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Physical activity during early pregnancy and antenatal depression: A prospective cohort study

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ABSTRACT

Background: Despite the known health benefits of physical activity, its impact on depression during pregnancy remains inconclusive, especially in Asian populations. A large prospective cohort study was conducted to ascertain the association between total and domain-specific physical activity during early pregnancy and antenatal depression in Chinese women.

Methods: Information was collected prospectively from a cohort of 1440 pregnant women in Chengdu, Western China. Habitual physical activities (total, domain-specific and intensity level) were measured by the validated Chinese version of the Pregnancy Physical Activity Questionnaire during the first trimester. Antenatal depressive symptoms were assessed using the Edinburgh Postnatal Depression Scale (EPDS) at 32–37 weeks of gestation. Multivariable linear and logistic regression analyses were undertaken, modelling EPDS as both continuous score and binary variable, respectively.

Results: Overall, the mean EPDS score was 9.3 (SD 3.7) and the prevalence of antenatal depression (EPDS ≥13) was 17.5% (n = 252). The mean total physical activity was 149.1 (SD 84.2) MET-hours/week. A high level of occupational activity (> 73 MET-hours/week) was associated with a reduced risk of antenatal depression (odds ratio 0.57; 95% CI 0.37 to 0.94). A similar inverse association was evident for the continuous EPDS score. However, no apparent associations with EPDS were observed for total, other domains and intensities of physical activity exposures.

Limitations: Lack of information on history of major depression. Use of self-reported questionnaires instead of objective measures of physical activity and clinical diagnosis of antenatal depression.

Conclusions: Being active at work during early pregnancy may reduce antenatal depressive symptoms for Chinese women.

1. Introduction

As a stressful life event accompanied by hormonal changes, pregnancy is often associated with heightened depressive symptoms (Bennett, Einarson, Taddio, Koren, & Einarson, 2004). The prevalence of antenatal depression can increase from 7.4% in the first trimester to 12% in the third trimester (Bennett et al., 2004), suggesting that women are more susceptible to depression during late pregnancy. Asian women are especially at higher risk of developing antenatal depressive symptoms than their European counterparts (Gavin et al., 2011). Previous studies showed that the prevalence of antenatal depression in Asia ranges from 5.5% to 23.1%, depending on the assessment tools used and study populations (Mohamad Yusuff, Tang, Binns, & Lee, 2016; Roomruangwong & Epperson, 2011; Schatz, Hsiao, & Liu, 2012). However, data from China remain limited, with an estimated prevalence varying between 4.4% and 35.9% (Lau, Yin, & Wang, 2011; Lee et al., 2004; Zeng, Cui, & Li, 2015). Antenatal depression is known to be a precursor for postpartum depression (Underwood, Waldie, D'Souza, Peterson, & Morton, 2017). It is also associated with obstetric events such as preeclampsia and preterm labor, and adverse delivery outcomes (e.g. low birth weight, admission to neonatal intensive care) (Alder, Fink, Bitzer, Hösli, & Holzgreve, 2007).

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The beneficial effects of physical activity against depression have been well documented in the general population (Rebar et al., 2015), but evidence concerning antenatal depression remains inconclusive (Demissie et al., 2011; Padmapriya et al., 2016; Szegda et al., 2018). A previous meta-analysis of intervention studies have reported that aerobic exercise can reduce depressive symptoms during pregnancy (Daley et al., 2015). It should be noted, however, the meta-analysis results were drawn from a small number (n = 6) of low-moderate quality studies with a high level of heterogeneity (Daley et al., 2015). The domains of physical activity may also play a role in the risk of antenatal depression. For example, one study showed that participation in adult/child care and indoor household activities increased depressive symptoms during pregnancy, opposite to the effect of total physical activity (Demissie et al., 2011). It is important to assess the association between habitual domain-specific physical activity and antenatal depression among Asian women, where evidence remains lacking before appropriate intervention could be developed.

