Research Square

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Prevalence and associated factors for social jetlag in women with gestational diabetes mellitus: a cross-sectional study

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Research Article

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Abstract

Background

Disturbed sleep during pregnancy is associated with adverse maternal and neonatal outcomes. As a modifiable lifestyle factor, social jetlag (SJL) may be relevant to the prevention and management of gestational diabetes mellitus (GDM). This study aimed to determine the prevalence of SJL and identify its associated factors in Chinese women with GDM.

Methods

In this cross-sectional study, 200 women with GDM in the third trimester were recruited from the Women's Hospital of Nanjing Medical University between October and December 2022. Sleep timing was assessed using the Munich Chronotype Questionnaire (MCTQ), and SJL was calculated as the absolute difference between mid-sleep on workdays and mid-sleep on rest days. Self-regulatory fatigue and quality of life were measured using the Self-Regulatory Fatigue Scale (SRF-S) and the Quality of Life Questionnaire for women with GDM (GDMQ), respectively. Associations were examined using Pearson correlation and binary logistic regression analyses.

Results

The prevalence of SJL ≥ 1 hour was 40%, with a mean SJL of 44 minutes. Higher SJL was correlated with greater self-regulatory fatigue ($r = 0.39$, $P < 0.01$) and poorer quality of life ($r = -0.42$, $P < 0.01$). Binary logistic regression identified younger age (< 35 years; OR = 0.31 for ≥ 35 years), family history of diabetes (OR = 3.36), pre-pregnancy alcohol consumption (OR = 2.97), employment in the civil service or public institutions (OR = 12.06), and lower quality of life (OR = 0.95 per point) as factors independently associated with SJL ≥ 1 hour.

Conclusions

SJL is common among women with GDM and is associated with demographic, familial, behavioural, occupational, and quality-of-life factors. These findings highlight the need to incorporate circadian rhythm assessment into prenatal care and to develop targeted interventions for high-risk subgroups.

Background

Gestational diabetes mellitus (GDM) is the most common metabolic disorder of pregnancy. Characterized by glucose intolerance first recognized during gestation, it affects up to 15–25% of pregnancies worldwide [1]. GDM is associated with an increased prevalence of pregnancy-related complications and with long-term metabolic risks for both mother and offspring [2]. Early detection and

systematic management of GDM not only mitigate these risks but are also economically beneficial, as reflected in reduced rates of pre-eclampsia, caesarean section, and neonatal hypoglycaemia [3, 4].

The 2022 consensus report of the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD) identifies healthy sleep as an essential component of a healthy lifestyle and a fundamental aspect of diabetes management [5]. Sleep patterns commonly change during pregnancy because of physiological factors such as hormonal fluctuations, physical discomfort, and anxiety about delivery, which can lead to difficulty falling asleep, daytime sleepiness, and a shift in the midpoint of sleep [6, 7]. A substantial body of evidence indicates that insufficient sleep during pregnancy is associated with an elevated risk of hyperglycaemia [8–12]. Mechanistically, inadequate sleep induces metabolic and neuroendocrine changes, particularly affecting the hypothalamic–pituitary–adrenal (HPA) axis [9, 13], which may contribute to glucose intolerance, insulin resistance, and GDM.

Healthy sleep, however, is not limited to sleep duration; it also encompasses the stability of circadian and nocturnal rhythms that orchestrate metabolic and endocrine activity. Modern lifestyles—including exposure to artificial light, irregular mealtimes, and shortened sleep periods—can cause chronic desynchronization between the internal clock and the external environment [14]. Social jetlag (SJL), a major circadian disruptor affecting more than half of the general population, is defined as the discrepancy between the biological rhythm governed by the circadian clock and the sleep–wake schedule imposed by professional and social obligations. Although subtle, SJL is chronic in nature [15]. Its clinical relevance has been demonstrated in several epidemiological studies: SJL has been associated with elevated glycated haemoglobin (HbA1c), higher body mass index (BMI), greater waist circumference, and increased odds of obesity [16]. Moreover, SJL is prevalent among pregnant women, and high SJL has been identified as a risk factor for the development of GDM [17]. Nevertheless, data on the prevalence of SJL and its associated factors among women already diagnosed with GDM remain scarce.

