Norms and Correlations of the Visually Induced Motion Sickness Susceptibility Questionnaire Short (VIMSSQ-short)

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Abstract

The short version of the Visually Induced Motion Sickness Susceptibility Questionnaires (VIMSSQ-short) was designed to estimate an individual's susceptibility to motion sickness caused by exposure to visual motion, for instance when using smartphones, simulators, or Virtual Reality. The goal of the present paper was to establish normative data of the VIMSSQ-short for men and women based on online surveys and to compare these results with findings from previously published work. VIMSSQ-short data from 920 participants were collected across four online surveys. In addition, the relationship with other relevant constructs such as susceptibilities to classic motion sickness (via the Motion Sickness Susceptibility Questionnaires [MSSQ]), Migraine, Dizziness, and Syncope, was explored. Normative data for the VIMSSQ-short showed a mean score of $M = 7.2$ (standard deviation [SD] = 4.2) and a median of 7, with a good test reliability (Cronbach's alpha = 0.80). No significant difference between men and women showed. The VIMSSQ-short correlated significantly with the MSSQ ($r = 0.55$), Migraine ($r = 0.48$), Dizziness ($r = 0.35$), and Syncope ($r = 0.31$). Exploratory factor analysis of all variables suggested two latent variables: nausea-related and oculomotor-related. Norms for this study were consistent with the only other large online survey. But average VIMSSQ-short values were lower in smaller studies of participants volunteering for cybersickness experiments, perhaps reflecting self-selection bias. The VIMSSQ-short provides reliability with efficient compromise between length and validity. It can be used alone or with other questionnaires, the most useful being the MSSQ and the Migraine Screen Questionnaire.

Keywords

Motion sickness, visually induced motion sickness, cybersickness, norms, sex, age, migraine, dizziness

1. Introduction

Motion sickness is a common sensation caused by real (e.g., ship, bus, aircraft) or apparent (e.g., video games, Virtual Reality) motion, with the latter often referred to as visually induced motion sickness (Keshavarz and Golding, 2022). Both classic motion sickness and visually induced motion sickness (VIMS) share many similarities and are characterized by a variety of symptoms such as nausea, headache, dizziness, or fatigue. However, vomiting is more common during classic motion sickness, whereas oculomotor discomfort such as eye strain, blurred vision, or difficulty focusing are more prominent during VIMS (Bronstein *et al.*, 2020; Cha *et al.*, 2021). The underlying mechanisms of classic motion sickness and VIMS

are not fully understood, but a sensory mismatch between the visual, vestibular, and/or proprioceptive systems, and also intravestibular mismatches, has been assumed to result in motion sickness/VIMS, when this conflict is not expected and does not match previous experiences (Benson, 2003; Reason and Brand, 1975). Additionally, the roles of postural stability (Riccio and Stoffregen, 1991) or eye movements (Ebenholtz, 1992) as well as an evolutionary approach (Bowins, 2010; Treisman, 1977), have been considered in the context of classic motion sickness and VIMS (see Golding, 2016 and Keshavarz *et al.*, 2014, for overviews).

An individual's susceptibility to motion sickness and VIMS is determined by many factors (Golding, 2006). Besides technological features such as motion profile (Diels and Howarth, 2013; McCauley *et al.*, 1976) or the size of the visual field of view (Adhanom *et al.*, 2020; Bos *et al.*, 2010), various individual characteristics have been linked to motion sickness/VIMS susceptibility. For instance, it has been often mentioned that women report more severe motion sickness and VIMS compared to men, even though the empirical evidence for biological sex as a factor remains inconclusive (see Lawson, 2014, for an overview). Large-scale surveys have suggested that female passengers on cruise ships reported more severe nausea and have a higher risk of vomiting compared to male passengers (Besnard *et al.*, 2021), a finding that was replicated under laboratory conditions in some studies (e.g., Flanagan *et al.*, 2005) but failed to emerge in others (e.g., (Stanney *et al.*, 2020). In addition to biological sex, it has been demonstrated that age is a prominent factor for classic motion sickness, with susceptibility peaking between the ages of 8–10 years and decreasing during adulthood (Paillard *et al.*, 2013). With regards to VIMS, a late peak in susceptibility in older adults (65+ years) has been reported (Brooks *et al.*, 2010; Keshavarz *et al.*, 2018), but recent evidence suggested that this late peak might not be robust under all VIMS-inducing scenarios (Dilanchian *et al.*, 2021). Other individual characteristics that have been studied in the context of motion sickness/VIMS susceptibility included personality traits, anxiety, visual field dependence, or fitness level, although the impact of these factors on motion sickness/VIMS susceptibility remains somewhat vague (see Keshavarz and Golding, 2022). Given the various factors associated with motion sickness and VIMS, estimating an individual's susceptibility to motion sickness/VIMS remains challenging.

The Motion Sickness Susceptibility Questionnaires (MSSQ) (Golding, 2006), sometimes called motion history questionnaires, predict individual differences in motion sickness susceptibility based on previous experiences. That is, the MSSQ was optimised for classic motion sickness provoked by transport motion in boats, cars, planes, etc. Based on an individual's tendency to experience motion sickness in the past, a likelihood of experiencing motion sickness in future situations can be estimated. The MSSQ has become the standard tool for measuring motion sickness susceptibility and is widely adopted by many researchers.

Since the MSSQ was particularly designed to measure the susceptibility to classic motion sickness, it may have limited applicability for VIMS-inducing situations (in fact, questions pertaining to VIMS were purposefully removed from the MSSQ during its original composition). The increasing use of visual technologies prompted us to develop a questionnaire optimised for predicting intrinsic individual differences in susceptibility to VIMS, the Visually Induced Motion Sickness Susceptibility Questionnaire (VIMSSQ). We have produced the 67-item long version of the VIMSSQ (Keshavarz *et al.*, 2019, 2023) as well as a short, six-item version of the VIMSSQ (Golding *et al.*, 2021). Both scales were developed in parallel and have their strengths and weaknesses. On the one hand, the VIMSSQ-long provides detailed information on exposure to a wide variety of potentially provocative visual environments and the estimated susceptibility for different symptoms in each environment. On the other hand, the VIMSSQ-short lacks this detailed information on experiences of visual environments but has the great practical advantage of being quick to complete. Both scales have been validated in experimental studies and showed good correlations with VIMS severity under laboratory conditions (Keshavarz *et al.*, 2019, 2023; Golding *et al.*, 2021). In the following, we will focus exclusively on the VIMSSQ-short.

The VIMSSQ-short is a relatively new scale; as such, only limited empirical data are available to date. Importantly, normative values have not yet been fully defined, although provisional norms have been proposed in our previous work (Lukacova *et al.*, 2023). Thus, the present study had three aims: (i) first, we aimed to provide normative data for the VIMSSQ-short based on a pooled dataset collected from a large online study; (ii) second, we aimed to further explore associations between VIMS susceptibility and other related factors including migraine, dizziness and syncope susceptibility; and (iii) lastly, to compare the

normative data of the VIMSSQ found in this study with existing and published data on the VIMSSQ-short conducted by other researchers.

2. Methods

2.1. Participants and Contributing Samples

To estimate norms for the VIMSSQ-short, we collected data via anonymous online surveys using Qualtrics across various projects. These data were then combined to form a pooled dataset. The contributing data to this pooled dataset came from three surveys that were presented at various meetings, including works by Golding and Jahanara (2022) with n = 90, Tsang and Golding (2022) with n = 108, and Ignatova and Golding (2024) with n = 282, as well as from a published study by Lukacova *et al.* (2023) with n = 440. Thus, the pooled dataset included a total sample size of N = 920 participants, with a mean age of M = 34.24 (SD = 13.01) years and an age range of 18–90 years. The sample was composed of 543 female and 377 male participants. All contributing data were from studies which had been approved by the Psychology Ethics Committee of the University of Westminster, London, United Kingdom.

2.2. Comparative Independently Published Data

Since the VIMSSQ-short is a relatively new questionnaire, empirical data for the VIMSSQ-short are relatively limited. To compare the norms from our pooled sample with existing data, we identified six relevant studies that were published using the VIMSSQ-short and reported normative data. These studies included works by, Doty *et al.* (2024), Golding *et al.* (2021) (see Note 1), Kelly *et al.* (2024), Papaefthymiou *et al.* (2024), Ugur (2023) and Umatheva *et al.* (2024).

2.3. Questionnaires

In addition to the VIMSSQ-short, which was included in all online surveys, a variety of other questionnaires were administered to investigate their relationship with (and their efficacy for predicting) VIMS

susceptibility as assessed by the VIMSSQ. Note that for Tsang and Golding (2022) the VIMSSQ-short data were collected but not the MSSQ-short, Migraine, SWID, Syncope. In detail, these questionnaires included:

VIMSSQ-short. The short form of the Visually Induced Motion Sickness Susceptibility Questionnaire VIMSSQ (Golding *et al.*, 2021) is a six-item short version of the VIMSSQ (Keshavarz *et al.*, 2019, 2023) (see Appendix [Note 2]). It was developed to capture individual susceptibility to VIMS and was designed with the expectancy that it would be used in conjunction with the MSSQ as a supplement for circumstances when VIMS is anticipated. The VIMSSQ-short enquires about the frequency of five different symptoms (nausea, headache, fatigue, dizziness, eye strain) as well as possible consequent avoidance when using a variety of visual devices and displays (e.g., smartphone, movie theatre, video games, tablets, Virtual Reality glasses, etc.). Each item is scored on a four-point rating scale ranging from 0 (Never) to 3 (Often). The VIMSSQ total score is calculated by the addition of all item responses, resulting in a possible maximum score of 18. Higher scores on the VIMSSQ-short indicate a stronger susceptibility to VIMS.

