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Maternal meal irregularities during pregnancy and lifestyle correlates

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ABSTRACT

Meal regularity can influence metabolic health. However, habits of skipping and delaying meals are rarely studied among pregnant women. This study examined the incidence of maternal meal skipping and meal delaying, and their associated lifestyle patterns during pregnancy. Pregnant women in the second trimester (18–24 weeks' gestation; n = 90) were recruited from the antenatal clinics in KK Women's and Children's Hospital, Singapore, 2019–2020. Data on sociodemographic, lifestyle and dietary habits were collected. Firstly, principal component analysis was used to identify lifestyle patterns. Subsequently, multiple logistic regression model was used to examine the association of lifestyle patterns with meal skipping and delaying. In total, 32 (35.6%) women had irregular meals, in which 25 (27.8%) and 26 (28.9%) women reported meal skipping and meal delaying for at least 3 times a week, respectively. Women with 'poor sleep and emotion' pattern as characterized by higher scores for poor sleep, depression, anxiety, and stress symptoms were associated with higher odds of meal skipping (OR 1.99; 95% CI 1.13, 3.53) and meal delaying (2.50; 1.31, 4.79). 'Sedentary' pattern, as characterized by greater daily time spent on television and screen electronic devices, and 'weight and inactivity' pattern, as characterized by higher BMI and physical inactivity level, were not associated with meal regularity. In this study, almost one-third of women reporting meal irregularities during pregnancy. 'Poor sleep and emotion' pattern is associated with a higher incidence of meal skipping and delaying. These findings suggest the need to address sleep and emotional health in interventions promoting healthy nutrition specifically regular eating in pregnancy.

1. Introduction

Irregular meal patterns are common in today's society, which can be attributable to the erratic work schedules, inconsistent family meal patterns, and unhealthy weight control practices (Lopez-Minguez, Gómez-Abellán, & Garaulet, 2019; Schoenfeld, Aragon, & Krieger, 2015). Meal skipping, defined as skipping either breakfast, lunch or dinner throughout the day, varies between 5 and 83% in adults (Lopez-Minguez et al., 2019; Pendergast, Livingstone, Worsley, & McNaughton, 2016). There is increasing evidence to show that meal skipping is linked with metabolic disease, including obesity, type 2 diabetes and cardiovascular diseases (Ballon, Neuenschwander, & Schlesinger, 2019; Gontijo et al., 2019; Kim, DeRoo, & Sandler, 2011). This could be attributed to metabolic aberrations secondary to disrupted circadian rhythms resulting from irregular meal patterns (Gonçalves, Freitas, Freitas-Rosa, & Machado, 2015). Nonetheless, meal skipping is not well studied in pregnant women, a population who is at higher risk of metabolic vulnerability (Gontijo et al., 2019; Gonçalves et al., 2015) due to hormonal and physiological changes such as increased insulin resistance, estrogen and progesterone levels (Soma-Pillay, Nelson-Piercy, Tolppanen, & Mebazaa, 2016), as well as shifts in circadian function for metabolic adaptions during pregnancy

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(Martin-Fairey et al., 2019).

Previous studies have associated lifestyle factors such as short sleep, physical inactivity, emotional stress, and high weight status with meal skipping behaviour among young adults (Aryee, Helegbe, Baah, Sarfo-Asante, & Quist-Therson, 2013; Chang, Boolani, Conroy, Dunietz, & Jansen, 2021; Gonçalves et al., 2015; Nas et al., 2017; Stanton et al., 2021). A recent cohort study of 329 American adults found that females with delayed timing of sleep and shorter sleep duration were more likely to skip breakfast as compared to males (Chang et al., 2021). Another cohort study among 220 full-time nurses in Ghana found that those who skipped their breakfast showed a higher risk of weight gain and increased sedentary lifestyle as compared to their counterparts (Aryee et al., 2013). Stanton et al. (2021) reported that meal skipping behaviours were associated with poor mental health including stress, anxiety, and depression among 500 Australian nursing students. However, majority of these studies mainly examined skipping of a single meal, did not assess the aforementioned lifestyle correlates simultaneously and were conducted among non-pregnant populations.