Because sleep during pregnancy is a modifiable lifestyle factor relevant to GDM prevention and control, this study aimed to evaluate the prevalence of SJL and to identify its associated factors among women with GDM. The findings may help healthcare professionals develop tailored and effective strategies for managing sleep disturbances in this population.

Methods

Design and participants

This descriptive, cross-sectional study enrolled 200 women with GDM who were admitted to clinics affiliated with the Women's Hospital of Nanjing Medical University between October and December 2022. A convenience sample of 200 was recruited based on feasibility within the study period. The inclusion criteria were: (1) age ≥ 18 years; (2) a diagnosis of GDM according to the criteria of the International Association of Diabetes and Pregnancy Study Groups (IADPSG) at 24–28 weeks of gestation; and (3) at least four weeks elapsed since diagnosis. Women who were shift workers or who had any other mental

or sleep-related disorder were excluded. The study was approved by the Ethics Committee of the Women's Hospital of Nanjing Medical University (2022-KY-1186-001) and was conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from all participants, and confidentiality was guaranteed throughout the research process.

Measures

Participant characteristics were obtained from medical records and a self-designed sociodemographic questionnaire, including age, pre-pregnancy BMI, educational level, occupational type, monthly income, and pregnancy-related information (method of conception, parity, family history of diabetes, and pre-pregnancy alcohol intake and smoking).

Munich Chronotype Questionnaire (MCTQ)

The Chinese version of the MCTQ was used to assess social jetlag [15, 18]. SJL was calculated as the absolute difference between the mid-point of sleep on rest days (MSF) and the mid-point of sleep on workdays (MSW): SJL = |MSF − MSW|. SJL was categorized as < 1 hour (no social jetlag) or ≥ 1 hour (social jetlag present).

Self-Regulatory Fatigue Scale (SRF-S)

The SRF-S was developed by Nes et al. in 2013 [19] and translated into Chinese by Wang et al. in 2015 [20] to assess chronic self-regulatory fatigue. The scale comprises 16 items across three dimensions: cognition, emotion, and behaviour. Each item is rated on a five-point scale ranging from "totally disagree" to "absolutely agree," with total scores ranging from 16 to 80. Higher scores indicate greater self-regulatory fatigue.

Quality of Life Questionnaire for women with GDM (GDMQ)

The GDMQ was developed by Mokhlesi et al. [21] to measure quality of life in women with GDM and was translated into Chinese by Yang et al. in 2021 [22]. The questionnaire includes 32 items rated on a five-point Likert scale from 1 (strongly disagree) to 5 (strongly agree), with total standardized scores ranging from 20 to 100. Higher scores indicate better quality of life.

Data collection

Before the survey, all investigators received standardized training according to the study requirements. Investigators explained the purpose and significance of the survey to participants to ensure that they understood the questionnaire items and could complete them independently during hospitalization. For participants who had difficulty reading or understanding the items, the investigator provided assistance and recorded responses consistent with the participant's statements on site. All completed

questionnaires were verified on site by two investigators. All 200 questionnaires were complete with no missing data.

Statistical analysis

Data were analysed using SPSS version 29.0. Continuous variables were expressed as mean ± standard deviation and compared using independent-samples *t*-tests. Categorical variables were expressed as proportions (%) and compared using the chi-square test or the Mann–Whitney U test, as appropriate. Pearson's correlation coefficients were used to examine associations among SJL, self-regulatory fatigue, and quality of life. Binary logistic regression was used to identify factors independently associated with SJL ≥ 1 hour, with results reported as odds ratios (ORs) and 95% confidence intervals (CIs). Independent variables showing $P < 0.05$ in univariate analysis, together with variables of established clinical relevance, were entered into the model. Model fit was assessed using the Omnibus likelihood-ratio test and the Hosmer–Lemeshow goodness-of-fit test. A two-sided $P < 0.05$ was considered statistically significant.

Results

Participant characteristics

A total of 200 women with GDM completed the survey. Their sociodemographic and clinical characteristics are summarized in Table 1. Most participants were younger than 35 years (79.5%), in the third trimester (89.0%), and in routine (non-shift) employment. Most pregnancies were conceived naturally (84.0%), and more than half of the women were nulliparous (54.0%). The vast majority did not smoke (98.0%) or consume alcohol (77.3%) before pregnancy.