MSSQ-short. The short form of the Motion Sickness Susceptibility Questionnaire MSSQ-short (Golding, 2006) was used to assess the participants' susceptibility to classic motion sickness from physical motion. The MSSQ-short enquires about the participants' previous experiences of motion sickness when using nine different modes of transportation (e.g., boat, car, bus, plane) or amusement rides (e.g., funfair rides). Participants rated the frequency of experiencing motion sickness for each item on a scale from 0 (Never) to 3 (Often). They can also indicate if they never used or experienced the respective item. The MSSQ-short has two sections, one asking about childhood experiences before the age of 12 (MSSQ Child) and one asking about experiences during adulthood over the last 10 years (MSSQ Adult). A raw score of the whole MSSQ-short scale can be calculated and, if required, can be translated into percentile scores based on the population norms reported in Golding (2006). Higher scores indicate a stronger susceptibility to motion sickness. The MSSQ was applied in all surveys.

Migraine Screen Questionnaire. The Migraine Screen Questionnaire (Láinez *et al.*, 2010) consists of five items that are rated on a binary scale (0 = No, 1 = Yes) in order to measure the participants' tendency to experience migraines. Items include, for instance, the person's experience of frequent or intense

headaches and the duration of those. A total score can be calculated by summing together the value of each item (maximum score = 5). Higher scores indicate a greater likelihood of migraines.

SWID. The Social Life and Work Impact of Dizziness questionnaire (SWID) (Bronstein *et al.*, 2010) consists of four items. It measures the negative impact of dizziness on everyday activities. The SWID consists of four social, travel, family, and work-related questions, and has been validated in patient and control samples. Responses are rated on a binary scale (0 = No, 1 = Yes) and a summed total score (maximum score = 4). Higher scores indicate greater probability of being affected by dizziness.

Syncope. The single-item Syncope question measures the participants' tendency to experience vasovagal syncope (Golding and Patel, 2017). Participants indicate how often they experience the feeling of faintness (e.g., if stressed, in pain, or sighting blood). This single-item question was adapted from Bosser *et al.* (2006). Higher scores indicate a more frequent tendency to syncope.

2.4. Data Analysis

Results were analysed using SPSS 28.0 (IBM®). Descriptive data, correlations (Pearson and non-parametric), exploratory factor analysis, and linear regression were employed. For all statistical analyses, the significance level was set a priori to $\alpha = 0.05$. Where statistical tests could be directional, the significances were two-tailed. The sample size for correlational analysis was reduced due to some missing data and since some questionnaires were not measured in all contributing data. The minimum sample size for listwise correlations in multivariate analyses had a reduced $n = 772$.

3. Results

3.1. Normative Data for the VIMSSQ-short

Table 1 shows the descriptive statistics of the VIMSSQ-short for our pooled dataset. The mean total score for the VIMSSQ-short was $M = 7.2$ (SD = 4.2) with a median score of 7.0 (25th percentile = 4.0 and 75th percentile = 10.0). See the Supplementary Material for item scores. Figure 1 illustrates the distribution of the

VIMSSQ-short data for the pooled dataset. Reliability was good with a Cronbach's alpha = 0.80. Table 2 shows the present results and comparative data from other published studies.

Table 1.

Descriptive statistics for the VIMSSQ-short separated by biological sex.

	M	SD	Range	P10	P25	Med	P75	P90
All	7.22	4.21	0-18	1	4	7	10	12
Female	7.41	4.61	0-18	2	5	8	10	12
Male	6.93	3.90	0-18	1	3	7	10	13

Note. Med = median, P10 = 10th percentile, P25 = 25th percentile, P75 = 75th percentile, P90 = 90th percentile.

Table 2.

Descriptive statistics for the VIMSSQ-short (separated by biological sex) for the pooled dataset of the present study and for other available published studies.

				VIMSSQ-short *M* (*SD*)		
Study	**Context**	***N***	**Age *M* (SD)**	**All**	**Male**	**Female**
Present study	Online survey (UK)	920	34.24 (13.01)	7.22 (4.21)	6.93 (4.61)	7.41 (3.90)
Umatheva *et al.*, 2024[1]	Online survey (Canada)	711	21.21 (4.73)	7.91 (3.65)	6.18 (3.14)	8.39 (3.64)
Papaefthymiou *et al.*, 2024	VR experiment (Greece)	47	27.4 (5.78)	3.47 (4.41)	*n/a*	*n/a*
Kelly *et al.*, 2024[2]	VR experiment (USA)	201	19.0 (1.1)	3.60 (2.47)	3.10 (2.26)	4.37 (2.54)
Doty et al,, 2024	VR experiment (USA)	103	19.2 (1.4)	4.0 (2.6)	*n/a*	*n/a*
Ugur, 2023[2]	In-person survey (Turkey)	49	22.12 (5.71)	5.24 (4.25)	4.07 (3.04)	5.71 (4.59)
Golding *et al.*, 2021	VIMS experiment (UK)	30	22.90 (5.03)	4.87 (4.06)	4.40 (4.38)	5.10 (3.99)

Notes: [1]Additional VIMSSQ separated by biological sex provided via *personal communication* from Emel Ugur, 5 May 2024.
[2]Values for VIMSSQ-short separated by biological sex averaged from published table.

-(Insert Fig 1 around here) -

3.2. Confirming the Factor Structure of the VIMSSQ-short

In line with our previous work, exploratory factor analysis of the VIMSSQ-short (n = 920) revealed only a single factor (Table 3).

Table 3.

Exploratory factor analysis of the six VIMSSQ-short items revealing a single factor.

VIMSSQ item	*Factor loading*
Nausea	0.73
Headache	0.75
Dizziness	0.73
Fatigue	0.67
Eye strain	0.66
Avoidance	0.71

When adding the variables MSSQ-short, Migraine susceptibility, SWID, and Syncope to the factor analysis (n = 772), a two-factor structure was revealed following an Oblimin rotation calculation (Table 4). The two latent variables might be termed *Nausea-related discomfort* (Factor 1) and *Oculomotor-related discomfort* (Factor 2), explaining 40.4% and 12.1% of the variance, respectively. The orthogonal and oblique rotated solutions were similar, with the oblique solution producing a somewhat more distinct pattern of factor loadings (see Supplementary Material for more details).

Table 4.

Oblique Rotated Component Matrix for all dependent variables revealing a two-factor solution.

VIMSSQ item	*Factor 1*	*Factor 2*
Nausea	0.60	
Headache		−0.66
Dizziness	0.49	
Fatigue		−0.75
Eye strain		−0.84
Avoidance		−0.54
MSSQ	0.54	
Migraine (score)	0.53	
SWID (score)	0.79	
Syncope (score)	0.74	

Note: Loadings < 0.40 not shown for clarity. Oblimin rotation with variances of 40.4% (Factor 1) and 12.1% (Factor 2).

3.3. Relationship of the VIMSSQ-short with Other Variables

3.3.1. VIMSSQ-short, Age, and Sex

In the pooled dataset, female participants (M = 7.4, SD = 3.9) reported slightly higher mean VIMSSQ-short scores than male participants (M = 6.9, SD = 4.6), but differences were not statistically significant as indicated by a t-test (t_{918} = 1.696, p = 0.09, two-tailed, Cohen's d = 0.11). Across all participants, VIMS susceptibility declined slightly with increasing age (r = −0.12, p < 0.001). Interestingly, when these data were grouped into age groups, there appeared to be an increase in older adults (70+ years). However, the sample size in this older group was quite low, which increased the associated 95% CI (see Figure 2).

-(Insert Fig 2 around here) -

3.3.2. VIMSSQ-short, MSSQ, Migraine, Dizziness, and Syncope

The VIMSSQ-short correlated significantly (*p*s < 0.001) with the MSSQ-short (*r* = 0.55), the Migraine Screen Questionnaire (*r* = 0.48), SWID (*r* = 0.35), and Syncope (*r* = 0.31). Detailed results are shown in Table 5 (with age and sex included for completeness). Figure 3 shows a scatterplot illustrating the correlation between the VIMSSQ-short and the MSSQ-short.

Table 5.

Bivariate correlations (*r*) of the VIMSSQ total score with other variables.

Variable	***N***	**Pearson *r* (Spearman *r*)**	***p***
MSSQ total score	789	0.55 (0.54)	0.001
Migraine Screen score	801	0.48 (0.48)	0.001
SWID score	797	0.35 (0.38)	<0.001
Syncope score	795	0.31 (0.31)	<0.001
Age (years)	920	−0.12 (−0.15)	<0.001
Biological sex	920	0.06 (0.07)	0.090

Note: n varies since some variables were not measured in all contributing datasets.

-(Insert Fig 3 around here) -

Correlations between the VIMSS-short and the MSSQ-short from previous studies are given in Table 6. All correlations were reported as highly significant. However, there were variations between studies, ranging from *r* = 0.26 to 0.63, with an overall median correlation of approximately *r* = 0.40.

Table 6.

Correlations (*r*) between the VIMSSQ-short and the MSSQ-short in this study and in other available studies.

