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**The impact of chatbot-assisted self-assessment (CASA) on intentions for sexual health screening
in people from minoritised ethnic groups at risk of sexually transmitted infections**

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Abstract

Introduction: Sexually transmitted infections (STIs) present a significant global public health issue, with disparities in STI rates often observed across ethnic groups. The study investigates the impact of Chatbot-Assisted Self-Assessment (CASA) on the intentions for sexual health screening within minoritised ethnic groups (MEGs) at risk of STIs as well as the subsequent use of a chatbot for booking STI screening.

Methods: A simulation within-subject design was utilised to evaluate CASA's effect on intentions for STI/HIV screening, concern about STIs, and attitudes towards STI screening. Screening intentions served as the dependent variable, while demographic and behavioural factors related to STI/HIV risk were the independent variables. ANCOVA tests were conducted to measure the impact of CASA on these perceptions.

Results: Involving 548 participants (54% women, 66% black, average age=30), the study found that CASA positively influenced screening intentions $t(547)=-10.3, p<0.001$], concerns about STIs $t(544)=-4.96, p<0.001$, and attitudes towards sexual health screening [$t(543)=-4.36, p<0.001$. Positive attitudes towards CASA were observed ($M=13.30, SD=6.73, \text{range}:-17 \text{ to } 21$). About 72% of users who booked STI screening appointments via chatbot were from MEGs.

Discussion: CASA increased motivations for STI screening intentions among ethnically diverse communities. The intervention's non-judgmental nature and the chatbot's ability to emulate sexual history-taking were critical in fostering an environment conducive to behavioural intention change. The study's high acceptability indicates the potential for broader application in digital health interventions. However, the limitation of not tracking actual post-intervention behaviour warrants further investigation into CASA's real-world efficacy.

Introduction

Sexually transmitted infections (STIs) are a major global health issue, with the World Health Organization estimating that one million new infections occur each day, worldwide.[1] Although age-standardized rates of STI incidence have decreased in most countries from 1990 to 2019, the actual number of new cases has increased.[2] This highlights the ongoing challenge that STIs pose to public health, particularly in regions such as sub-Saharan Africa and Latin America. Although STIs potentially affect all people, there are significant ethnic disparities reported in some Western countries, such as the United States and the United Kingdom.[3,4] STIs disproportionately affect people from minoritised ethnic groups (MEGs), with people of black heritage or mixed race being significantly more likely to be diagnosed with STIs such as chlamydia, gonorrhoea, and syphilis compared to their white counterparts.[5] Addressing the disparities in STI prevalence and advancing sexual health equity requires an understanding of the complex relationships between ethnic groups, disease prevalence, and social structures.

Poorer STI outcomes for ethnic minorities are commonly caused by systemic issues such as limited access to quality healthcare, social stigma, and economic inequalities rather than differences in behaviour.[6] Unfortunately, cultural stereotypes and biases in healthcare, including assumptions about sexual promiscuity and racism, can discourage MEGs from seeking care. Moreover, economic disparities, unemployment, insecure work and migration status may further exacerbate these issues, making it difficult for people to access sexual health services.[7] Additionally, these disparities are not only health-related but are also evident in research and policy.

People from MEGs are notably underrepresented in sexual health research. For instance, in the IMPACT trial, which explored the feasibility of HIV pre-exposure prophylaxis (PrEP), only 1.5% of participants identified as black African.[8] Therefore, addressing the epidemiology of STIs requires an understanding of the complex interplay of social determinants of health, such as socio-economic deprivation, and social stigma, as well as access and utilisation of quality sexual health services, especially in the era of digitalisation and automation.[9,10]

Digital sexual health services are becoming increasingly important in addressing ethnic disparities in STIs. These services offer remote consultations, online testing kits, and digital resources

for education and support, which can overcome barriers to access, such as location and stigma associated with in-person visits.[11] Digital sexual health interventions have the potential to address these disparities by providing targeted and accessible resources to underserved populations.[12] It is necessary for these interventions to be culturally sensitive, inclusive, and tailored to the specific needs of the target population in order to effectively address disparities, improve engagement and outcomes. However, the effectiveness of these services depends on their design and implementation. To ensure that they address both medical and socio-cultural factors that contribute to health disparities, digital services should be co-developed with stakeholders from these communities.[13] If implemented thoughtfully and inclusively, digital sexual health services hold tremendous promise for reducing health inequalities.