Table 1
Demographic and clinical characteristics of women with GDM (*n* = 200)

Characteristic	**n(%)**
Age	
< 35 (years)	159 (79.3%)
≧ 35 (years)	41 (20.7%)
Pre-pregnancy BMI	
< 18.5 kg/m2	7 (3.3%)
18.5–23.9 kg/m2	89 (44.7%)
24-27.9 kg/m2	67 (33.3%)
≧ 28 kg/m2	37 (18.7%)
Gestational week	
$< 27^{+7}$ (weeks)	1 (0.5%)
$28–31^{+7}$ (weeks)	21 (10.5%)
≧ 32 (weeks)	178 (89.0%)
Pregnancy methods	
Natural	168 (84.0%)
Assisted reproduction	32 (16.0%)
Parity	
Nulliparous	108 (54.0%)
Multiparous	92 (46.0%)
Occupation	
Civil servants/public institution	37 (18.7%)
Enterprise employee	128 (64.0%)
Self-employed	15 (7.3%)
Homemaker	1 (0.7%)
Others	19 (9.3%)
Monthly income	
Prevalence of social jetlag and univariate analysis	

Characteristic	n(%)
< 3000 (yuan)	13 (6.7%)
3000–5999 (yuan)	51 (25.3%)
6000–9000 (yuan)	65 (32.7%)
> 9000 (yuan)	71 (35.3%)
Educational level	
Undergraduate	152 (76.0%)
Junior college	35 (17.3%)
High school	9 (4.7%)
Middle school	3 (1.3%)
Primary school	1 (0.7%)
Pre-pregnancy alcohol consumption	
Yes	45 (22.7%)
No	155 (77.3%)
Pre-pregnancy smoking	
Yes	4 (2.0%)
No	196 (98.0%)
Family history of diabetes mellitus	
Yes	64 (32.0%)
No	136 (68.0%)
Prevalence of social jetlag and univariate analysis	

The mean mid-sleep time was 03:03 on workdays and 03:42 on rest days. The mean SJL was 44 minutes (SD = 40 minutes), and 80 participants (40%) had SJL ≥ 1 hour. Women with SJL ≥ 1 hour differed significantly from those with SJL < 1 hour in age, pre-pregnancy BMI, parity, occupational type, pre-pregnancy alcohol consumption, and family history of diabetes (all $P < 0.05$); details are presented in Table 2.

Table 2
Affected factors for SJL with GDM (*n* = 200)

Variables	**SJL<1h (*n* = 120) n(%)**	**SJL≧1h (*n* = 80) n(%)**	χ^2 /Z	*P*
Age			-2.40	0.02
< 35 (years)	95 (78.9%)	75 (93.3%)		
≧ 35 (years)	25 (21.1%)	5 (6.7%)		
Pre-pregnancy BMI			-2.52	0.01
< 18.5 kg/m^2	4 (3.3%)	2 (2.5%)		
18.5–23.9 kg/m^2	65 (54.4%)	25 (31.3%)		
24-27.9 kg/m^2	31 (25.6%)	36 (45.0%)		
≧ 28 kg/m^2	20 (16.7%)	17 (21.3%)		
Parity			4.58	0.03
Nulliparous	73 (61.1%)	35 (43.3%)		
Multiparous	47 (38.9%)	45 (56.7%)		
Occupation			11.45	0.02
Civil servants/public institutions	16 (13.3%)	21 (26.7%)		
Enterprise employee	79 (65.6%)	49 (61.7%)		
Self-employed	7 (5.6%)	8 (10.0%)		
Homemaker	1 (1.1%)	0		
Others	17 (14.4%)	1 (1.7%)		
Pre-pregnancy alcohol consumption			6.49	0.01
Yes	19 (15.6%)	27 (33.3%)		
No	101 (84.4%)	53 (66.7%)		
Family history of diabetes mellitus			14.89	< 0.001
Yes	24 (20.0%)	40 (50.0%)		
No	96 (80.0%)	40 (50.0%)		

Correlations among social jetlag, self-regulatory fatigue, and quality of life

Correlation analysis (Table 3) showed that SJL was positively correlated with self-regulatory fatigue (r = 0.39, P < 0.01) and negatively correlated with quality of life (r = − 0.42, P < 0.01). Self-regulatory fatigue was strongly and negatively correlated with quality of life (r = − 0.62, P < 0.01).