The aim of the present study was to investigate the association between total and domain-specific physical activity during early pregnancy and antenatal depression in Chinese women, whose patterns of physical activity during pregnancy are different from those of Western populations (Hallal et al., 2012).

2. Methods

2.1. Study design and participants

This study is part of a large prospective cohort study of maternal health in China (Tang et al., 2017). Between May and August 2015, 1901 pregnant women were recruited from four maternity hospitals in Chengdu, capital of Sichuan Province. All pregnant women who attended routine antenatal care at baseline (15–20 weeks of gestation) were invited to participate in the study. Eligibility criteria were 18–40 years of age, singleton pregnancy, without infertility treatment and without severe chronic or infectious diseases. Face-to-face interviews were conducted by trained nurses at baseline and at 32–37 weeks of gestation. All participants provided written informed consent. The study protocol was approved by the human research ethics committees of the researchers' institution (approval no. HR30/2015).

Of the 1901 participants, those with missing information on antenatal depressive symptoms (n = 461) were excluded, leaving 1440 individuals for statistical analysis. The original sample size (n = 1850) was derived from the comparison of expected macrosomia rates between overweight/obese women and normal/underweight women at childbirth. For the present study, assuming an odds ratio of 0.5 for antenatal depression among women with a high level of physical activity (Padmapriya et al., 2016), a sample of 1430 would be required to yield 80% power at 5% significance level, using the Fleiss method with the correction factor (Fleiss, Levin, & Paik, 2003). Therefore, the final sample size of n = 1440 should be sufficient to determine the association between physical activity and depression during pregnancy for Chinese women. There were no significant differences between excluded and included participants in terms of age, education level, occupation, income, parity, pre-pregnancy BMI, smoking before pregnancy, presence of gestational diabetes and other maternal health conditions ($p > 0.05$).

2.2. Assessment of physical activity

Habitual physical activity during the first trimester was assessed at baseline using the validated Pregnancy Physical Activity Questionnaire (PPAQ), Chinese version, which has shown good reliability and validity for assessing total physical activity with an intraclass correlation coefficient of 0.77 and Spearman correlation coefficient of 0.35 ($p < 0.01$) between the questionnaire and accelerometer data (Xiang et al., 2016). The PPAQ measures the duration, frequency, and intensity of physical activity during the past three months of pregnancy. It is a semi-quantitative questionnaire that solicits the time spent in 31 activities under four domains, namely, household/caregiving, occupation, sports/exercise, and transportation. For each activity, an energy expenditure in terms of metabolic equivalent task (MET)-hours per week was calculated by multiplying the reported duration and its intensity (Xiang et al., 2016). Total physical activity was the sum of energy expenditures across all activities. The scoring mechanism specified the classification of physical activity into sedentary (< 1.5 METs), light (1.5- < 3 METs), moderate (3–6 METs) and vigorous (> 6 METs) intensity levels (Xiang et al., 2016). In this study, the physical activity variables were (1) standardized by subtracting their mean and dividing by the corresponding standard deviation (SD), and (2) categorized into two or three groups depending on their empirical distribution.

2.3. Assessment of antenatal depressive symptoms

Maternal depressive symptoms were assessed during the third trimester (32–37 weeks of gestation), using a Chinese version of the Edinburgh Postnatal Depression Scale (EPDS) (Wang et al., 2009). EPDS is a 10-item self-reported scale on depressive symptoms such as sad feelings, anxiety and thoughts of self-harming. Each item is rated on a 4-point scale (from 0 to 3), and the total EPDS score ranges from 0 to 30, with higher scores representing higher levels of depressive symptoms. The Chinese version of EPDS has been shown to be reliable and valid for screening Chinese women for antepartum depression, with Cronbach's alpha, Guttman's split-half coefficient and test-retest reliability ranging from 0.76 to 0.85, which are above the generally accepted value of 0.7 (Wang et al., 2009). We further dichotomized the EPDS variable, with score ≥13 indicating probable antenatal depression. Although a cut-off score of 9.5 has been proposed (Wang et al., 2009), our analysis adopted the conservative threshold of 13 to avoid overestimation of the prevalence, as well as being optimal in detecting major depressive disorder for the Chinese population (Su et al., 2007).