Study	*N*	Correlation statistic	*r*
Present study[1, 2]	789	Pearson	0.55

Umatheva *et al.*, 2024	711	Spearman	0.42
Papaefthymiou *et al.*, 2024[3]	47	Pearson	0.26
Kelly *et al.*, 2024	201	Pearson	0.44
Doty *et al.*, 2024	103	Pearson	0.41
Ugur, 2023	49	Spearman	0.63
Golding *et al.*, 2021	30	Pearson	0.38

Notes: [1]Reduced *N* of 789 from 920 due to missing data for the MSSQ-short in one contributing dataset.

[2]Equivalent Spearman correlation $r = 0.51$.

[3]Bivariate correlation by *personal communications*, the equivalent Spearman correlation was $r = 0.32$.

3.4. Multiple Linear Regression

Multiple linear regression models, using both general and stepwise approaches, were employed to identify those variables best able to predict the VIMSSQ-short. The most efficient model (multiple $R = 0.65$, adjusted $R^2 = 0.41$, $F_{6,764} = 91.12$, $p < 0.001$) included the predictors MSSQ ($\beta = 0.39$, p < 0.001), Migraine ($\beta = 0.28$, $p < 0.001$), Age ($\beta = -0.10$, $p < 0.001$), SWID ($\beta = 0.09$, $p < 0.01$), Syncope ($\beta = 0.08$, $p < 0.05$) (see Figure 4). Sex was not significant. Perusal of the full correlation matrix indicated that the variables Syncope and SWID had much lower contributions than might be expected from their bivariate correlations with the VIMSSQ-short. Examination of the correlation matrix suggested that this was due to multicollinearity (i.e., SWID and Syncope correlated with the dominant predictors MSSQ and Migraine). Despite showing a relatively weak bivariate correlation with the VIMSSQ (see Table 5), age did not drop out from the model. This indicated that age did contribute significant unique predictive power.

-(Insert Fig 4 around here) -

4. Discussion

The goals of the present study were threefold: We aimed to (1) provide normative data for the VIMSSQ-short, (2) to compare these findings with previously published data, and (3) to explore associations with other relevant variables. The mean score for the VIMSSQ score was 7.2 across all participants with a median score of 7. No significant differences between sexes showed, but negative correlations with age suggested a decline of VIMS susceptibility with age. Additionally, high correlations with the susceptibility to classic motion sickness, dizziness, migraine, and syncope were found. We will discuss these findings in more detail in the following sections.

4. 1. VIMSSQ Norms and Factor Structure

Overall, the mean VIMSSQ-short scores across all participants found in the present study closely resembled norms reported by another large-scale survey by Umatheva *et al.* (2024). Both of these studies were comprised of online surveys with large sample sizes, and both used anonymous online reporting which tends to encourage truthful responding. However, when compared to VIMSSQ scores obtained from experimental studies or an in-person survey, lower mean n data could be due to a degree of self-selection in the experimental studies. That is, individuals who are very susceptible to VIMS tend not to volunteer for such experiments knowing that they will be exposed to provocative stimuli. The distribution of the VIMSSQ-short scores was continuous but not normal, with a cluster of individuals reporting very low susceptibility scores. At present, the best normative estimate would appear to be a mean and median VIMSSQ-short score of around 7 for both sexes combined.

Factor analysis of the VIMSSQ-short revealed only one factor, which was consistent with the high Cronbach's alpha of 0.8 and supports the previous results (Golding *et al.*, 2021). However, Ugur (2023), albeit on a relatively small sample, suggested the existence of two factors in the VIMSSQ-short. Given this observation, we conducted an exploratory factor analysis on the six items of VIMSSQ-short while including the correlated variables MSSQ-short, migraine susceptibility, dizziness susceptibility, and syncope susceptibility. This exploratory analysis revealed a two-factor structure and, based on the item loadings, these two latent variables could be described as nausea- related (Factor 1) and oculomotor-related (Factor 2), being

reminiscent of the two-factor structure for the SSQ proposed by Bouchard *et al.* (2021). Perhaps the most interesting and original aspect of the solution found here concerns headache and migraine susceptibility. One might expect them both to load preferentially onto the Oculomotor factor, but our results suggest otherwise. That is, migraine susceptibility loaded on the nausea factor which comprises of those aspects concerning classic motion sickness susceptibility. However, the headache item of the VIMSSQ-short loaded on the oculomotor factor. It seems that the mechanisms underlying migraine susceptibility are more related to nausea and dizziness, whereas headache in the context of VIMS is more a reflection of those visual stimulus-specific mechanisms related to symptoms such as eye strain. The avoidance item of the VIMSSQ-short loaded across both the nausea and oculomotor factors, but the relationship was stronger with the oculomotor factor. From this perspective, it could be argued that the oculomotor-related symptoms such as eye strain and headache may have a much greater role in reducing or even preventing usage of new visual technologies, rather than nausea *per se*.

4. 2. The Roles of Sex and Age on VIMS Susceptibility

The role of biological sex has been frequently investigated for classic motion sickness and for VIMS. A frequent finding has been that women tend to be more susceptible than men to motion sickness, although many studies have failed to find such differences (see Lawson, 2014; Lawson and Bolkhovsky, 2023, for overviews). In the present study, women tended to be slightly more susceptible in terms of higher VIMSSQ-short scores, but this difference was not statistically significant. In contrast, the other published studies using the VIMSSQ-short, including the large survey by Umatheva *et al.* (2024) suggested a more consistent and significant pattern of higher scores in women. However, taking together these findings, it appears that any greater susceptibility in women may be relatively small and may be estimated as around one to two points of the VIMSSQ scale.

Over the whole lifespan, age differences in motion sickness susceptibility are greater than sex differences. Infants and very young children are relatively immune to classic motion sickness (Huppert *et al.*, 2019), with susceptibility peaks around 9 to 10 years and a subsequent decline of susceptibility during the

teenage years towards adulthood, probably due to habituation (Bronstein *et al.*, 2020; Reason and Brand, 1975). Fewer data are available on VIMS susceptibility and age; it has been suggested that children might be less susceptible to VIMS (Tychsen and Foeller, 2020), but this assumption is challenged by studies finding similar VIMS reports between children and adults (Chang *et al.*, 2021). In addition, a potential peak in VIMS susceptibility later in life has been indicated by some studies (Brooks *et al.*, 2010; Keshavarz *et al.*, 2018), but, again, this finding remains controversial (Saredakis *et al.*, 2020). In this study, VIMSSQ-short scores in adults declined to a small but significant extent with age, mirroring the findings from classical motion sickness. However, when the data were segmented by age groups, a potential increase in older adults aged 70+ years showed, but the interpretation of this finding is strongly limited by the small sample size in this age group. Unfortunately, the data from other published work did mainly focus on younger, healthy adults, not allowing to draw meaningful comparisons across age groups. It is worth noting that the relationship between age and VIMS may be complicated by the role of several influences, some synergistic and others opposing (see Golding *et al.*, 2021). For instance, people become more visually dependent with increasing age for spatial orientation and balance, as they reduce reliance on vestibular and proprioceptive inputs (which often become less reliable with ageing). In addition, older adults may have had less experience and opportunity to habituate to newer visual technologies. These two influences should increase the susceptibility to VIMS. At the same time, the opposing factor is that overall motion sickness susceptibility to physical motion is known to decline with age (with individual variation). The investigation of VIMS susceptibility in older age merits further investigation.

4. 3. Other Individual Characteristics and VIMS Susceptibility

A number of other individual characteristics correlated significantly with the VIMSSQ-short, the most commonly studied being the MSSQ-short. The correlation between the VIMSSQ-short and the MSSQ-short was high in the present study and for the other published studies (ranging from medium to high). This correlation between VIMSSQ-short and the MSSQ-short was to be expected, since VIMS and classic motion sickness share the same core symptomatology of gastrointestinal and autonomic responses (see Cha *et al.*,

2021). However, these correlations also indicated that there was much unshared variation. In other words, the susceptibility to VIMS does not fully overlap with the susceptibility to classic motion sickness. This reflects the observation that they are similar but not identical phenomena. The moderately strong correlations between the VIMSSQ-short and dizziness impact on general quality of life (SWID) can be explained by the importance of symptoms such as dizziness and vertigo for VIMS.

Associations between migraine susceptibility with both VIMS and classic motion sickness have long been noted (Abouzari *et al.*, 2020; Golding and Patel, 2017; Grunfeld and Gresty, 1998). The results of this study were in accordance with these previous findings and suggest that VIMS, classic motion sickness, and the tendency to experience migraines are positively linked with each other. The mechanism underlying this relationship remains unknown; various suggestions include that it may be due to altered serotonergic system functioning or alternatively defective functioning of calcium ion channels (Golding, 2016). Regardless of the exact mechanism, migraine appears to share underlying genetic factors with motion sickness susceptibility (Hromatka *et al.*, 2015). The significant association of syncope susceptibility with VIMSSQ-short supports the notion that autonomic reactivity may be an additional factor in motion sickness susceptibility, consistent with previous findings with classic motion sickness both from physical motion sources (Bosser *et al.*, 2006) and when provoked by visual stimuli (Golding *et al.*, 2021).