To date, most studies investigating meal irregularities have focused on breakfast skipping (Gibney et al., 2018; Shiraishi, Haruna, & Matsuzaki, 2019). However, not only breakfast, skipping any meal is likely to be detrimental to health (Pendergast et al., 2016). In women, lunch and dinner skipping occur more frequently than in men (Neslişah & Emine, 2011; Pendergast et al., 2016). Interestingly, most of the studies of meal irregularities focused only on meal skipping, but not meal delaying. Indeed, certain circadian clocks such as plasma glucose rhythms were found to be delayed in conjunction with meal timings (Wehrens et al., 2017).

In this study, we aimed (1) to examine the incidence of maternal meal irregularities, as defined by skipping and/or delaying breakfast, lunch, and dinner, and (2) to understand the lifestyle patterns associated with meal irregularities among pregnant women from general population. These findings have the potential to provide evidence to support the design of subsequent dietary and lifestyle interventions aiming to improve maternal outcomes during pregnancy.

2. Methods

2.1. Study design and participants

Data was derived from an on-going prospective cohort study designed to investigate maternal night-eating patterns and glucose tolerance during pregnancy (Clinicaltrials.gov, NCT 03803345), as described elsewhere (Loy et al., 2019). This study was conducted according to the Helsinki Declaration and approved by the Centralised Institutional Review Board of SingHealth (2018/2529). Written informed consent was obtained from all participants.

Women attending antenatal care in their second trimester of pregnancy (18–24 weeks gestation) at KK Women's and Children's Hospital (KKH) in Singapore were recruited. These women aged ≥18 years and were Singaporean citizens or Singapore permanent residents. Women diagnosed with gestational diabetes mellitus (GDM) at recruitment, with pre-existing type-1 or type-2 diabetes, on routine night-shift work, using anticonvulsant medications or oral steroids were excluded.

2.2. Data collection

Trained research staff conducted face-to-face interview to ascertain maternal socio-demographic and lifestyle characteristics. Smoking exposure (yes/no) was defined as currently smoking or reported passive smoking exposure. Height in centimetres (cm) were measured using a stadiometer (SECA model 213, Hamburg, Germany). Pre-pregnancy body mass index (BMI) was calculated using the formula: recalled pre-pregnancy weight (kg)/height measured at recruitment (m^2) (World Health Organization, 2004).

Sedentary behaviour was assessed by asking about times spent i) sitting/lying down while watching television, and ii) sitting/lying down viewing electronic devices other than television and computer use at work (Padmapriya et al., 2015). Physical activity was assessed using the International Physical Activity Questionnaire-Short (IPAQ, 2004). The data was computed into metabolic equivalents (MET-minutes/week) scores and categorized as "highly inactive" (<600 MET-minutes/week), "moderately inactive" (≥600 and < 3000 MET-minutes/week) or "minimally inactive" (≥3000 MET-minutes/week) (Padmapriya et al., 2015).

Participants self-administered the Pittsburgh Sleep Quality Index (PSQI) questionnaire to assess their sleep quality (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989), and the Depression Anxiety Stress Scale (DASS-21) questionnaire to assess the severity of symptoms of depression, anxiety and stress (Lovibond & Lovibond, 1995). A global PSQI score of <5 and ≥ 5 indicate good and poor sleep quality, respectively (Buysse et al., 1989). The DASS-21 contains seven questions for each of the three subscales: depression, anxiety, and stress. Each question was scored on a four-point scale ranging from 0 to 3, where 0 implied not applicable and 3 applicable very much or most of the time. The subscale scores were summated and multiplied by 2 for proper labelling of severity (Lovibond & Lovibond, 1995). A score of >9 points, >7 points, and >14 points on each subscale indicate the presence of depression, anxiety, and stress over the previous week, respectively. For data analysis, we grouped each subscale into two categories; "Yes" (indicate either the presence of depression, anxiety, or stress) and "No" (normal). The DASS-21 was shown to be valid and reliable to assess these three domains among Asian pregnant women (Tran, Tran, & Fisher, 2013), and has been previously used in Singapore population (Ng, Koh, Tagore, & Mathur, 2020).

