: Participant Information Sheet

1. Research Title:

Healing the healer: a qualitative study exploring doctors and nurses' workplace nutritional behaviour on their health and wellbeing.

2. Invitation

You are being invited to take part in this research project. Before you decide to do so, it is important you understand why the research is being done and what it will involve. Please take time to read the following information carefully and to decide whether you wish to take part. Please feel free to ask the research team if there is anything that is unclear and or if you would like more information.

3. What is the purpose of the study?

The purpose of this study is to understand the impacts of workplace nutrition among doctors and nurses, including understanding their nutritional behaviour, and its impact on mood and emotions during their working hours. The research will also explore potential strategies that might be acceptable to doctors and nurses to support their health and wellbeing (e.g. use of mobile technologies). The aim is to design an intervention that can be used to promote workplace well-being. This project is being conducted as part of a PhD research at University of Westminster.

4. Why have I been invited?

You have been invited because you are a UK-based doctor or nurse - your experiences and perspectives on your health and wellbeing when at work will be greatly valued.

5. Do I have to take part?

It is up to you to decide whether to take part. If you do decide to take part, you will be able to keep a copy of this information sheet and you should indicate your agreement to the consent form. You are free to withdraw at anytime, without giving a reason, including withdrawing their data before the thesis results chapters are drafted.

6. What will happen to me if I decide to take part?

If you want to take part, please email the researcher Kiu Sum (k.sum@my.westminster.ac.uk). She will then contact you to arrange a convenient time and date for an interview. It is expected that the interview will last 1 hour, where you will be able to discuss your experiences of nutrition (i.e. what you eat), health and wellbeing when at work with the researcher (see Section 13 for exact topics covered). The interview will be conducted online and will be audio-recorded.

7. Are there any possible disadvantages or risks from taking part?

Participating in the research is not anticipated to cause you any discomfort. You do not have to answer any questions you do not wish to. Please see Section 8 for benefits of taking part

8. What are the possible benefits of taking part?

Whilst there are no immediate and direct benefits for those taking part, it is hoped that this research will provide understanding on doctors' and nurses' health and wellbeing. Results may be used in the future to improve support and facilities for doctors and nurses. If you wish, you can receive information on the results of the research. Please indicate on the consent form if you would like to receive this information.

9. Will I be reimbursed?

Participation in this study is voluntary and there is no reimbursement for taking part.

10. What happens if the research study stops earlier than expected?

Should the research stop earlier than planned, we will tell you and explain why.

11. Will my taking part in the study be kept confidential?

Yes. The identity of people taking part in the study will only be known to the researcher and her supervisors at the University of Westminster. Participants will be anonymised, and identification numbers will be used when referenced in reports and thesis. Any identifying information (e.g. names, places of workplace) will be deleted from transcripts by the researcher. Short quotes (with no identifying information) from interviews may be used when presenting the data, but these will be anonymised.

According to the university policy, your information will be securely stored separately by the researcher, so it is not possible to match the participant information with the data. All recordings and transcripts will only be identified by your participant number and will be stored and used only on University of Westminster computers that are password protected. Anonymised data may also be worked on, on research's laptops which are also password protected. Only the researcher and the supervisory team will have access to any participant personal data during the study. Personal data will be kept in storage will be destroyed 5 years after the completion of the PhD or associated publications.

The researcher will keep copies of paper files in a secure place, stored in a locked filing cabinet in a locked room on the University of Westminster premises, complying with the with the requirements of the Data Protection Act 2018 and the General Data Protection Regulation.

12. Will I be recorded, and how will the recorded media be used?

Interviews will be audio-recorded so that we have a record of the interview. Recordings are sent to a professional transcriber who signs a confidentiality agreement and deletes the recording after it has been transcribed. Transcripts are returned to the researcher for analysis and any identifiable information (such as name, place of workplace) will be deleted. Recordings are stored securely on University of Westminster servers and will only be identifiable via participant number. Files will be saved in a separate file and password protected, so that it will not be possible to match the participant information with the data. The data will be deleted once the PhD project and publications arising from it have been completed.