2.4. Other measurements

The baseline interview collected information on age, pre-pregnancy weight, family history of diabetes, education, employment status, household income and parity. Height was measured by a stadiometer. Body mass index (BMI) was calculated by pre-pregnancy weight (kg) divided by square of height (m^2). Gestational diabetes was diagnosed using the standard 75 g, 2-h oral glucose tolerance test. Maternal conditions, including hypertension before pregnancy, gestational hypertension, preeclampsia, hypertensive disorder in pregnancy and gestational anaemia, were extracted from medical records.

2.5. Statistical analysis

The socio-demographic characteristics of participants were presented and compared between EPDS groups (≥13 and < 13) using Pearson's chi-square test. The mean (SD) EPDS scores by these characteristics were also compared using t-tests or analysis of variance. Multivariable linear regressions and logistic regressions were undertaken to determine the association between physical activity during early pregnancy and antenatal depression, using EPDS as continuous and binary variables respectively, adjusting for age, education level, occupation and annual household income per capita in the models. These plausible confounders were chosen based on the literature (Lancaster et al., 2010; Rich-Edwards et al., 2006), their apparent univariate association with the outcome ($p < 0.2$) and a 10% "change-in-estimate" (Maldonado & Greenland, 1993). Statistical analyses were performed using Stata version 14.2 (Stata Corp LP, College Station, TX).

Table 1
Characteristics of participants by antenatal EPDS score and depression status.

Characteristics	Total	EPDS score		EPDS ≥13		
	n (%) or mean ± SD	mean ± SD	p[a]	No, n (%)	Yes, n (%)	p[b]
Total	1440 (100)	9.3 ± 3.7		1188 (82.5)	252 (17.5)	
Age (year)			< 0.01			0.03
< 25	568 (39.4)	9.8 ± 3.7		450 (37.9)	118 (46.8)	
25–29	635 (44.1)	9.1 ± 3.7		530 (44.6)	105 (41.7)	
30–34	196 (13.6)	8.9 ± 3.6		171 (14.4)	25 (9.9)	
≥35	41 (2.9)	8.6 ± 3.7		37 (3.1)	4 (1.6)	
Education level			< 0.001			< 0.001
Junior secondary school or below	363 (25.2)	10.1 ± 3.7		275 (23.1)	88 (34.9)	
Senior/technical secondary school	551 (38.3)	9.4 ± 3.6		456 (38.4)	95 (37.7)	
University or above	526 (36.5)	8.7 ± 3.7		457 (38.5)	69 (27.4)	
Occupation before pregnancy			< 0.01			0.09
Unemployed; farmer/fisherman/hunter	360 (25.0)	9.8 ± 3.7		285 (24.0)	75 (29.8)	
Driver/electric welder/machine operator; service workers	563 (39.1)	9.4 ± 3.8		464 (39.1)	99 (39.3)	
Office staff; professional/technical worker; administrator/executive/manager	517 (35.9)	8.9 ± 3.6		439 (37.0)	78 (31.0)	
Annual household income (RMB)[c]			0.03			0.04
< 40,000	574 (40.1)	9.6 ± 3.8		454 (38.5)	120 (47.6)	
40,000–79,999	510 (35.6)	9.4 ± 3.5		426 (36.1)	84 (33.3)	
80,000–119,999	255 (17.8)	8.8 ± 3.7		220 (18.6)	35 (13.9)	
≥120,000	93 (6.5)	8.9 ± 3.9		80 (6.8)	13 (5.2)	
Parity[c]			0.50			0.90
0	994 (69.1)	9.4 ± 3.7		819 (69.1)	175 (69.4)	
≥1	444 (30.9)	9.2 ± 3.7		367 (30.9)	77 (30.6)	
Pre-pregnancy BMI (kg/m^2)			0.31			0.47
< 18.5	335 (23.3)	9.4 ± 3.7		278 (23.4)	57 (22.6)	
18.5–23.9	938 (65.1)	9.4 ± 3.7		767 (64.6)	171 (67.9)	
≥24.0	167 (11.6)	8.9 ± 3.5		143 (12.0)	24 (9.5)	
Active smoking before pregnancy[c]			0.65			0.69
No	1363 (94.7)	9.3 ± 3.7		1123 (94.6)	240 (95.2)	
Yes	76 (5.3)	9.5 ± 3.8		64 (5.4)	12 (4.8)	
Presence of gestational diabetes mellitus[c]			0.83			0.90
No	1040 (84.5)	9.3 ± 3.7		862 (84.4)	178 (84.8)	
Yes	191 (15.5)	9.3 ± 3.4		159 (15.6)	32 (15.2)	
Presence of maternal health conditions[c,d]			0.71			0.39
No	1347 (93.7)	9.3 ± 3.7		1114 (93.9)	233 (92.5)	
Yes	91 (6.3)	9.2 ± 4.0		72 (6.1)	19 (7.5)	