4. 4. Limitations and Future Research

This study had a number of limitations. Although susceptibility decreased with age overall, the sample was underrepresented in the older age groups. Consequently, whether or not there may be a reversal of this trend in older age remains uncertain. Equally, any changes in susceptibility in younger age groups less than 18 years remains unexamined, and this topic deserves further attention. Possible differences in susceptibility between ethnic groups were not addressed but could be of interest, too. Finally, the predictive validity of the VIMSSQ-short was not examined in the present paper; however, this will be addressed in a separate publication, both with new data and comparisons with published studies.

5. Conclusion

In conclusion, the six-item VIMSSQ-short provides reliability with an efficient compromise between length (reduced time cost) and validity (predicted VIMS susceptibility). It is useful to predict individual susceptibility to VIMS. It can be used alone or with other questionnaires, the most useful being the MSSQ-short and the Migraine Screen.

Note

1 The data from Golding *et al.* (2021) were not included in the pooled sample since the study did not use an anonymous online survey but contained a laboratory motion sickness experiment.
2 This appendix includes the actual questionnaire, scoring procedure and percentiles of the VIMSSQ-short, offering rapid access to a quick 'stand-alone' document for practical use.

References

Abouzari, M., Cheung, D., Pham, T., Goshtasbi, K., Sarna, B., Tajran, S., Sahyouni, S., Lin, H. W. and Djalilian, H. R. (2020). The relationship between vestibular migraine and motion sickness susceptibility, *Otol. Neurotol.* **41**, 1116–1121. DOI: 10.1097/MAO.0000000000002705.

Adhanom, I. B., Griffin, N. N., MacNeilage, P. and Folmer, E. (2020). The effect of a foveated field-of-view restrictor on VR sickness, in: *2020 IEEE Conference on Virtual Reality and 3D User Interfaces (VR)*, Atlanta, GA, USA, pp. 645–652. DOI: 10.1109/VR46266.2020.00087.

Benson, A. (2003). *Medical Aspects of Harsh Environments, Vol. 2, Ch. 35, Motion Sickness*. https://www.semanticscholar.org/paper/Medical-Aspects-of-Harsh-Environments%2C-Volume-2%2C-Sickness-Benson/597fc4bb6f50e51665cb64e743a8badd0ffd5178.

Besnard, S., Bois, J., Hitier, M., Vogt, J., Laforet, P. and Golding, J. F. (2021). Motion sickness lessons from the Southern Ocean, *Aerospace Med. Hum. Perform.* **92**, 720–727. DOI: 10.3357/AMHP.5696.2021.

Bos, J. E., de Vries, S. C., van Emmerik, M. L. and Groen, E. L. (2010). The effect of internal and external fields of view on visually induced motion sickness, *Appl. Ergon.* **41**, 516–521. DOI: 10.1016/j.apergo.2009.11.007.

Bosser, G., Caillet, G., Gauchard, G., Marçon, F. and Perrin, P. (2006). Relation between motion sickness susceptibility and vasovagal syncope susceptibility, *Brain Res. Bull.* **68**, 217–226. DOI: 10.1016/j.brainresbull.2005.05.031.

Bouchard, S., Berthiaume, M., Robillard, G., Forget, H., Daudelin-Peltier, C., Renaud, P., Blais, C. and Fiset, D. (2021). Arguing in favor of revising the *Simulator Sickness Questionnaire* factor structure when assessing side effects induced by immersions in virtual reality, *Front. Psychiatry*, **12**, 739742.. DOI: 10.3389/fpsyt.2021.739742.

Bowins, B. (2010). Motion sickness: a negative reinforcement model, *Brain Res. Bull.* **81**, 7–11. DOI: 10.1016/j.brainresbull.2009.09.017.

Bronstein, A. M., Golding, J. F. and Gresty, M. A. (2020). Visual vertigo, motion sickness, and disorientation in vehicles, *Semin. Neurol.* **40**, 116–129. DOI: 10.1055/s-0040-1701653.

Bronstein, A. M., Golding, J. F., Gresty, M. A., Mandalà, M., Nuti, D., Shetye, A. and Silove, Y. (2010). The social impact of dizziness in London and Siena, *J. Neurol.* **257**, 183–190. DOI: 10.1007/s00415-009-5287-z.

Brooks, J. O., Goodenough, R. R., Crisler, M. C., Klein, N. D., Alley, R. L., Koon, B. L., Logan, W. C. jr, Ogle, J. H., Tyrrell, R. A. and Wills, R. F. (2010). Simulator sickness during driving simulation studies, *Accid. Anal. Prev.* **42**, 788–796. DOI: 10.1016/j.aap.2009.04.013.

Cha, Y.-H., Golding, J. F., Keshavarz, B., Furman, J., Kim, J.-S., Lopez-Escamez, J. A., Magnusson, M., Yates, B. J., Lawson, B. D. and Advisors: (2021). Motion sickness diagnostic criteria: Consensus Document of the Classification Committee of the Bárány Society, *J. Vestib. Res.* **31**, 327–344. DOI: 10.3233/VES-200005.

Chang, C.-H., Stoffregen, T. A., Tseng, L.-Y., Lei, M. K. and Cheng, K. B. (2021). Control of a virtual vehicle influences postural activity and motion sickness in pre-adolescent children, *Hum. Mov. Sci.* **78**, 102832. DOI: 10.1016/j.humov.2021.102832.

Diels, C. and Howarth, P. A. (2013). Frequency characteristics of visually induced motion sickness, *Hum. Factors* **55**, 595–604. DOI: 10.1177/0018720812469046.

Dilanchian, A. T., Andringa, R. and Boot, W. R. (2021). A pilot study exploring age differences in presence, workload, and cybersickness in the experience of immersive virtual reality environments, *Front. Virtual Real.* **2**, 736793.. DOI: 10.3389/frvir.2021.736793.

Doty, T. A., Kelly, J. W., Gilbert, S. B. and Dorneich, M. C. (2024). Cybersickness abatement from repeated exposure to VR with reduced discomfort, in: *IEEE Trans. Vis. Comput. Graph.* DOI: 10.31234/osf.io/4mujq.

Ebenholtz, S. M. (1992). Motion sickness and oculomotor systems in virtual environments, *Presence (Camb.)* **1**, 302–305. DOI: 10.1162/pres.1992.1.3.302.

Flanagan, M. B., May, J. G. and Dobie, T. G. (2005). Sex differences in tolerance to visually-induced motion sickness, *Aviat. Space Environ. Med.* **76**, 642–646.

Golding, J. F. (2006). Predicting individual differences in motion sickness susceptibility by questionnaire, *Pers. Individ. Dif.* **41**, 237–248. DOI: 10.1016/j.paid.2006.01.012.

Golding, J. F. (2016). Motion sickness, in: *Handbook of Clinical Neurology*, J. M. Furman and T. Lempert (Eds), Vol. 137, pp. 371–390, Elsevier, Amsterdam, The Netherlands. DOI: 10.1016/B978-0-444-63437-5.00027-3.

Golding, J. F. and Jahanara, R. (2022). *Persistent Postural-Perceptual Dizziness (PPPD), Motion Sickness, Migraine, Syncope and Dizziness* [unpublished work]. Imperial College, London, United Kingdom.

Golding, J. F. and Patel, M. (2017). Meniere's, migraine, and motion sickness, *Acta Oto-Laryngol.* **137**, 495–502. DOI: 10.1080/00016489.2016.1255775.

Golding, J. F., Rafiq, A. and Keshavarz, B. (2021). Predicting individual susceptibility to visually induced motion sickness by questionnaire, *Front. Virtual Real.* **2**, 576871. DOI: 10.3389/frvir.2021.576871.

Grunfeld, E. and Gresty, M. A. (1998). Relationship between motion sickness, migraine and menstruation in crew members of a "round the world" yacht race, *Brain Res. Bull.* **47**, 433–436. DOI: 10.1016/S0361-9230(98)00099-9.

Hromatka, B. S., Tung, J. Y., Kiefer, A. K., Do, C. B., Hinds, D. A. and Eriksson, N. (2015). Genetic variants associated with motion sickness point to roles for inner ear development, neurological processes and glucose homeostasis, *Hum. Mol. Gen.* **24**, 2700–2708. DOI: 10.1093/hmg/ddv028.

Huppert, D., Grill, E. and Brandt, T. (2019). Survey of motion sickness susceptibility in children and adolescents aged 3 months to 18 years, *J. Neurol.* **266**, 65–73. DOI: 10.1007/s00415-019-09333-w.

Ignatova, S. and Golding, J. F. (2024). Prevalence and Correlates of Motion Sickness Disorder (MSD) and visually induced motion sickness disorder (VIMSD), in: *British Society of Neuro-Otology BSNO London Meeting 17 Nov 2023*. DOI: 10.13140/RG.2.2.23103.89767.

Kelly, J W.., Doty T. A., Gilbert, S. B. and Dorneich, M. C. (2024). Field of view restriction and snap turning as cybersickness mitigation tools, *IEEE Trans. Vis. Comput. Graph.* DOI: 10.1109/TVCG.2024.3470214.

Keshavarz, B. and Golding, J. F. (2022). Motion sickness: current concepts and management, *Curr. Opin. Neurol.* **35**, 107–112. DOI: 10.1097/WCO.0000000000001018.

Keshavarz, B., Hecht, H. and Lawson, B. D. (2014). Visually induced motion sickness: characteristics, causes, and countermeasures, in: K. S. Hale and K. M. Stanney (Eds), *Handbook of Virtual Environments: Design, Implementation, and Applications*, 2nd ed., pp. 648–697, CRC Press, Boca Raton, FL, USA.