Healthcare advancements, especially in the field of automation and artificial intelligence (AI), show great promise for improving sexual health outcomes.[14,15] AI has been rapidly integrated into sexual health, covering areas such as health promotion, identification of individuals in need of PrEP and STI/HIV screening, as well as education on sex, sexuality, and risky sexual practices.[16,17] AI's capabilities extend to improving disease surveillance, detecting anomalies in screening tests, and offering personalised health advice based on individual risk and behavioural patterns.[18] Among conversational AI systems, chatbots, also known as virtual agents or artificial human avatars, have proven to be moderately acceptable for sexual health education and promotion amongst people from MEPS.[19] Unlike static websites, chatbots engage in message exchanges, using natural language processing to understand questions and respond with clinically validated answers. They also employ behavioural algorithms for decision-making, symptom checking, or online triage, enhancing health literacy and support for treatment, screening, counselling, and behaviour change.[20] Such tailoring of information can increase chatbots' cultural competence, making them more relevant and accessible to people from ethnically, culturally, and linguistically diverse communities.

Chatbot-assisted self-assessment (CASA)

Stigma and discrimination can create barriers to accessing necessary healthcare services, which is where conversational AI can be particularly useful. Chatbots can make it easier for people to assess their sexual health needs and encourage more open conversations around sensitive topics, such

as STIs.[21] This could lead to a higher frequency of clinical consultations and uptake of STI screening, compared to traditional face-to-face settings. Chatbots can also facilitate numerous behaviour change techniques to promote healthy habits, while presenting content in multiple translations, thus overcoming language barriers.[22] Chatbots can help with goal setting, self-monitoring and provide personalised feedback, empowering users to better understand and manage their health. By offering emotionally intelligent support and tailored messaging, chatbots can help overcome barriers to STI screening that are experienced by ethnic minorities such as stigma, fear of discrimination and challenges related to language and culture.[23] Additionally, disclosing information to chatbots can motivate some individuals from linguistically diverse groups to access appropriate healthcare services in their language. Meta-analyses indicate a 'question-behaviour effect', where personal and health-related inquiries from chatbots significantly impact behaviour change.[24,25] This suggests that AI systems incorporating conversational techniques could lead to better user reflections and positive health outcomes.

Our previous mixed-methods research identified design principles for a chatbot-based intervention aimed at behaviour change in ethnically diverse communities.[19] The current study aimed to apply CASA principles in the context of ethnic disparities in sexual health outcomes. Our objective was to examine the impact of chatbot conversation on motivation for STI screening as well as understand the attitudes and level of information disclosure to the chatbot.

Method

Design

A within-subject design was used to assess the impact of CASA on intentions for STIs/HIV screening, concern about STIs and a general attitude towards STI screening. While the dependent variable was screening intentions, the independent variables were demographic and behavioural factors related to STI/HIV susceptibility. The study was approved by the University of XXX Research Ethics Committee [ref: XXX]

Participants and recruitment

The study focused on ethnically diverse populations that are likely to be at an increased risk of STIs. Eligible participants were above the age of 18 years, residing in the UK and able to provide informed consent. Those who indicated their residence outside the UK were excluded from the analysis to make the study relevant to the UK healthcare context.