13. What type of information will be sought from me and why is the collection of this information relevant for achieving the research project's objectives?

The interview will ask you about your experiences as a doctor/ nurse in your workplace, relevant to the research's aims and objectives. Topics covered in the interview will include: 1) Your current nutrition, in relation to your health and well-being during working hours, 2) The current challenges related to your nutrition and what you eat and 3) Identifying possible strategies to induce nutritional and behavioural change to improve your health and wellbeing at work.

14. What will happen to the results of this study?

The results of the study will feed into the researcher's PhD thesis. Results of the research may be published in scientific journals and or presented at conferences. You will not be identified in any report or publication. Your Trust and Hospital will not be identified in any report of publications.

15. Who is organising and funding the study?

This study is organised and carried out at the University of Westminster as part of a PhD research project. The PhD projected is funded by the University of Westminster.

16. Who has reviewed the study?

The research has been reviewed and approved by the College Research Ethics Committee (LAS-CREC), College of Liberal Arts and Sciences, University of Westminster.

17. Further information and contact details

Kiu Sum (Doctoral Researcher), College of Liberal Arts and Sciences, University of Westminster. Email: k.sum@my.westminster.ac.uk

Dr Sanjoy Deb (Director of Studies), College of Liberal Arts and Sciences, University of Westminster. Email: s.deb@westminster.ac.uk (0207911500)

Professor Brendon Noble, Head of the School of Life Sciences, College of Liberal Arts and Sciences, University of Westminster. Email: B.Noble@westminster.ac.uk

If you have a complaint about this research project, please contact Dr Deb (details above) in the first instance.

Thank you for considering taking part.

Appendix 6 – Qualitative Study: Sensitivity Protocol

When participants volunteer to answer interview questions about personal issues, it may lead to them thinking of - or talking about - things that they find difficult or even distressing. To address situations where this can occur, a number of approaches are commonly considered to help address potential distress to participants. These include making good use of participant information sheets and consent forms, referral sheets, and the implementation of a research sensitive protocol.

Patient Information Sheet and Consent form

Participant Information Sheet and consent form will be provided at the beginning of the interview, outlining:

a) What the overall interview topic will be
b) What are the typical kinds of questions that will be asked
c) That they may stop or delay the survey/interview at any time
d) That they may withdraw from the research entirely, without having to give any reason at all
e) That they may additionally withdraw their data from the research, provided writing up has not yet begun
f) (If relevant) that their participation in the research, including their comments on it, or their declining to participate in the research, will not affect their occupation in any way
g) That all data they provide is confidential and will be reported in a way that preserves their anonymity
h) That you will provide all participants with a referral sheet after the research that participants can use to gain further help

Research sensitive protocol

For interviews, the researcher will implement a ‘sensitive research protocol’, which will involve:

- Monitoring participants for distress during interviews
- Stopping an interview if a participant becomes upset and only recommencing when (and if) the interviewee is ready to do so
- Any interview will be ceased completely if the interviewee is too distressed to continue, without any blame from the researcher or pressure to reschedule
- Asking specifically if there are any issues raised by doing the interview (at the end of the interview)
- Offering to sit with, and listen to, any participant who has become upset during interview, for as long as it takes.
- Encouraging participants to contact the researcher by email or direct phone line if they have any concerns post interview
- Providing all participants with a support and information sheet that includes free and low-cost counselling options (see below)
- Following up any participants that become upset in the days following the interview, e.g. by email or phone.

Researcher experience and expertise

The researcher will be able to have a debrief with their supervisors post interviews. Alternatively, it may be recommended that a researcher talk to a counsellor to further debrief if they are particularly affected by an interview.

Support and referral sheet

Consider providing participants with a list of organisations who can provide support including information and free or low cost counselling options, once the research is over.

Type of organisation	**Support**	**Contacts**
Telephone counselling e.g. Samaritans	Free or Low cost counselling	e.g. Helpline 116 123 Website www.samaritans.org

Mental health charity for further support – relevant for both participants and researcher	Charity about mental health and related topics also provides counselling in some areas.	Website www.mind.org.uk
Consultation and support service in person and or via telephone	Free, confidential NHS service for doctors and dentists across England with mental illness and addiction problems, who are working or looking to return to clinical practice.	Email: https://www.practitionerhealth.nhs.uk/

Appendix 7 – UK Biobank: SQL Queries for shift patterns

SQL Queries of doctors and nurses with shift work and the different shift patterns.