2.3. Meal regularity assessment

We assessed maternal meal skipping and delaying by asking the following questions: "During the past one month, how often did you skip your breakfast, lunch and/or dinner?" and "During the past one month, how often did you delay your breakfast, lunch and/or dinner for more than 2 h from your regular meal timings?" respectively. We defined meal skipping and delaying based on respective skipping and delaying of at least one main meal for ≥3 times a week. We defined meal irregularity based on the combination of skipping and/or delaying of at least one main meal for ≥3 times a week.

2.4. Statistical analysis

All statistical analyses were performed using the IBM Statistical Package for the Social Sciences, version 19. Differences between the groups were assessed by Fisher's exact tests for categorical variables and independent *t*-tests for continuous variables. We conducted principal component analysis with varimax rotation to identify lifestyle patterns to reduce the number of variables in the model to avoid overfitting. All the variables were standardized to Z-score with a standard deviation of 1. Three components were derived: 1) poor sleep and emotion, 2) sedentary behaviour, 3) weight and physical inactivity, with eigenvalues exceeding 1.0. In total, these components accounted for 67% of the variance (Table 1). We performed multiple logistic regression analysis to examine the associations of these three components with meal irregularity, adjusted for age, ethnicity, smoking exposure and employment status. Potential confounders that have been commonly reported to influence meal irregularity and its lifestyle factors were determined from the literature (Leech, Worsley, Timperio, & McNaughton, 2015; Zhang, Cordeiro, Liu, & Ma, 2017), based on clinical judgement and using a directed acyclic graph. Data were presented as odds ratios (ORs) and confidence intervals (CIs).

Table 1
Structures of three orthogonally rotated factors identified by principal component analysis in 90 pregnant women.

Patterns	Variables	Factor loadings coefficient	Cumulative variance explained (%)
Sleep & emotion	PSQI score	0.63	36.40
	Depression score	0.90	
	Anxiety score	0.91	
	Stress score	0.92	
Sedentary behaviour	Electronic devices use	0.76	52.38
	Television watching	0.78	
Weight & inactivity	Physical inactivity	0.64	67.68
	Pre-pregnancy BMI	0.68	

* Variables with factor loading between 0.35 and −0.35 are not listed. PSQI, Pittsburgh Sleep Quality Index; BMI, body mass index.

3. Results

A total of 90 pregnant women with mean gestational age of 20.5 weeks were recruited between March 2019 and January 2020. The proportion of women who skipped meals for ≥3 times a week was 21.1% (n = 19) for breakfast, 1.1% (n = 1) for lunch and 6.7% (n = 6) for dinner. The proportion of women who delayed meals for ≥3 times a week was 20.0% (n = 18) for breakfast, 11.1% (n = 10) for lunch and 8.9% (n = 8) for dinner (Fig. 1).

There were 27.8% (n = 25) and 28.9% (n = 26) women reported skipping and delaying their meals for ≥3 times a week, respectively. Of which, 21.1% (n = 19) reported both skipping and delaying their meals for ≥3 times a week. In total, 35.6% (n = 32) women showed irregular meal intake during pregnancy. Women who skipped meals for ≥3 times a week were more likely to be ethnically Malay (60.0% vs. 13.8%), be exposed to cigarette smoke (76.0% vs. 32.3%) and have poor sleep quality (92.0% vs. 40.0%) compared with women who skipped meals <3 times a week. Women who delayed their meals for ≥3 times a week were more likely to be ethnically Malay (53.8% vs. 15.6%), be unemployed (34.6% vs. 7.8%), be exposed to cigarette smoke (73.1% vs. 32.8%), spend longer time on screen electronic devices (3.8 vs. 2.1 h/day), have poor sleep quality (92.3% vs. 39.1%) and display symptoms of depression (46.2% vs. 20.3%) and stress (46.2% vs. 18.8%), as compared to their counterparts (Table 2).