Between December 2022 and July 2023, we used social media platforms, including Twitter, Facebook, Instagram, and Reddit, and employed various handles and hashtags relevant to our study aims, such as “#BlackSexualHealth”. We also advertised our study on Prolific, a platform specifically designed for research participation and data collection. We reached out to student organisations and unions in UK-based universities to circulate our study advert. We distributed paper leaflets and posters across multiple university campuses and halls of residence in London and used an in-person leafleting strategy in public spaces across London with a high representation of people from ethnically diverse communities. We also engaged with 3rd sector organisations such as HIV and sexual health charities to circulate our study advert within their networks. Due to the multi-channel approach to recruitment, we could not record participation rates via each recruitment strategy.

Procedure and measurement

Potential participants could access the study, hosted on Qualtrics, via a URL or QR code. The information page outlined the study aims, including the CASA simulation for sexual health, eligibility criteria and information about optional entry to a prize draw worth £100 for those who completed it. Consent was gathered by ticking a button indicating that participants had understood the nature of the study and their rights. The survey began with demographic questions, i.e. country of residence, age, ethnicity, gender identity and relationship status. Next, participants were asked to indicate their agreement to three statements related to sexual health screening, in particular, their intentions to undergo a sexual health check-up in the next 3 weeks, their concern about STIs and their attitude towards regular sexual health screening. For all survey attitudinal items, seven optional responses ranged from “-3 Strongly disagree” to “0 Neither agree nor disagree” and “+3 Strongly agree”, with higher scores indicating stronger intentions, more concern and positive attitudes.

Afterwards, participants were asked for a nickname combining 4 letters and 2 numbers to link their responses with chatbot conversations. They were given information about CASA and its purpose, including a confidentiality statement. Participants were asked to exit the Qualtrics survey using a link to a platform where the CASA was hosted. There, the chatbot introduced itself and asked users to insert their nickname. Using a conversational approach, it asked users about their age, gender identity, racial identity, ethnic origin and the language they speak at home. Next, it asked behavioural questions such as the last time they had sexual contact (if ever), any current STI symptoms, past STI diagnosis, the gender of their sexual partners, the consistency of condom use, the last time they tested for STIs, and the number of sexual partners since the last STI test. Afterwards, the chatbot informed the users about their eligibility for a free sexual health check-up and asked if they wished to learn more. The last question of the CASA asked whether users wanted to order an STI screening kit, book a check-up appointment, talk to a human operator or visit the Positive East website for more information. Throughout the conversation, the chatbot language used empathic language and explained the purpose of asking these specific questions to promote self-reflection about personal susceptibility to STIs. Users were also given a 'prefer not to say' option to indicate non-disclosure of information.

The chatbot then asked users to complete the Qualtrics survey, which again asked about intentions, STI concerns, and attitudes towards sexual health screening. There were also seven attitudinal questions about CASA related to the ease of use, satisfaction, perceived relevance and usefulness. The participants were then presented with a link to another chatbot called XXX, hosted by leading HIV charity - XXX.[26] This chatbot, which used natural language processing was able to understand user questions and offer further information concerning sexual health and HIV as well as it allowed users to book an STI/HIV check-up appointment directly. Users were able to follow pre-selected questions such as "*Where should I test for HIV or STI?*" or type their questions using a free text box.

Data analysis

Descriptive statistics were first conducted to identify trends in data and check for assumptions. Paired-sample t-tests were conducted to determine the impact of the CASA on intentions

and attitudes towards STI screening and STI concerns. ANCOVA tests were then conducted, with baseline STI screening intentions as a covariate and post-CASA STI screening intentions as the dependent variable. Each demographic and behavioural variable was entered as an independent variable to determine its association with STI screening intentions. Afterwards, the attitude variable 'chatbot is a bad idea' was reversed and seven attitudes towards CASA variables were summed, ranging from -21 to 21. ANOVA tests were performed to identify demographic and behavioural variables associated with positive attitudes towards the CASA. Finally, a phrase count analysis of the Pat chatbot script was used to explore the type and frequency of information about sexual health and HIV that was requested from users and the number of subsequent STI/HIV screening appointments booked.