Keshavarz, B., Ramkhalawansingh, R., Haycock, B., Shahab, S. and Campos, J. L. (2018). Comparing simulator sickness in younger and older adults during simulated driving under different multisensory conditions, *Transp. Res.Part F: Traffic Psychol. Behav.* **54**, 47–62. DOI: 10.1016/j.trf.2018.01.007.

Keshavarz, B., Saryazdi, R., Campos, J. L. and Golding, J. F. (2019). Introducing the VIMSSQ: measuring susceptibility to visually induced motion sickness, *Proc. Hum. Fact. Ergon. Soc. Annu. Meet.* **63**, 2267–2271. DOI: 10.1177/1071181319631216.

Keshavarz, B., Murovec, B., Mohanathas, N. and Golding, J. F. (2023). The visually induced motion sickness susceptibility questionnaire (VIMSSQ): estimating individual susceptibility to motion sickness-like symptoms when using visual devices, *Hum., Fact.* **65**, 107–124. DOI: 10.1177/00187208211008687.

.Láinez, M. J., Castillo, J., Domínguez, M., Palacios, G., Díaz, S. and Rejas, J. (2010). New uses of the Migraine Screen Questionnaire (MS-Q): validation in the Primary Care setting and ability to detect hidden migraine. MS-Q in Primary Care, *BMC Neurol.* **10**, 39. DOI: 10.1186/1471-2377-10-39.

Lawson, B. D. (2014). Motion Sickness Scaling. In K. S. Hale and K. M. Stanney (Eds.), *Handbook of Virtual Environments*, 2nd ed., CRC Press, Boca Raton, FL, USA.

Lawson, B. D. and Bolkhovsky, J. (2023). Attention military/commercial simulation developers, users, & trainers: visually-induced or motion-induced sickness is not necessarily more severe for women, in: J. Wright and D. Barber (Eds), *Human Factors*

and Simulation, AHFE (2023) International Conference, Vol. 83, AHFE International, New York, NY, USA. DOI: 10.54941/ahfe1003571.

Lukacova, I., Keshavarz, B. and Golding, J. F. (2023). Measuring the susceptibility to visually induced motion sickness and its relationship with vertigo, dizziness, migraine, syncope and personality traits, *Exp. Brain Res.* **241**, 1381–1391. DOI: 10.1007/s00221-023-06603-y.

McCauley, M. E., Royal, J. W., Wylie, C. D., O'Hanlon, J. F. and Mackie, R. R. (1976). *Motion Sickness Incidence: Exploratory Studies of Habituation, Pitch and Roll, and the Refinement of a Mathematical Model*. Human Factors Research, Inc., Goleta, CA, USA.

Paillard, A. C., Quarck, G., Paolino, F., Denise, P., Paolino, M., Golding, J. F. and Ghulyan-Bedikian, V. (2013). Motion sickness susceptibility in healthy subjects and vestibular patients: effects of gender, age and trait-anxiety, *J. Vestib. Res.* **23**, 203–209. DOI: 10.3233/VES-130501.

Papaefthymiou, S., Giannakopoulos, A., Roussos, P. and Kourtesis, P. (2024). Mitigating cybersickness in virtual reality: impact of eye–hand coordination tasks, immersion, and gaming skills, *Virt. Worlds* **3**, 506–535. DOI: 10.3390/virtualworlds3040027.

Reason, J. T. and Brand, J. J. (1975). *Motion Sickness*. Academic Press, London, United Kingdom.

Riccio, G. E. and Stoffregen, T. A. (1991). An ecological theory of motion sickness and postural instability, *Ecol. Psychol.* **3**, 195–240. DOI: 10.1207/s15326969eco0303_2.

Saredakis, D., Szpak, A., Birckhead, B., Keage, H. A. D., Rizzo, A. and Loetscher, T. (2020). Factors associated with virtual reality sickness in head-mounted displays: a systematic review and meta-analysis, *Front. Hum. Neurosci.* **14**, 96. DOI: 10.3389/fnhum.2020.00096.

Stanney, K. M., Fidopiastis, C. and Foster, L. (2020). Virtual reality is sexist: but it does not have to be, *Front. Robot. AI* **7**, 4. DOI: 10.3389/frobt.2020.00004.

Treisman, M. (1977). Motion sickness: an evolutionary hypothesis, *Science* **197**, 493–495. DOI: 10.1126/science.301659.

Tsang, B. and Golding, J. F. (2022). *The Relationship between Video Games and Stress Levels in Young Adults* [unpublished work]. University of Westminster, London, United Kingdom.

Tychsen, L. and Foeller, P. (2020). Effects of immersive virtual reality headset viewing on young children: visuomotor function, postural stability, and motion sickness, *Am. J. Ophthalmol.* **209**, 151–159. DOI: 10.1016/j.ajo.2019.07.020.

Ugur, E. (2023). Investigation of the correlation between the Visually Induced Motion Sickness Susceptibility Questionnaire and the Turkish Motion Sickness Susceptibility Questionnaire, *J. Audiol. Otol.* **28**, 36–43. DOI: 10.7874/jao.2023.00122.

Umatheva, N., Russo, F. A. and Keshavarz, B. (2024). The role of lifestyle factors, biological sex, and racial identity for (visually induced) motion sickness susceptibility: insights from an online survey, *Displays* **82**, 102666. DOI: 10.1016/j.displa.2024.102666.

Figure Legends

Figure 1. Distribution of the total score of the Visually Induced Motion Sickness Susceptibility Questionnaire short form.

Figure 2. Mean the Visually Induced Motion Sickness Susceptibility Questionnaire short scores broken down by age groups (*n* of each age group in brackets).

Figure 3. A scatterplot of the relationship between the Visually Induced Motion Sickness Susceptibility Questionnaire total score and the Motion Sickness Susceptibility Questionnaire score. The dotted lines represent the 95% confidence intervals shown on either side of the fitted regression line. Each point represents an individual person, some points may overlap and represent more than one individual.

Figure 4. Multiple linear regression prediction of susceptibility to visually induced motion sickness measured by the Visually Induced Motion Sickness Susceptibility Questionnaire using the predictors Motion Sickness Susceptibility Questionnaire, Migraine, Age, Syncope, Social Life and Work Impact of Dizziness. Sex failed significance. The standardised predictor is shown on the *x*-axis, with the beta values of the individual predictors. Dotted lines represent the 95% confidence intervals shown on either side of the fitted regression line. Each point represents an individual person, some points may overlap and represent more than one individual.

Appendix Figure 1. Cumulative distribution percentiles of the scores of the VIMSSQ-short (*n* = 920).

Appendix Figure 2. Fifth-order polynomial fit for VIMSSQ-short total score to percentiles conversion.

Appendix

The Visually Induced Motion Sickness Susceptibility Questionnaire short form (VIMSSQ-short): Questionnaire, Scoring, and Percentile Conversion Formula.

Visually Induced Motion Sickness Susceptibility Questionnaire (VIMSSQ-short)

This questionnaire is designed to measure your experience with different visual display or entertainment devices and if they ever caused discomfort.

Visual display or entertainment devices include Movie Theatre or Cinema, Smartphones and Tablets with movies or games, Video games, Virtual Reality Glasses or Head-Mounted Displays, Simulators, Large Public Moving Display Advertising or Information Screens.

Please answer these questions solely with respect to your experiences during adulthood (older than 18 years) and ignore childhood experiences.

Q1. How often have you experienced each of the following symptoms when using any of these devices? (circle your response)

Nausea	*Never*	*Rarely*	*Sometimes*	*Often*
Headache	*Never*	*Rarely*	*Sometimes*	*Often*
Dizziness	*Never*	*Rarely*	*Sometimes*	*Often*
Fatigue	*Never*	*Rarely*	*Sometimes*	*Often*
Eye strain	*Never*	*Rarely*	*Sometimes*	*Often*

Q2. Have any of these symptoms **stopped** you using any of these devices or made you **avoid** viewing such displays? (circle your response)

Never *Rarely* *Sometimes* *Often*

Q3. If you have answered stopped or avoided, please list the devices or displays that you avoid:

Scoring the VIMSSQ- short

Q1 and Q2 Sections of VIMSSQ-short

There are five symptom items in Q1 and one avoidance item in Q2. All items are scored Never=0, Rarely=1, Sometimes=2, Often=3.

The total score is formed by the addition of all items giving a maximum possible range for the VIMSSQ-short total score with minimum of 0 to maximum of 18. Higher scores indicate a stronger susceptibility to VIMS.

Q3 Section of VIMSSQ-short

This enquires about the devices and displays that a person has avoided or stopped using. It is a question to provide additional information about device avoidance. It does not contribute to the total score for the VIMSS-short.

Percentile Scores of the VIMSSQ-short

Using weighted-averages approach (SPSS V28.0) the key percentiles for the VIMSSQ-short total score are as follows:

5th = 0; 25th = 4; 50th = 7; 75th = 10; 95th = 14.

Detailed distribution of percentile conversion is given below in **Appendix Figure 1** and in **Appendix Table 1.** Use interpolation where necessary.

-(Insert Appendix Figure 1 around here)-

Appendix Table 1. Mean, standard deviation and cumulative percentiles statistics for the VIMSSQ-short (*n* = 920).