As shown in Table 3, women with 'poor sleep and emotion' pattern, as characterized by higher scores for poor sleep, depression, anxiety and stress, were associated with higher odds of meal skipping (OR 1.99; 95% CI 1.13, 3.53), meal delaying (OR 2.50; 95% CI 1.31, 4.79) and meal irregularity (OR 2.29; 95% CI 1.29, 4.08). 'Sedentary' pattern as characterized by greater daily time spent on television and screen electronic devices while sitting or lying down, and 'weight and inactivity' pattern as characterized by higher BMI and physical inactivity level were not associated with meal skipping, meal delaying and meal irregularity.

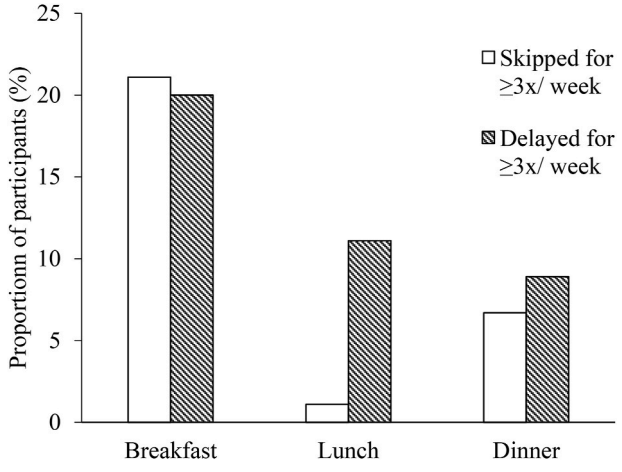

Fig. 1. Bar chart presenting the distribution of meal skipping and meal delaying for each main meal.

4. Discussion

In this study, we examined the incidence and lifestyle correlates of meal irregularity in pregnant women during the second trimester. We found that 36% of women had irregular meals, in which 28% reported meal skipping and 29% reported meal delaying for at least 3 times a week. Breakfast represented the most frequently skipped and delayed meal as compared to lunch and dinner. Not surprisingly, breakfast was also the most frequently studied, where previous studies showed that breakfast skipping ranged from 20% to 38% in pregnant women, depending on the trimester and definition used (Englund-Ögge et al., 2017; Fowles et al., 2011; Shiraishi et al., 2019). To our knowledge, the current study is the first to examine the incidence of maternal meal skipping and delaying independently, along with the associated maternal characteristics. We provided novel data on the regularity of other meals, namely lunch and dinner.

We found that women with a 'poor sleep and emotion' pattern had a higher likelihood of meal skipping and delaying in pregnancy. So far, evidence for the relationship between sleep and meal regularity in pregnant women is very limited. A large prospective cohort study of 27,983 American women aged 35–74 years showed that those with less than 6 h of sleep often eat at unconventional timings (i.e., before regular mealtimes and after bedtime) and had a snack-dominated eating pattern (Kim et al., 2011). In another cross-sectional study of 15,199 Americans adult aged 20 years and above, short sleepers tended to skip main meals and obtained ≥50% of energy from snack episodes (Kant, 2018). However, both studies focused only on sleep duration, and involved non-pregnant populations. We provided additional evidence supporting poor sleep quality, which is a common problem among pregnant women, was associated with meal irregularity during pregnancy.