Public and patient involvement

Throughout the research process, a Public and Patient Involvement (PPI) group played an integral role, being involved at key stages, from the study's co-design to data collection to finalising the research outputs.[27] This engagement ensured that the study reflected real-world perspectives and addressed relevant concerns. The PPI group comprised eight public members from MEGs, representing a diverse cohort. They actively reviewed and validated the study's findings, providing valuable insights into the application of the CASA for sexual health services.

Results

Sample characteristics

A total of 548 participants took part in the study (Table 1). The majority were women, native English speakers, identified as Black, with an average age of 30 years. There were equal proportions of those who were single and in a monogamous relationship. While 10% reported not having had sexual intercourse before, 79% of those sexually active reported having sexual partners of the opposite sex, 45% had sex within the last 2 weeks, 41% had one sexual partner since their last STI check-up, 16% had a previous STI diagnosis, and 32% did not use condoms consistently. Just under

half (47%) had never been tested for STIs. In response to using CASA, just over half (54%) wanted to learn more about STI testing, 44% reported the willingness to order an STI testing kit and 9% to book a sexual health screening appointment. In general, the non-disclosure of information to the chatbot was low across all variables, ranging between 0.5% to 3%, with one exception for the question about condom use (9%).

Impact of CASA on screening motivations

Before the CASA, most participants had not had strong intentions to screen for STIs ($M=-0.96$, $SD=1.97$), had low concerns about STIs ($M=-0.32$, $SD=2.15$) and had positive attitudes towards regular sexual health screening ($M=2.07$, $SD=1.21$). After the CASA, there was a significant positive increase in intentions towards STI screening ($M=0.33$, $SD=2.12$) [$t(547)=-10.3$, $p<0.001$, Cohen's $d=0.63$], a significant increase in concerns about STIs ($M=0.32$, $SD=2.17$) [$t(544)=-4.96$, $p<0.001$, Cohen's $d=0.30$], and a significant increase in positive attitudes towards sexual health screening ($M=2.36$, $SD=1.02$) [$t(543)=-4.36$, $p<0.001$, Cohen's $d=0.26$] (Figure 1).

The analysis revealed statistically significant differences in intentions to screen for STI (Table 2). These increases in intentions were most pronounced amongst those who identified as Asian/Pacific Islander from south/southeastern Asia, had sex in the last 2 weeks, reported having an STI symptom or being unsure, had a history of STI diagnosis, had sex with both men and women, had an STI test within 3 months, had 4 to 5 sexual partners since the last STI screening, and/or were a non-native English speaker. There were no differences in intentions by age, gender identity and relationship status (Figure 2).

Attitudes towards CASA

There were positive attitudes towards the CASA intervention ($M=13.30$, $SD=6.73$, range: -17 to 21, Table 3). Most thought that the chatbot helped them to understand their STI risk and decide whether they needed to undergo STI screening. The majority thought it was easy to use, were satisfied with the intervention and would recommend the chatbot to others like them. Attitudes differed by ethnic identity $F(6, 537)=2.78$, $p=.01$; post hoc comparisons found that those who identified as Asian had significantly more positive attitude scores than black participants. Attitudes did not differ by age group $F(4,542)=2.01$, $p=.09$, gender $F(3,543)=1.64$, $p=0.179$ or relationship status $F(2,538)=1.66$,

$p=.190$. Non-native English speakers had significantly more positive attitudes than native English speakers [$t(545)=-3.08$, $p=.001$]. Attitudes differed significantly by current STI symptoms $F(2,479)=3.13$, $p=.04$, those who were 'not sure' had more positive attitudes than those who had no symptoms. Attitude did not differ by previous STI test $F(3,475)=.617$, $p=.604$, but differed by condom use $F(3,484)=13.66$, $p<.001$, with those who used condoms some of the time having a more positive attitude than those who never used condoms and those who preferred not to say. Those who reported having had 2-3 partners had more positive attitudes than those who had no partners or one sexual partner.