Nurses (any kind, at any level) – Field ID 32113075

Doctors (medical doctor, general practitioner, hospital consultant) – Field ID 22113066

Field IDs	SQL Queries
22601 Job coding 22604 Work hours – lumped category 22605 Work hours per week – exact value 22620 Job involved shift work	**Job Coding:** Select count(*) From ukb_data where `22601-0.0`="32113072"; Select count(*) From ukb_data where `22601-0.0`="22113066"; **Doctors and work hours (lumped category):** Select count(`22604-0.0`),`22604-0.0` From ukb_data where `22601-0.0`="22113066" GROUP BY `22604-0.0`; **Nurses and work hours (lumped category):** Select count(`22604-0.0`),`22604-0.0` From ukb_data where `22601-0.0`="32113072" GROUP BY `22604-0.0`; **Doctors and work hours (exact value):** Select count(`22605-0.0`) From ukb_data where `22601-0.0`="22113066" AND `22605-0.0` >= 40; **Nurses and work hours (exact value):** Select count(`22605-0.0`) From ukb_data where `22601-0.0`="32113072" AND `22605-0.0` >= 40;

	Doctors with shift work: Select count(*) From ukb_data where `22601-0.0`="22113066" AND `22620-0.0`="1"; **Nurses with shift work:** Select count(*) From ukb_data where `22601-0.0`="32113072" AND `22620-0.0`="1"; **Doctors with shift work and hours per week:** Select count(`22604-0.0`),`22604-0.0` From ukb_data where `22601-0.0`="22113066" AND `22620-0.0`="1" GROUP BY `22604-0.0`; **Nurses with shift work and hours per week:** Select count(`22604-0.0`),`22604-0.0` From ukb_data where `22601-0.0`="32113072" AND `22620-0.0`="1" GROUP BY `22604-0.0`;
Mixture of day and night shifts 22640 Mixture of day and night shifts worked 22641 Period spent working mix of day and night shifts 22642 Usual length of each night shift during mixed shift periods	**Category code:** 0 Shift pattern was worked for some (but not all) of job 1 Shift pattern was worked for whole of job 9 This type of shift pattern was not worked during job **Number of doctors with mix of day and night shift** Select count(`22640-0.0`), `22640-0.0` From ukb_data where `22601-0.0`="22113066" AND `22620-0.0`="1" GROUP BY `22640-0.0`; **Number of nurses have a mixed day and night shift**

22643 Number of night shifts worked monthly during mixed shift periods 22644 Consecutive night shifts during mixed shift periods 22645 Rest days during mixed shift periods	Select count(`22640-0.0`), `22640-0.0` From ukb_data where `22601-0.0`="32113072" AND `22620-0.0`="1" GROUP BY `22640-0.0`; **Number of doctors with a period spent working mix day and night shift** -1001 represents less than 1 year Select count(`22640-0.0`), `22640-0.0`, `22641-0.0` From ukb_data where `22601-0.0`="22113066" AND `22620-0.0`="1" GROUP BY `22640-0.0`, `22641-0.0`; **Number of nurses with a period spent working mix day and night shift** -1001 represents less than 1 year Select count(`22640-0.0`), `22641-0.0`, `22640-0.0` From ukb_data where `22601-0.0`="32113072" AND `22620-0.0`="1" GROUP BY `22640-0.0`, `22641-0.0`; **Doctors and length of night shift:** Select count(`22640-0.0`), `22640-0.0`, `22641-0.0`, `22642-0.0` From ukb_data where `22601-0.0`="22113066" AND `22620-0.0`="1" GROUP BY `22640-0.0`, `22641-0.0`, `22642-0.0`; **Nurses Length of night shift:** Select count(`22640-0.0`), `22641-0.0`, `22640-0.0`,`22642-0.0`