Consistent with previous studies involving pregnant women (Fowles et al., 2011; Gonçalves et al., 2015), we showed that those who experienced emotional issues such as depression, anxiety, and/or perceived stress were more likely to have irregular meals in pregnancy. Distress symptoms have been reported to potentially influence an individual's ability to maintain a healthy eating pattern (Gonçalves et al., 2015). A prospective cohort study reported that compared to healthy women in the third trimester of pregnancy, those with physical or emotional distress were more likely to consume a greater amount of snacks and often binge-eat (Gonçalves et al., 2015). Similarly, another cross-sectional study examining 71 low-income Hispanic women in their first trimester found that antenatal depression and stress were associated with poor eating habits such as meal skipping and having less control over meal preparation (Fowles et al., 2011). This highlights the pivotal importance of elucidating such psychological conditions that underpins the behavioural manifestation of irregular meal patterns. Addressing the underlying psychological condition may be key to correcting the irregular meal patterns, which have been associated with poor metabolic health (Gonçalves et al., 2015).

The current study has several strengths and limitations. It is the first to examine meal irregularity based on breakfast, lunch and dinner skipping and delaying among pregnant women. Multiple lifestyle correlates of meal irregularity were also assessed simultaneous in this study. This study is mainly limited by the use of questionnaires to assess lifestyle and meal irregularity behaviour, as well as the use of self-reported pre-pregnancy weight, which could subject to recall bias. However, those lifestyle questionnaires for the assessments of sleep, emotion, physical activity and sedentary behaviour have shown to be

Table 2
Descriptive characteristics of 90 pregnant women according to the regularity of meal consumption during the past one month.