Table 3
SJL correlations with other scales (n = 200)

Variables	**Mean**	**1**	**2**	**3**
1. social jetlag (min)	44 ± 40	1		
2. Self -regulatory fatigue	35.57 ± 6.21	0.39**	1	
3. Quality of life	101.19 ± 13.9	-0.42**	-0.62**	1
Note: **p < 0.01				
Binary logistic regression				

Binary logistic regression was performed to identify factors independently associated with SJL ≥ 1 hour (Table 4). The Homemaker category (n = 1) was excluded from the model owing to a zero cell count. Women aged ≥ 35 years had significantly lower odds of SJL ≥ 1 hour compared with those aged < 35 years (OR = 0.31, 95% CI 0.10–0.99, P = 0.05). Having a family history of diabetes was associated with more than three-fold higher odds (OR = 3.36, 95% CI 1.41–7.99, P < 0.01). Pre-pregnancy alcohol consumption was also a significant risk factor (OR = 2.97, 95% CI 1.09–8.07, P = 0.03). Higher quality of life was associated with lower odds (OR = 0.95, 95% CI 0.91–0.99, P = 0.03). Among occupational categories, women employed in the civil service or public institutions had significantly higher odds compared with the reference group (OR = 12.06, 95% CI 1.22–119.00, P = 0.03), although the wide confidence interval reflects the small subgroup size and warrants cautious interpretation. Self-regulatory fatigue was entered into the model but did not reach statistical significance (P > 0.05), likely owing to its strong collinearity with quality of life (r = − 0.62). The model explained 44% of the variance in SJL status (Nagelkerke R^2 = 0.44) and demonstrated adequate fit (Hosmer–Lemeshow χ^2 = 7.72, P = 0.46).

Table 4
Binary logistic regression of factors associated with SJL ≥ 1 hour (*n* = 199)

Constant	**B**	***SE***	**Wald χ^2**	***P***	***OR***	**95*CI***
	-1.972	**3.622**	**0.296**	**0.59**	**0.14**	**-**
Age (≥ 35 *vs* < 35)□	-1.18	0.592	3.92	0.05	0.31	0.10–0.99
Family history of diabetes mellitus (yes *vs* no)	1.21	0.44	7.49	< 0.01	3.36	1.41–7.99
Pre-pregnancy alcohol consumption (yes *vs* no)	1.09	0.51	4.56	0.03	2.97	1.09–8.07
Quality of life (per point)	-0.05	0.02	4.64	0.03	0.95	0.91–0.99
Occupation (ref: Other)□			8.00	0.05		
Civil servants/public institutions	2.49	1.17	4.54	0.03	12.06	1.22–119.00
Enterprise employee	1.34	1.10	1.49	0.22	3.81	0.45–32.59
Self-employed	2.54	1.31	3.74	0.05	12.67	0.97-166.12

□ Reference category: < 35 years. OR < 1 indicates that women aged ≥ 35 years had lower odds of SJL ≥ 1 hour.

□ Occupation modelled with "Other" as the reference category. The Homemaker category (n = 1) was excluded owing to zero cell count (complete separation).

Model fit: Omnibus $\chi^2 = 58.82$, P < 0.001; Nagelkerke $R^2 = 0.44$; Hosmer–Lemeshow $\chi^2 = 7.72$, *P* = 0.46.

Discussion

To our knowledge, this is the first study to determine the prevalence of social jetlag and its associated factors among pregnant women diagnosed with GDM. We found that 40% of women with GDM experienced SJL of at least one hour. This high prevalence underscores the importance of addressing circadian misalignment as an essential component of prenatal care. Existing assessments of sleep in women with GDM have focused largely on sleep duration and quality, yet social jetlag is also widespread during pregnancy. A recent cohort study reported that social jetlag was significantly associated with the development of GDM [17], and animal models have shown that disruption of the circadian system reduces reproductive success in mammals, as evidenced by fewer offspring and restricted intrauterine growth [23, 24]. Social jetlag has also been shown to complicate glycaemic control [25]. Collectively, these findings highlight the importance of incorporating circadian rhythm management into clinical

practice. Healthcare professionals should regularly assess social jetlag in pregnant women with GDM—potentially with the aid of wearable devices and continuity-of-care models—and implement targeted early interventions to promote maternal and neonatal health.