	From ukb_data where `22601-0.0`="32113072" AND `22620-0.0`="1" GROUP BY `22640-0.0`, `22641-0.0`, `22642-0.0`; **Doctors and number of night shifts worked monthly** Select count(`22640-0.0`), `22640-0.0`, `22643-0.0` From ukb_data where `22601-0.0`="22113066" AND `22620-0.0`="1" GROUP BY `22640-0.0`, `22643-0.0`; **Nurses and number of night shifts worked monthly** Select count(`22640-0.0`), `22640-0.0`, `22643-0.0` From ukb_data where `22601-0.0`="32113072" AND `22620-0.0`="1" GROUP BY `22640-0.0`, `22643-0.0`; **Doctors Consecutive night shifts during mixed shift periods 22644 – see spreadsheet** -1 represents more than a month Select count(`22640-0.0`), `22640-0.0`, `22644-0.0` From ukb_data where `22601-0.0`="22113066" AND `22620-0.0`="1" GROUP BY `22640-0.0`, `22644-0.0`; **Nurses with consecutive night shifts during mixed shift periods** Select count(`22640-0.0`), `22640-0.0`, `22644-0.0` From ukb_data where `22601-0.0`="32113072" AND `22620-0.0`="1" GROUP BY `22640-0.0`, `22644-0.0`;

	Doctors and the number of rest days during mixed shift periods -1 represents more than a month Select count(`22640-0.0`), `22640-0.0`, `22645-0.0` From ukb_data where `22601-0.0`="22113066" AND `22620-0.0`="1" GROUP BY `22640-0.0`, `22645-0.0`; **Nurses and the number rest days during mixed shift periods** -1 represents more than a month Select count(`22640-0.0`), `22640-0.0`, `22645-0.0` From ukb_data where `22601-0.0`="32113072" AND `22620-0.0`="1" GROUP BY `22640-0.0`, `22645-0.0`;

Appendix 8 – UK Biobank: SQL Queries for food items

SQL Queries of food items doctors and nurses with shift work.

Eid and Job Code

Select eid,`22601-0.0` From ukb_data where (`22601-0.0`="22113066" OR `22601-0.0`="32113072") Order by eid;

Water Intake

Select eid,`22601-0.0`, `1528-0.0` From ukb_data where (`22601-0.0`="22113066" OR `22601-0.0`="32113072") Order by eid;

Cheese Intake

Select eid,`22601-0.0`, `1408-0.0` From ukb_data where (`22601-0.0`="22113066" OR `22601-0.0`="32113072") Order by eid;
Logic: if(C2 = 0, "<1.0", if(C2 = 1, "<1.0", if(C2 = 2, "=1.0", if(C2=3, "2-4.9", if(C2=4, ">=5.0", if(C2 = 5, ">= 5.0", if(C2 = -1, C2, if(C2 = -3, C2, "NA")))))))

Total.fruit.intake (same for vegetable.intake)

Logic: IF(AND(C2>=0,D2>=0), C2+D2, IF(AND(C2>=0,D2<0), C2, IF(AND(C2<0, D2>=0),D2,C2+D2)))
For servings: IF(AND(E2 < 2, E2 >= 0), "<2.0", IF(AND(E2 >= 2, E2 < 3), "2.0-2.9", IF(AND(E2 >= 3, E2 < 4), "3.0-3.9", IF(E2>=4, ">4.0", IF(E2 < 0, "NA",)))))

Smoking status

Select eid,`22601-0.0`, `20116-0.0` From ukb_data where (`22601-0.0`="22113066" OR `22601-0.0`="32113072") Order by eid;
Logic: IF(C2=0,"Never",IF(C2=1,"Previous",IF(C2=2,"Current","NA")))

Total meat intake

Select eid,`22601-0.0`, `1349-0.0`, `1359-0.0`, `1369-0.0`, `1379-0.0`, `1389-0.0` From ukb_data where (`22601-0.0`="22113066" OR `22601-0.0`="32113072") Order by eid;

Logic: IF(C2=0, 0, IF(C2=1, 0.5, IF(C2=2, 1, IF(C2=3, 3, IF(C2=4, 5.5, IF(C2 = 5, 7,))))))