Maternal characteristics	Total (N = 90)	Meal skipping		P[a]	Meal delaying		P[a]	Meal irregularity		P[a]
		≥3x/week (n = 25, 27.8%)	<3x/week (n = 65, 72.2%)		≥3x/week (n = 26, 28.9%)	<3x/week (n = 64, 71.1%)		Yes (n = 32, 35.6%)	No (n = 58, 64.4%)	
Age, years	30.9 ± 4.37	30.0 ± 4.31	31.3 ± 4.37	.219	29.8 ± 4.63	31.4 ± 4.21	.117	29.8 ± 4.27	31.6 ± 4.32	.060
Prepregnancy BMI, kg/m2	23.09 ± 3.99	23.51 ± 5.05	22.93 ± 3.54	.607	23.51 ± 5.05	22.93 ± 3.54	.320	23.66 ± 4.72	22.78 ± 3.54	.365
Ethnicity				.001			.002			.001
Chinese	60 (66.7)	8 (32.0)	52 (80.0)		10 (38.5)	50 (78.1)		13 (40.6)	47 (81.0)	
Malay	24 (26.7)	15 (60.0)	9 (13.8)		14 (53.8)	10 (15.6)		17 (53.1)	7 (12.1)	
Indian	5 (5.6)	2 (8.0)	3 (4.6)		2 (7.7)	3 (4.7)		2 (6.3)	3 (5.2)	
Others	1 (1.1)	0	1 (1.5)		0	1 (1.6)		0	1 (1.7)	
Education				.133			.145			.157
Below tertiary	10 (11.1)	5 (20.0)	5 (7.7)		5 (19.2)	5 (7.8)		6 (18.8)	4 (6.9)	
Tertiary	80 (88.9)	20 (80.0)	60 (92.3)		21 (80.8)	59 (92.2)		26 (81.3)	54 (93.1)	
Employment Status				.522			.003			.030
Unemployed	14 (15.6)	5 (20.0)	9 (13.8)		9 (34.6)	5 (7.8)		9 (28.1)	5 (8.6)	
Employed	76 (84.4)	20 (80.0)	56 (86.2)		17 (65.4)	59 (92.2)		23 (71.9)	53 (91.4)	
Smoking exposure				.001			.001			.001
Yes	40 (44.4)	19 (76.0)	21 (32.3)		19 (73.1)	21 (32.8)		23 (71.9)	17 (29.3)	
No	50 (55.6)	6 (24.0)	44 (67.7)		7 (26.9)	43 (67.2)		9 (28.1)	41 (70.7)	
Alcohol consumption 3 months before conceiving				.774			.570			1.000
Yes	19 (21.1)	6 (24.0)	13 (20.0)		4 (15.4)	15 (23.4)		7 (21.9)	12 (20.7)	
No	71 (78.9)	19 (76.0)	52 (80.0)		22 (84.6)	49 (76.6)		25 (78.1)	46 (79.3)	
Sedentary behaviour (hours)										
Television watching	1.68 ± 1.61	1.35 ± 1.31	1.80 ± 1.71	.236	1.89 ± 2.01	1.59 ± 1.43	.423	1.77 ± 1.87	1.62 ± 1.46	.673
Screen electronic devices use	2.59 ± 2.87	3.24 ± 3.09	2.33 ± 2.76	.175	3.82 ± 3.59	2.08 ± 2.37	.030	3.41 ± 3.38	2.13 ± 2.46	.042
Physical inactivity				.844			.395			.934
Highly inactive	18 (20.0)	5 (20.0)	13 (20.0)		7 (26.9)	11 (17.2)		7 (21.9)	11 (19.0)	
Moderate inactive	47 (52.2)	12 (48.0)	35 (53.8)		14 (53.8)	33 (51.6)		16 (50.0)	31 (53.4)	
Minimally inactive	25 (27.8)	8 (32.0)	17 (26.2)		5 (19.2)	20 (31.3)		9 (28.1)	16 (27.6)	
PSQI score	6.02 ± 2.44	7.84 ± 2.17	5.32 ± 2.17	.001	7.85 ± 2.29	5.28 ± 2.09	.001	7.59 ± 2.21	5.16 ± 2.11	.001
Sleep Quality				.001			.001			.001
Poor Sleep	49 (54.4)	23 (92.0)	26 (40.0)		24 (92.3)	25 (39.1)		28 (87.5)	21 (36.2)	
Good Sleep	41 (45.6)	2 (8.0)	39 (60.0)		2 (7.7)	39 (60.9)		4 (12.5)	37 (63.8)	
DASS 21										
Depression				.122			.019			.015
Yes	25 (27.8)	10 (40.0)	15 (23.1)		12 (46.2)	13 (20.3)		14 (43.8)	11 (19.0)	
No	65 (72.2)	15 (60.0)	50 (76.9)		14 (53.8)	51 (79.7)		18 (56.3)	47 (81.0)	
Anxiety				.347			.102			.082
Yes	42 (46.7)	14 (56.0)	28 (43.1)		16 (61.5)	26 (40.6)		19 (59.4)	23 (39.7)	
No	48 (53.3)	11 (44.0)	37 (56.9)		10 (38.5)	38 (59.4)		13 (40.6)	35 (60.3)	
Stress				.109			.016			.045
Yes	24 (26.7)	10 (40.0)	14 (21.5)		12 (46.2)	12 (18.8)		13 (40.6)	11 (19.0)	
No	66 (73.3)	15 (60.0)	51 (78.5)		14 (53.8)	52 (81.3)		19 (59.4)	47 (81.0)	

Values are in means ± SDs or n (%); unless otherwise stated. BMI, body mass index; PSQI, Pittsburgh Sleep Quality Index; DASS21, Depression Anxiety Stress Scale.
[a] Based on independent *t*-test for continuous variables or Fisher's exact test for categorical variables.

valid for use in pregnant population (Padmapriya et al., 2015). For meal irregularity assessment, multiple days food diaries during weekdays and weekends will be an ideal approach. However, the use of questionnaires for asking meal irregularity has been widely reported across studies (Englund-Ögge et al., 2017; Gontijo et al., 2019; Kant, 2018), with good validation shown against food diaries (Crozier, Inskip, Godfrey, & Robinson, 2008). As this study only focused on the second trimester, thereby restricting the findings to other trimesters of pregnancy.