Chatbot script

The analysis of the Pat chatbot showed that out of 1,066 HIV/STI test appointments booked with Positive East, 11% (N-124) were made directly via the chatbot, with 72% of users identifying with MEGs. Overall, 42% of chatbot users searched for information about STI/HIV testing, 15% wanted to understand '*when to test for STI/HIV*', 12% suspected having an STI and needed more information, and less than 5% searched for information about Mpox, contraception, HIV pre-and post-exposure prophylaxis, specific STI symptoms, test results, STI treatment and condoms, respectively.

Discussion

Findings indicate that chatbot-assisted self-assessment had a positive impact on the motivation to screen for STIs in ethnically diverse communities. Chatbot that imitates sexual history-taking and explains the purpose of each question can increase concerns about STIs, create positive attitudes and encourage intentions for sexual health screening in those more susceptible to STIs/HIV. The intervention was also well-received, indicating high acceptability. Additionally, data from the Pat chatbot showed that booking screening appointments through this technology is an acceptable way of accessing relevant healthcare services such as sexual health education and screening. Our simulation study provides evidence on the feasibility and effectiveness of conversational AI technology for sexual health and its potential to reduce health inequalities among ethnic minority populations.

There are several explanations for these observations. The CASA provides a non-judgmental and anonymous space for individuals from MEGs to share relevant information about personal sexual behaviour without fear of judgment, which may be present in face-to-face interactions.[17] Similarly, the intervention ensures consistency in the way information is presented, regardless of the user's ethnicity or background. This standardisation can help avoid unintentional biases or cultural insensitivities that might occur in human interactions. The CASA was designed to adapt its language, tone, and content in an inclusive way reflective of various cultural backgrounds, which was incorporated in our two-question approach about ethnic identity and origin, making the interaction more relatable.[19] Participants who were not native English speakers showed a higher intention to get screened for STIs, compared to those who were native English speakers, suggesting that CASA might be helpful for individuals who experience language barriers when accessing healthcare services.[28] By creating a private and confidential environment to discuss STIs and sexual health, chatbots could potentially reduce the stigma associated with these health topics.[29] This could help individuals feel more comfortable seeking screening services. Additionally, CASA was designed to provide instant feedback and information based on the responses given by the user. This immediacy could encourage self-reflection and help educate individuals about their risks and the importance of STI screening right when they might be most receptive.[30,31] The CASA intervention, in combination with a chatbot for sexual health information and booking STI screening, could allow users to reduce indecisions about STI testing and nudge them to seek appropriate services.

The largest increase in the intention for STI screenings was observed in those who had been previously diagnosed with an STI, had a higher number of sexual partners, reported inconsistent condom use as well as those who had sex with both men and women. Conversely, the STI screening intentions were the lowest amongst participants who had never had sex before or reported 'zero' sexual partners since the last STI check-up. The results indicate that automated history-taking via chatbot can reduce indecision for STI screening in those at higher risk of STIs, while this effect does not seem to occur for people who are at lower risk of STIs. This supports previous research showing that computer-assisted self-interview sexual history improved detection of STIs.[32] Also, this may be due to the 'question-behaviour effect' in which the act of questioning users about their sexual health

per se could be a cue to action for seeing STI screening.[25]. Also, the sex-positive and encouraging language of the chatbot could remind users about their eligibility for STI screening, instead of focusing on their risk of STIs and associated stigma.[33] By asking demographic and behavioural questions, chatbots can subtly educate users about risk factors and the importance of screening, leading to increased awareness and motivation to get screened. Many people from MEGs are still unaware of different ways they can test for STIs/HIV, including remote STI testing kits and community-based testing as part of a charity outreach.[34] Additionally, repeated interaction with e-health interventions such as chatbots about sexual health could normalise the topic, reducing associated fears and stigmas.[35] Positive reinforcement and affirmations from chatbots can bolster an individual's self-worth and confidence, making them more likely to take positive health actions.[36] Therefore, the chatbot might have raised their awareness about various services available to them, which was reflected in their willingness to learn more about sexual health.