VIMSSQ-short score	Cumulative percentiles
0	6.8
1	11.2
2	16.8
3	22.8
4	28.9
5	35.3
6	43.0
7	50.4
8	58.3
9	67.4
10	76.0
11	82.9
12	90.8
13	93.7
14	96.5
15	98.2
16	99.0
17	99.5
18	100.0

VIMSSQ-short
Mean = 7.2
Standard deviation = 4.2

Numbers are rounded

Alternatively, a 5th-order polynomial function provides a close fit for VIMSSQ-short to percentile conversion. y =percentile and x = VIMSSQ-short score. Appendix Figure 2 below shows the fit.

Fifth-order polynomial fit: $y = a + bx + cx^2 + dx^3 + ex^2 + fx^3$.

Coefficient data:

a = 2.2926016

b = 10.124353

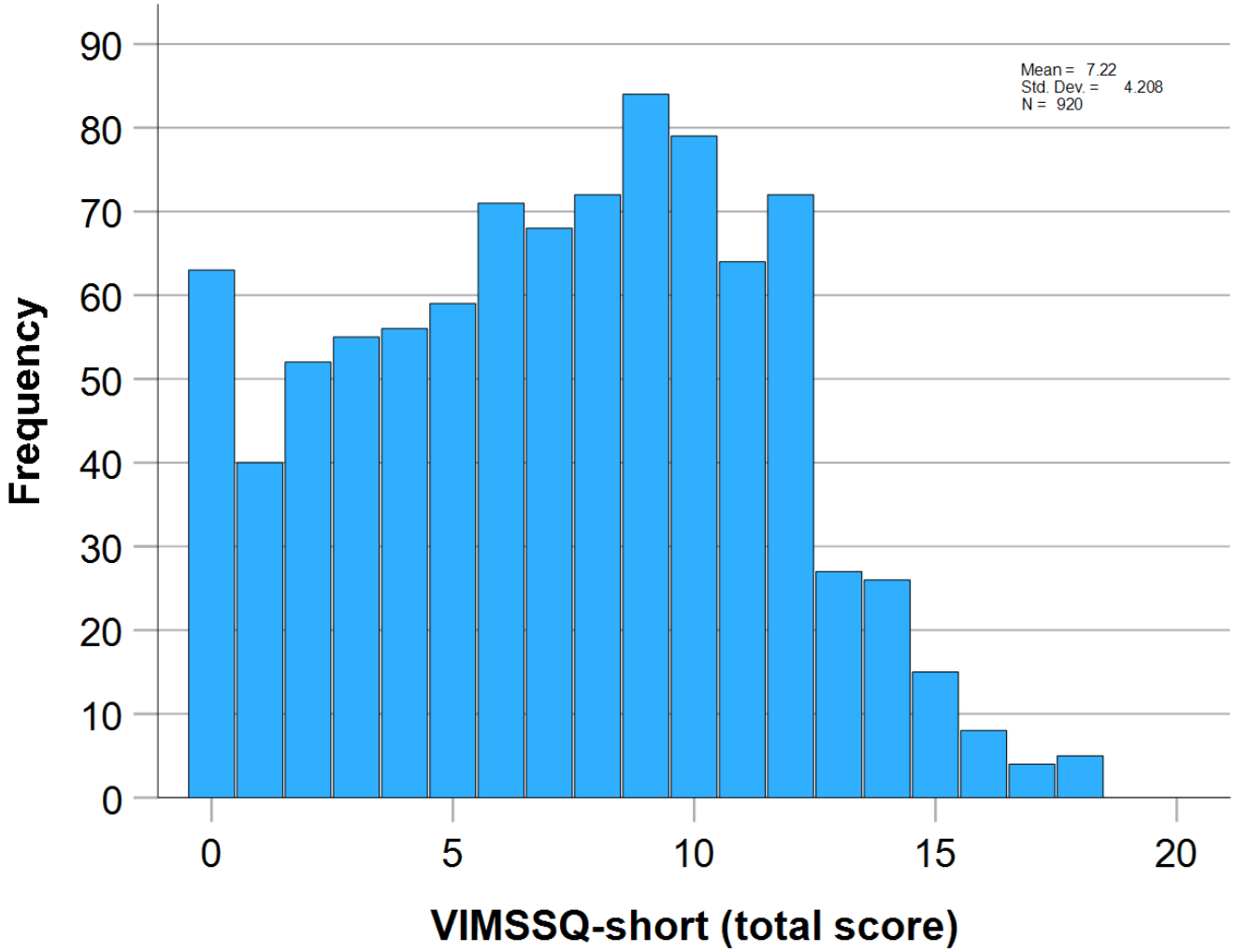
c = −1.9304833

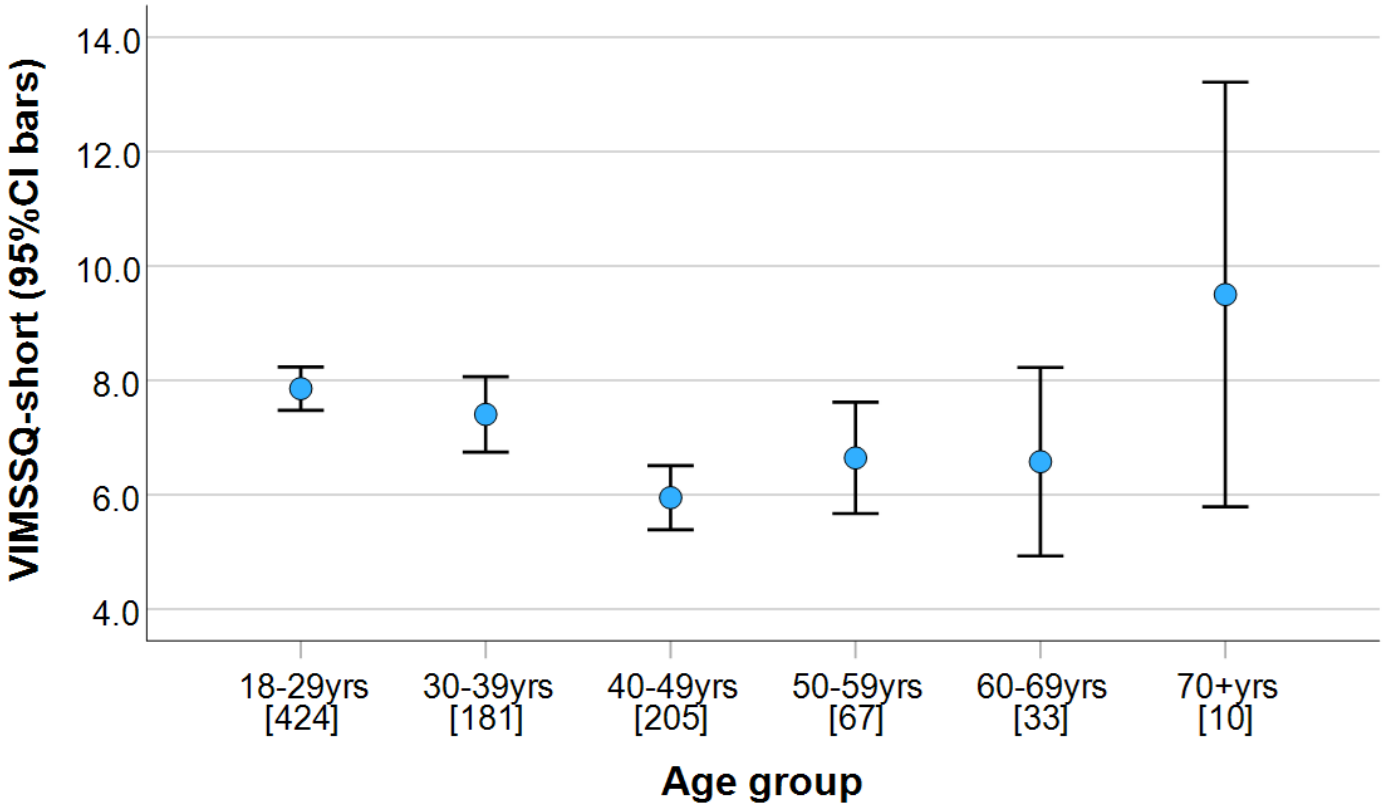
d = 0.34920201

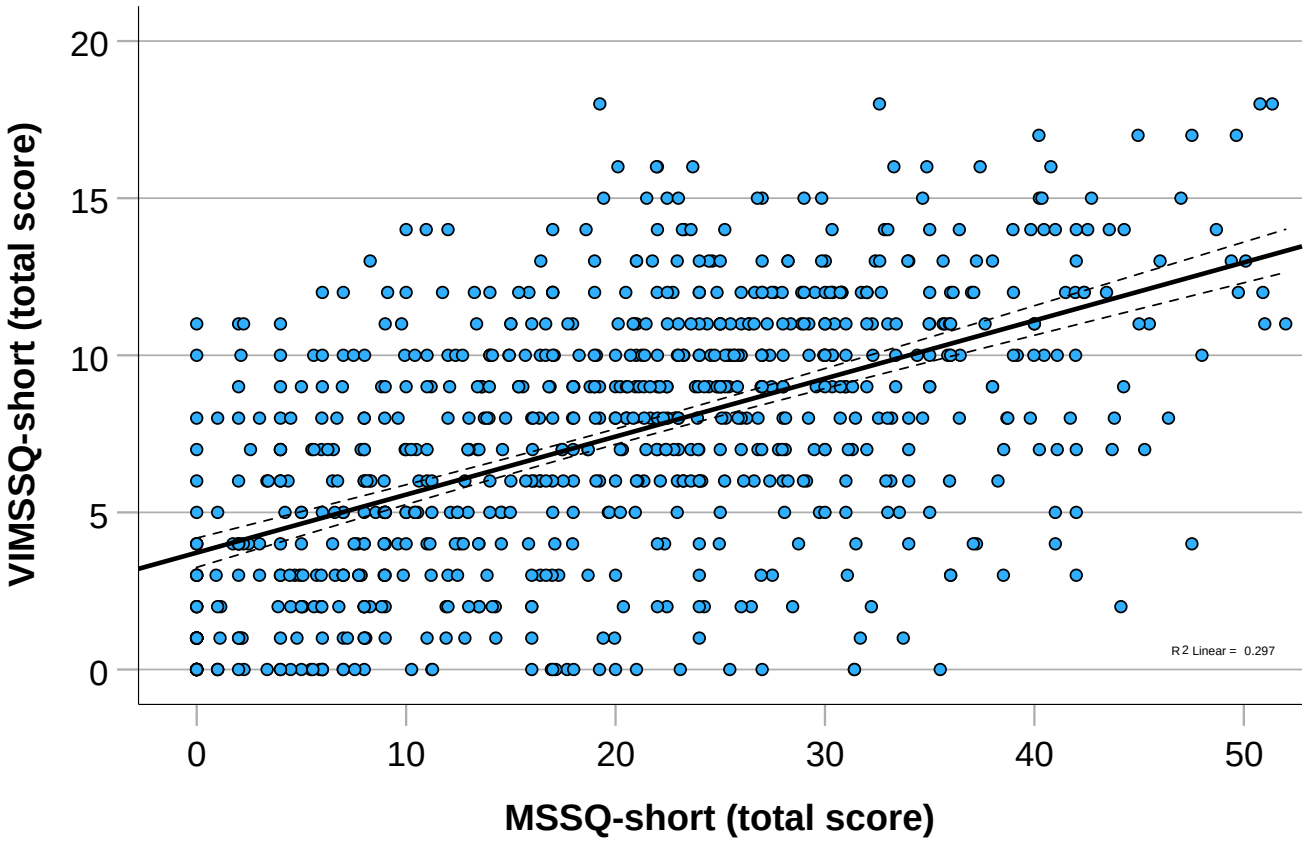
e = −0.023566472

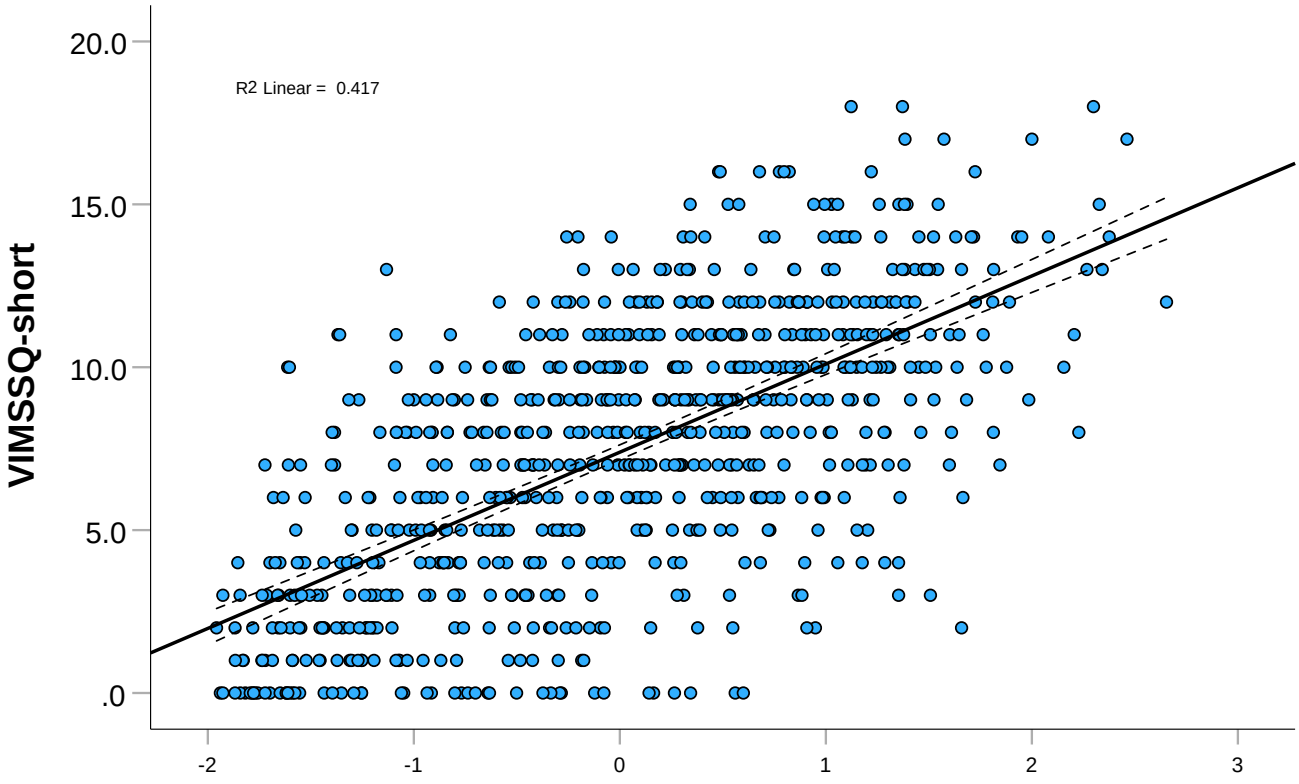
f = 0.00051780082

-(Insert Appendix Figure 2. Around here)-

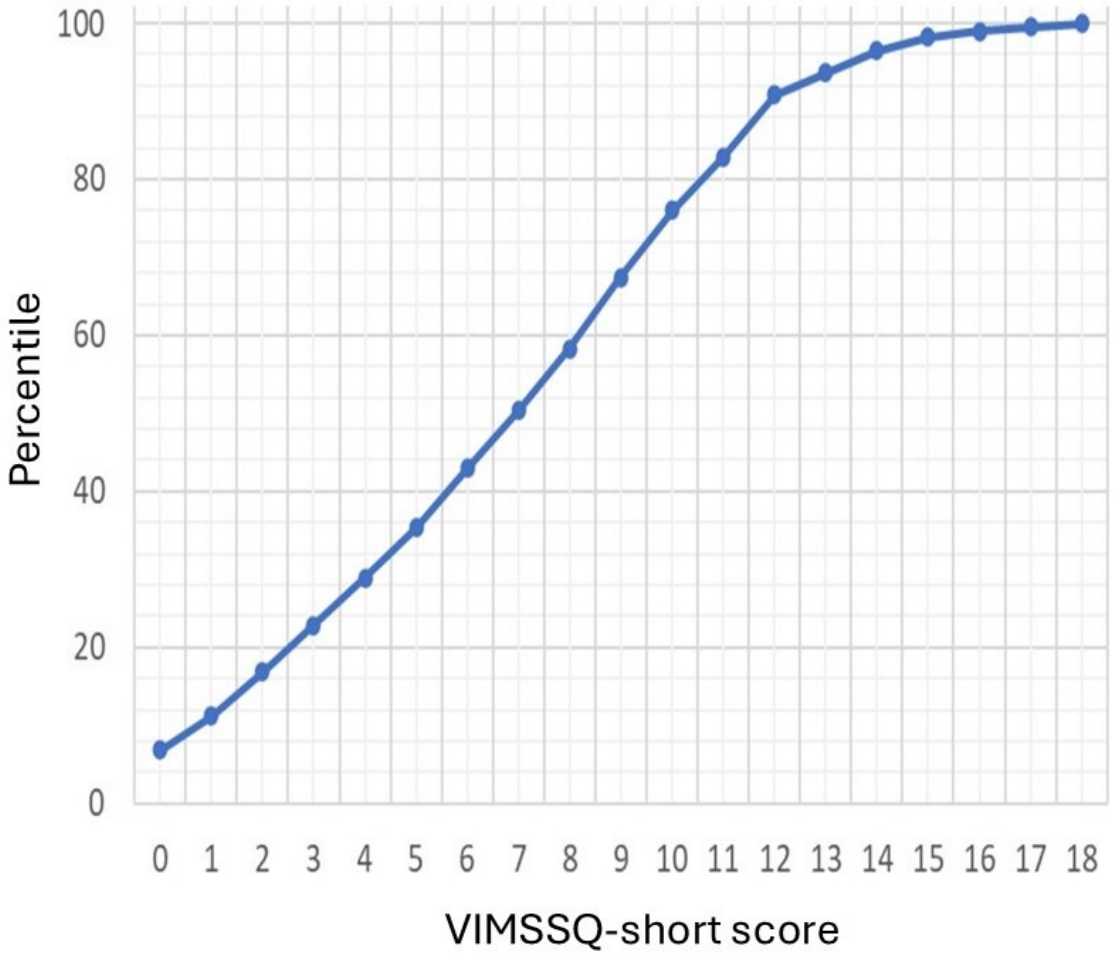

Mean = 7.22
Std. Dev. = 4.208
N = 920
Frequency
90
80
70
60
50
40
30
20
10
0
0
5
10
15
20
VIMSSQ-short (total score)