The present findings may have public health implications as irregular meal intake during pregnancy has the potential to increase insulin resistance and postprandial plasma glucose (Englund-Ögge et al., 2017), predisposing them to an increased risk of gestational diabetes. Evidence suggests that maternal dietary inadequacies due to frequent meal skipping or delaying during pregnancy can also negatively influence fetal growth, with implications for adverse later life metabolic effects on offspring's future health (Lowensohn, Stadler, & Naze, 2016; Morrison & Regnault, 2016). In particular, breakfast skipping in early pregnancy was associated with off-spring obesity development through the first 12 years of life (Morrison & Regnault, 2016).

Future prospective cohort study can consider assessing maternal meal skipping and delaying behaviour using multiple food diaries across different trimesters. This will provide a better understanding on the meal pattern changes at each specific pregnancy windows. In addition, it is worth to consider using mobile phone food record app with image capture function and timestamps to improve accuracy of meal regularity assessment. These methods allow flexibility of using different time frames to define types of meals and provide a complete meal intake pattern over 24 h. Importantly, there is a need to continue follow-up these women to evaluate how would meal irregularity during pregnancy can influence their metabolic health and pregnancy outcomes.

5. Conclusion

Almost one-third of women skipped and/or delayed their meals during pregnancy, particularly breakfast. 'Poor sleep and emotion' pattern was associated with a higher incidence of meal skipping and delaying. Though with uncertain causal relations, these preliminary findings serve as reference and highlight the need to evaluate sleep and

Table 3
Associations between maternal lifestyle patterns and meal irregularity during pregnancy (n = 90).

Lifestyle patterns	Meal skipping	Meal delaying	Meal irregularity
	Adjusted OR (95% CI)	Adjusted OR (95% CI)	Adjusted OR (95% CI)
Poor sleep and emotion[a]	1.99 (1.13, 3.53)	2.50 (1.31, 4.79)	2.29 (1.29, 4.08)
Sedentary behaviour[b]	1.09 (0.56, 2.12)	1.81 (0.94, 3.50)	1.40 (0.77, 2.53)
Weight and physical inactivity[c]	0.97 (0.56, 1.67)	1.97 (0.95, 4.08)	1.38 (0.75, 2.52)

Analysis was performed using multiple logistic regression model, adjusted for age, ethnicity, smoking exposure, and employment status. OR, odds ratio; CI, confidence interval.

[a] Characterized by higher scores for poor sleep, depression, anxiety and stress.

[b] Characterized by longer hours for television watching and screen electronic device use per day while sitting/lying down.

[c] Characterized by higher pre-pregnancy body mass index and physical inactivity level.

emotional health in interventions improving maternal dietary habits specifically regular eating during pregnancy.

Contributors

Rachael Si Xuan Loo: Formal analysis, Recruitment, Writing – Original draft preparation. **See Ling Loy:** Supervision, Conceptualization, Methodology, Writing – Reviewing and Editing. **Yin Bun Cheung:** Conceptualization, Statistical advice, Methodology, Writing – Reviewing and Editing. **Fabian Yap, Chee Wai Ku, Kok Hian Tan, Jerry Kok Yen Chan:** Conceptualization, Recruitment, Writing – Reviewing and Editing.

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Ethical statement

This research is supported by the Singapore Ministry of Health's National Medical Research Council under its Open Fund-Young Individual Research Grant (NMRC/OFYIRG/0082/2018). The funder has no role in the study design, collection, analysis, interpretation of data, the writing of the manuscript, or the decision to submit the manuscript for publication. Ethical approval has been granted by the Centralised Institutional Review Board of SingHealth (reference 2018/2529).

Declaration of competing interest

The authors declare no conflict of interest.

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