Total Fish intake

Select eid,`22601-0.0`, `1329-0.0`, `1339-0.0`

From ukb_data where (`22601-0.0`="22113066" OR `22601-0.0`="32113072") Order by eid;

Logic: IF(C2=0, 0, IF(C2=1, 0.5, IF(C2=2, 1, IF(C2=3, 3, IF(C2=4, 5.5, IF(C2 = 5, 7,))))))

Milk Intake

Select u.eid, `1418-0.0`, `1458-0.0`, `1488-0.0`, `1498-0.0`

From ukb_data u, ukb_new_data n

where u.eid = n.eid and (`22601-0.0`="22113066" OR `22601-0.0`="32113072")

Order by eid;

Logic:IF(AND(C2>=0,D2>=0,E2>=0),((C2*100)+(D2*35)+(E2*25))/7, IF(AND(C2>=0,D2<0,E2>=0),((C2*100)+(E2*25))/7, IF(AND(C2>=0,D2>=0,E2<0),((C2*100)+(D2*35))/7,IF(AND(C2<0,D2>=0,E2>=0),((D2*35)+(E2*25))/7, IF(AND(C2<0,D2<0,E2>=0),((E2*25))/7,IF(AND(C2<0,D2>=0,E2<0),((D2*35))/7,IF(AND(C2>=0,D2<0,E2<0),((C2*100))/7, IF(AND(C2<0,D2<0,E2<0),C2+D2+E2, "NA"))))))))

Tea Inkake logic:

=IF(AND(B2 < 2, B2 >= 0), "<2.0", IF(AND(B2 >= 2, B2 < 4), "2.0-3.9", IF(AND(B2 >= 4, B2 < 6), "4.0-5.9", IF(B2>=6, ">6.0", IF(B2 =-10, "<2.0",B2)))))

Sleep and Healthy Sleep Score

Select u.eid, `1160-0.0`, `1180-0.0`, `1200-0.0`, `1210-0.0`, `1220-0.0`

From ukb_data u

Where (`22601-0.0`="22113066" OR `22601-0.0`="32113072") Order by eid;

Sleep Duration -> =IF(C2 < 7, "Short", IF(C2 >= 9, "Long", "Normal"))

SD_Recoding -> =IF(D2 = "Normal", 0, 1)

Chronotype -> =IF(OR(F2=1,F2=2),0,IF(OR(F2=3,F2=4),1,0))

Sleeplessness_insomnia-> =IF(H2=1, 0, 1)
Snoring-> =IF(J2=1, 1, 0)
Daytime_dozing_sleeping -> =IF(OR(L2=0,L2=1),0,IF(OR(L2=2,L2=3),1,0))
Healthy_Sleep_Score -> =E2+G2+I2+K2+M2

Alcohol Consumption

```
Select u.eid, `20117-0.0`, `1557-0.0`, `1568-0.0`, `1578-0.0`, `1588-0.0`, `1598-0.0`,
`1606-0.0`, `5364-0.0`, `4407-0.0`, `4418-0.0`, `4429-0.0`, `4440-0.0`, `4451-0.0`,
`4462-0.0`
From ukb_data u, ukb_new_data n
where u.eid = n.eid and (`22601-0.0`="22113066" OR `22601-0.0`="32113072")
Order by eid;
```

Partial Fibre Score

```
Select u.eid, `1309-0.0`, `1319-0.0`, `1289-0.0`, `1299-0.0`, `1448-0.0`, `1438-
0.0`,`1468-0.0`, `1458-0.0`
From ukb_data u, ukb_new_data n
where u.eid = n.eid and (`22601-0.0`="22113066" OR `22601-0.0`="32113072")
Order by eid;
```

Socioeconomic Status

```
Select u.eid, `22601-0.0`,`33-0.0`, `52-0.0`, `34-0.0`, `31-0.0`, `189-0.0`, `21000-
0.0`,`21001-0.0`, `50-0.0`, `21002-0.0`, `20116-0.0`, `1070-0.0`, `1160-0.0`, `1329-
0.0`, `6138-0.0`
From ukb_data u, ukb_new_data n
where u.eid = n.eid and (`22601-0.0`="22113066" OR `22601-0.0`="32113072")
Order by eid;
```