The large majority of the participants were willing to disclose demographic and sensitive information to the chatbot, confirming our expectations.[19] There was a relatively higher rate of non-disclosure to the question related to condom use. This could be due to the ambiguity surrounding the appropriate response for individuals who are not sexually active or are in a monogamous relationship. Therefore, this question requires further development to eliminate any potential uncertainty. Nevertheless, such high levels of disclosure to chatbots have been reported in previous studies, suggesting that by interacting with a chatbot, the pressure to conform to social norms or to give answers deemed "acceptable" might be reduced. Chatbots' lack of emotions or anticipated biases may lead to more candid responses.[37]

Limitations and further implications

The CASA intervention was created with input from diverse groups, which may explain why it was well-received in this study and has the potential for broader use. One of the study's strengths was the application of two chatbot services: the anonymous CASA and the confidential Pat, which was able to answer additional questions about STI testing and book appointments automatically, making sexual health services more accessible. Our previous research indicated that users were more willing to discuss their sexual behaviours if chatbots were anonymous. As a result, we implemented a

two-chatbot design; however, due to technical and ethical issues, it was not feasible to trace an individual user's journey from the automated sexual history taking to the STI screening test results. Thus, we were unable to report the impact of chatbots on appointment booking and uptake of sexual health screening, that goes beyond motivations and intentions. Nevertheless, our simulation study provides insights into the ecological validity of this intervention. Users from a wide spectrum of STI susceptibility can discuss their sexual health with chatbots, making the findings more generalisable in a wider context. Future randomised controlled trials are needed to understand the impact of the CASA on uptake of screening and overall STI/HIV rates in MEGs.

We used a within-subject design to examine the effect of CASA on individuals' motivation to undergo STI screening. However, carryover effects may confound the results, as participants' responses may be influenced by their previous experiences of the three measurements.[36] Despite this, the results showed that those who were not sexually active reported reduced STI screening intentions, indicating minimal impact of such effects. Although a wide range of recruitment methods, e.g. online and community-based, were used in the study to reach 'seldom heard' populations susceptible to STIs and HV, the recruitment process raises concerns about potential selection bias as the participants were mainly sourced from social media channels and locations, which may not represent the broader UK population. However, the rate of those who had never tested for STIs in our sample is comparable to rates seen in the UK, indicating the potential representativeness of the findings.[39] Also, using chatbot interventions may make it difficult to reach the most underserved groups that lack access to technology or the Internet. Future research should address this digital divide to ensure all populations can access AI-powered interventions. Additionally, self-reported data may be subject to social desirability bias, which may affect the accuracy of the results.[40] Nevertheless, this bias may be less relevant in digital interventions where concerns about human judgement are eliminated. Lastly, the study was not designed to track actual behaviour post-intervention, which limits the ability to draw causal inferences regarding the impact of CASA. Therefore, future research should focus on providing evidence of the impact of CASA on individual motivation, behaviour, and STI screening uptake.

The evidence that CASA can enhance motivation for STI screening highlights the importance of leveraging technological advancements to address health inequalities. The chatbot's ability to mimic sexual history-taking and articulate the rationale behind each query appears to have the effect of increasing concern about STIs and fostering positive attitudes, which are essential precursors to action in health-seeking behaviours. Notably, the increased intention to engage in sexual health screening amongst those susceptible to STIs/HIV suggests that such digital interventions could be particularly effective in targeting at-risk populations. The study's finding of high acceptability and the preference for booking appointments through conversational AI suggests that such technologies can play a crucial role in facilitating easier access to healthcare services. This aligns with the wider digital transformation of healthcare and points towards a future where AI augments healthcare provision to meet diverse patient needs.

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Data availability statement

Data supporting the findings of this study are available from the corresponding author, Dr Tom Nadarzynski, upon reasonable request. Due to privacy and ethical restrictions, the dataset cannot be made publicly available. Interested researchers may contact t.nadarzynski@westminster.ac.uk with requests for data access, which will be considered in line with the study's ethical approval stipulations and in compliance with applicable data protection regulations.

Conflict of interest statement

The authors declare no conflicts of interest.