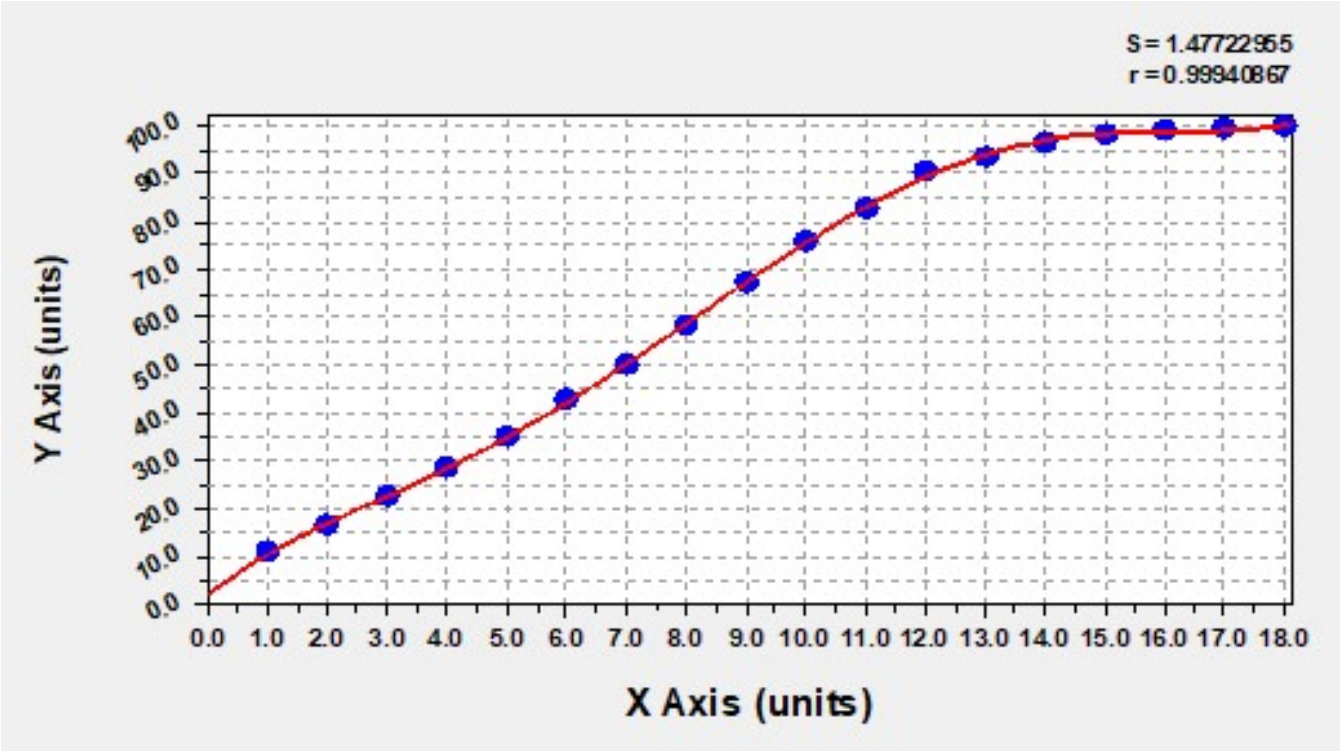

VIMSSQ-short (95%CI bars)
14.0
12.0
10.0
8.0
6.0
4.0
18-29yrs [424]
30-39yrs [181]
40-49yrs [205]
50-59yrs [67]
60-69yrs [33]
70+yrs [10]
Age group


VIMSSQ-short (total score)
20
15
10
5
0
0
10
20
30
40
50
MSSQ-short (total score)
R 2 Linear = 0.297



Predictors (beta): MSSQ (.39) Migraine (.28) Age (-.10) SWID (.09) Syncope (.08)


100
80
60
40
20
0
Percentile
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
VIMSSQ-short score


S = 1.47722955
r = 0.99940867
Y Axis (units)
X Axis (units)
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
100.0
0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 11.0 12.0 13.0 14.0 15.0 16.0 17.0 18.0

Supporting Information

Table S1.
Factor analysis: Orthogonal Rotated Component Matrix.

	Factor	
	1	2
Nausea (item)	0.64	0.43
Headache (item)	0.30	0.69
Dizziness (item)	0.54	0.44
Fatigue (item)		0.73
Eye strain (item)		0.80
Avoidance (item)	0.37	0.59
MSSQ (score)	0.58	0.38
Migraine (score)	0.56	0.32
SWID (score)		0.75
Syncope (score)	0.69	

Loadings <0.3 not shown for clarity; Varimax Rotation; Variance: Factor 1=40.4%; Factor 2=12.1%.

Table S2.

Correlation matrix of all questionnaires used for the pooled data.

		VIMSSQ	MSSQ	Migraine	SWID	Syncope	Age	Sex
VIMSSQ_total	Pearson's *r*	–						
	p-value	–						
MSSQ	Pearson's *r*	0.545***	–					
	p-value	< 0.001	–					
Migrn_Total	Pearson's *r*	0.478***	0.348***	–				
	p-value	< 0.001	< 0.001	–				
SWIDtot	Pearson's *r*	0.347***	0.357***	0.343***	–			
	p-value	< 0.001	< 0.001	< 0.001	–			
Syncope	Pearson's *r*	0.308***	0.266***	0.276***	0.321***	–		
	p-value	< 0.001	< 0.001	< 0.001	< 0.001	–		
Age	Pearson's *r*	−0.124***	−0.035	−0.139***	0.038	−0.042	–	
	p-value	< 0.001	0.255	< 0.001	0.220	0.171	–	
Sex	Pearson's *r*	0.056	0.055	0.166***	−0.003	−0.040	−0.074**	–
	p-value	0.090	0.074	< 0.001	0.912	0.199	0.008	–

Table S3.

Breakdown of item scores of the VIMSSQ-short (percentages and means [standard deviations, SD], *n* = 920).

Item of VIMSSQ	Never (0)	Rarely (1)	Sometimes (2)	Often (3)	Mean (SD)
Nausea	40.8%	21.4%	29.3%	8.5%	1.06 (1.02)
Headache	22.3%	28.0%	36.0%	13.7%	1.41 (0.98)
Dizziness	38.2%	31.7%	23.6%	6.5%	0.98 (0.94)
Fatigue	36.0%	24.5%	28.5%	11.1%	1.15 (1.03)
Eye strain	20.1%	22.6%	37.8%	19.5%	1.57 (1.02)
Avoidance	31.6%	28.5%	31.7%	8.2%	1.16 (0.97)

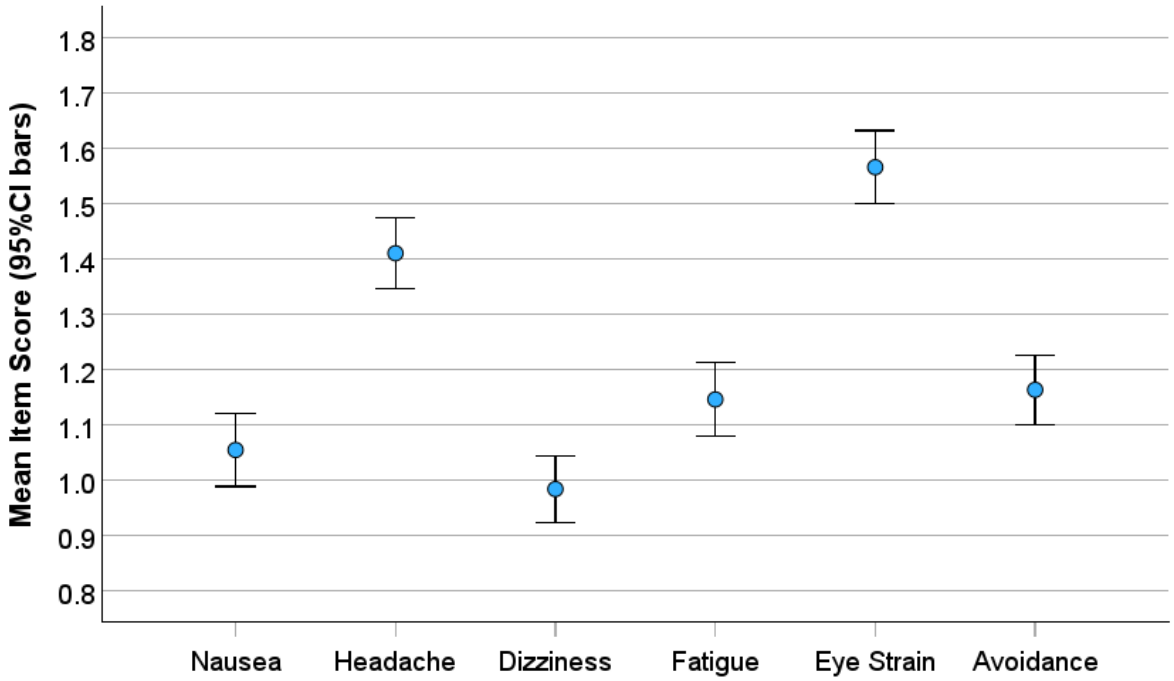


Figure S1. Graphical overview of means ± 95% confidence intervals (CIs) for item scores of the VIMSSQ-short (*n*=920).