Our study identified younger age (< 35 years) as an important factor associated with SJL ≥ 1 hour. Younger individuals have been shown to prefer later sleep timing and to use information technology more than older adults [26]. Constrained by work schedules during the week, younger women may "compensate" with increased screen exposure at night and on weekends. Use of mobile devices before bedtime prolongs exposure of light-sensitive retinal ganglion cells to blue light, thereby delaying the circadian rhythm and contributing to chronic social jetlag [27]. In contrast, women with GDM older than 35 years are more often multiparous; their need to care for existing children on both workdays and weekends may impose a relatively regular daily routine and more stable sleep behaviour. The sleep of younger pregnant women therefore warrants particular attention. Healthcare professionals should advise women with GDM to increase daytime activity, reduce night-time recreational use of mobile devices, and maintain a regular activity and sleep cycle on rest days.

We found that pre-pregnancy alcohol consumption was a significant risk factor for circadian misalignment in women with GDM, consistent with findings in adolescents [28]. This association may reflect the use of alcohol to cope with multiple stressors and persistent low mood. Even after cessation of alcohol intake during pregnancy, the disruptive effects of prior alcohol consumption on sleep may persist for a year or longer [29]. This highlights the need for healthcare providers to educate women of childbearing age who have a history of pre-pregnancy alcohol consumption, advising them to limit alcohol intake for at least one year before conception to reduce its lasting effects on neural regulation, and to adopt healthier coping strategies and seek professional support to strengthen psychological resilience.

Women with GDM who remained employed during pregnancy, particularly in the civil service or public institutions, were more likely to experience circadian misalignment. This may be attributable to the unpredictable demands and complexity of such occupations, which can expose women to occupational stress and irregular routines and may be associated with reduced sleep quality. Accordingly, when conducting risk assessment and health education for women with GDM engaged in high-demand cognitive work, healthcare professionals should establish mechanisms to assess occupational stress, attend to the effect of work-related events on mental health, and offer non-pharmacological interventions and counselling to alleviate occupational stress and social jetlag. Given the wide confidence interval associated with this occupational subgroup (OR = 12.06, 95% CI 1.22–119.00), however, this finding should be interpreted with caution and confirmed in larger samples.

Women with GDM who had a family history of diabetes showed greater social jetlag. A prevalence of social jetlag as high as 65% has been reported in patients with type 2 diabetes [25], and family history of diabetes is a well-established independent risk factor for GDM [30, 31]. The association observed here may partly reflect shared household lifestyle patterns. Women with a family history may also be more

anxious about the effect of the disease on pregnancy outcomes and on future generations, which could disrupt the sleep cycle and reduce sleep quality. For these women, healthcare professionals should attend closely to their informational, physiological, and psychological needs—providing comprehensive disease knowledge, effective glycaemic management, and psychological assessment and support—and should advise family members to establish synchronized, healthy sleep cycles.

In bivariate analysis, higher self-regulatory fatigue was significantly correlated with greater social jetlag ($r = 0.39$, $P < 0.01$). However, self-regulatory fatigue did not remain an independent predictor in the multivariable logistic regression model, likely because of its strong negative correlation with quality of life ($r = -0.62$), which suggests substantial shared variance between the two constructs. Nonetheless, the bivariate association warrants discussion. Self-regulatory fatigue refers to a temporary decline in the ability or willingness to engage in volitional activity when self-control is required, reflecting impaired executive function resulting from depletion of mental energy. Patients with chronic multisymptom illnesses are prone to self-regulatory fatigue [32], which can create a vicious cycle with poor sleep quality [33]. GDM management depends heavily on self-management—resisting palatable food and increasing physical activity—throughout pregnancy. In this study, the mean self-regulatory fatigue score was 35.57, lower than that reported in patients with type 2 diabetes [34]. Nonetheless, the ongoing demands of treatment and the desire for a good pregnancy outcome may lead to chronic depletion of self-regulatory resources, psychological burden, and reduced sleep quality. Healthcare professionals should therefore remain attentive to self-regulatory fatigue as a potential contributor to circadian misalignment, even though its independent effect may be captured through the quality-of-life pathway in multivariable models.