Healthy Eating Index

```
Select u.eid,`22601-0.0`,`100006-0.0`,`100007-0.0`, `100003-0.0`, `100005-0.0`,
`100009-0.0`
From ukb_data u, ukb_new_data n
where u.eid = n.eid and (`22601-0.0`="22113066" OR `22601-0.0`="32113072")
Order by eid;
```

Total non-milk extrinsic sugars [26002 – missing]

```
Select u.eid,`22601-0.0`,`100008-0.0`, `26002-0.0`
From ukb_data u, ukb_new_data n
where u.eid = n.eid and (`22601-0.0`="22113066" OR `22601-0.0`="32113072")
Order by eid;
```

Calcium

```
Select u.eid,`22601-0.0`, `26018-0.0`
From ukb_data u, ukb_new_data n
where u.eid = n.eid and (`22601-0.0`="22113066" OR `22601-0.0`="32113072")
Order by eid;
```

Red Meat and Meat Products

```
Select u.eid,`22601-0.0`,`103020-0.0`,`103030-0.0`, `103040-0.0`, `103100-0.0`,
`103060-0.0`, `102620-0.0`, `103010-0.0`, `103070-0.0`, `103080-0.0`, `103090-0.0`
From ukb_data u, ukb_new_data n
where u.eid = n.eid and (`22601-0.0`="22113066" OR `22601-0.0`="32113072")
Order by eid;
```

Fish

```
Select u.eid,`22601-0.0`,`103150-0.0`,`103160-0.0`, `103190-0.0`, `103200-0.0`,
`103210-0.0`, `103220-0.0`, `103230-0.0`, `20109-0.0`
From ukb_data u, ukb_new_data n
where u.eid = n.eid and (`22601-0.0`="22113066" OR `22601-0.0`="32113072")
Order by eid;
```

Pulses and Nuts (Values – 555 means half and 444 means quarter -> 555 replaced by 0.5 and 444 by 0.25)

```
Select u.eid,`22601-0.0`,`104000-0.0`,`104010-0.0`,`104110-0.0`, `102410-0.0`,
`102420-0.0`, `102430-0.0`, `102440-0.0`, `102450-0.0`
From ukb_data u, ukb_new_data n
where u.eid = n.eid and (`22601-0.0`="22113066" OR `22601-0.0`="32113072")
Order by eid;
```

Fruits and vegetables

```
Select u.eid,`22601-0.0`, `104060-0.0`,
`104070-0.0`,
`104100-0.0`,
`104130-0.0`,
`104140-0.0`,
`104150-0.0`,
`104160-0.0`,
`104170-0.0`,
`104180-0.0`,
`104190-0.0`,
`104200-0.0`,
`104210-0.0`,
`104220-0.0`,
`104230-0.0`,
`104240-0.0`,
`104250-0.0`,
`104260-0.0`,
`102490-0.0`,
`104270-0.0`,
`104280-0.0`,
`104090-0.0`,
`104290-0.0`,
`104300-0.0`,
`104310-0.0`,
`104320-0.0`,
`104340-0.0`,
`104350-0.0`,
`104120-0.0`,
`104360-0.0`,
`104370-0.0`,
`104380-0.0`,
`102620-0.0`,
```

```
`104410-0.0`,
`104420-0.0`,
`104430-0.0`,
`104440-0.0`,
`104450-0.0`,
`104460-0.0`,
`104470-0.0`,
`104480-0.0`,
`104490-0.0`,
`104500-0.0`,
`104510-0.0`,
`104520-0.0`,
`104530-0.0`,
`104540-0.0`,
`104550-0.0`,
`104560-0.0`,
`104570-0.0`,
`104580-0.0`,
`104590-0.0`

From ukb_data u, ukb_new_data n
where u.eid = n.eid and (`22601-0.0`="22113066" OR `22601-0.0`="32113072")
Order by eid;
```

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