Finally, lower quality of life was independently associated with greater social jetlag. Quality of life is an important indicator of treatment effectiveness and health status, and higher quality of life supports better pregnancy outcomes. The mean quality-of-life score in this study was 101.19, indicating a moderate level. Sleep difficulty has been shown to mediate the effect of chronic disease on health-related quality of life [35]. In women with GDM, concerns about fetal safety, dietary and lifestyle restrictions, and limited support from spouses, peers, and healthcare professionals may increase psychological stress and negative emotions, thereby contributing to sleep disturbance. Interventions targeting sleep alone may therefore be insufficient; addressing the underlying determinants of quality of life—by strengthening social support, providing systematic disease education, and offering more acceptable glycaemic-control protocols—may better promote sleep health in women with GDM.

Limitations

This study has several limitations. First, its cross-sectional design precludes causal inference regarding the relationship between SJL and its associated factors. Second, sleep timing was assessed using a self-reported questionnaire (MCTQ) rather than objective measures such as actigraphy, which may introduce recall bias. Third, all participants were recruited from a single tertiary hospital in Nanjing, which limits generalizability to other settings and populations. Fourth, the relatively small sample size

produced wide confidence intervals for some subgroups (e.g., the civil service / public institution category), and these estimates should be interpreted with caution. Fifth, glycaemic indicators such as HbA1c and pregnancy outcomes were not collected; their inclusion would have strengthened the clinical interpretation. Finally, although self-regulatory fatigue was significantly correlated with SJL in bivariate analysis, its collinearity with quality of life precluded assessment of its independent contribution in the multivariable model. Prospective studies incorporating objective circadian measures, glycaemic data, and larger samples are warranted to confirm and extend these findings.

Conclusions

Social jetlag is highly prevalent among women with GDM, with 40% experiencing SJL of at least one hour. Higher social jetlag was independently associated with younger age, family history of diabetes, pre-pregnancy alcohol consumption, employment in the civil service or public institutions, and lower quality of life. Beyond subjective sleep complaints, women with GDM may also be at risk of objective circadian misalignment, particularly those younger than 35 years, those with a family history of diabetes or pre-pregnancy alcohol consumption, and those with an impaired work–life balance. Healthcare professionals should conduct early assessment and screening for these risk factors and implement timely, personalized interventions to improve the sleep patterns and circadian rhythms of women with GDM, thereby promoting better maternal and neonatal outcomes.

Abbreviations

GDM
Gestational Diabetes Mellitus
SJL
Social Jetlag
ADA
American Diabetes Association
EASD
European Association for the Study of Diabetes
BMI
Body Mass Index
HPA
Hypothalamic–Pituitary–Adrenal
MSF
Mid-Sleep on Free Days
MSW
Mid-Sleep on Workdays
MCTQ
Munich Chronotype Questionnaire
SRF-S

Self-Regulatory Fatigue Scale
GDMQ
Quality of Life Questionnaire for women with GDM
OR
Odds Ratio
CI
Confidence Interval
HbA1c
Glycated Hemoglobin

Declarations

Ethics approval and consent to participate

This study was approved by the Ethics Committee of the Women's Hospital of Nanjing Medical University (approval number 2022-KY-1186-001) and was conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from all participants prior to enrolment.

Consent for publication

Not applicable. This manuscript does not contain any individual person's identifiable data.

Competing interests

The authors declare that they have no competing interests.

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Author Contribution

HJ: conceptualization, methodology, formal analysis, data curation, writing – original draft. ZZJ: investigation, data curation, project administration, writing – review and editing. WJ: writing – review and editing. SCJ: conceptualization, methodology, investigation, resources, supervision, funding acquisition, writing – review and editing. HGF: conceptualization, methodology, investigation, resources, supervision, writing – review and editing. All authors read and approved the final manuscript.

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Availability of data and materials

The datasets generated and analysed during the current study are not publicly available owing to participant privacy considerations but are available from the corresponding author on reasonable request.

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