BMI, body mass index; EPDS, Edinburgh Postnatal Depression Scale; SD, standard deviation.
[a] Based on analysis of variance or t-tests.
[b] Based on χ^2 tests.
[c] Missing data present.
[d] Maternal health conditions include hypertension before pregnancy, gestational hypertension, preeclampsia, hypertensive disorder in pregnancy or gestational anaemia.

3. Results

Table 1 presents the characteristics of participants. Overall, the mean EPDS score at the third trimester was 9.3 (SD 3.7). The prevalence of antenatal depression was 17.5% (n = 252). The participants were mostly below 30 years old (83.5%), achieved high school education (38.3%), employed (76.0%), had an annual income below 40,000 RMB (40.1%), nulliparous (69.1%), with normal BMI (65.1%) and did not smoke before pregnancy (94.7%). Higher antenatal EPDS scores were observed among women with younger age, lower education level, lower annual household income, who were unemployed or farmers (Table 1). No significant difference in EPDS score was found in terms of parity, pre-pregnancy BMI, smoking before pregnancy, presence of gestational diabetes and other maternal conditions.

Overall, the mean total physical activity was 149.1 (SD 84.2) MET-hours/week based on the self-reported PPAQ measure. Table 2 summarises the results from linear and logistic regression analyses. No significant association was found between different levels of total physical activity and score of EPDS in both models. However, occupational physical activity was associated with lower EPDS scores at the third trimester, with each SD increase in occupational activity level reducing the EPDS score by 0.26 on average (95% CI -0.47 to −0.05). Similarly, increasing occupational physical activity during early pregnancy appeared to lower the risk of incurring antenatal depressive symptoms (odds ratio (OR) 0.78; 95% CI 0.65 to 0.94). Indeed, women with EPDS < 13 were more active at work (mean 35.3, SD 1.6 MET-hours/week) than others reporting EPDS ≥13 (mean 21.0, SD 2.7 MET-hours/week), p < 0.001. Significant inverse associations with EPDS (−0.72; 95% CI -1.27 to −0.16) and the prevalence of antenatal depression (OR 0.57; 95% CI 0.37 to 0.94) were also evident for high occupational physical activity level exceeding 73 MET-hours/week. Nevertheless, no apparent associations were observed for other domains and various intensities of physical activity exposures.

We have examined the potential modifying effects of maternal characteristics (including age, education level, occupation before pregnancy, annual household income, parity, pre-pregnancy BMI, smoking before pregnancy, presence of gestational diabetes, and presence of maternal health conditions) on the association between occupational physical activity and antenatal depressive symptoms. Results showed that a higher occupational physical activity level (> 73.0 MET-hours/week) was significantly associated with a lower EPDS score in the age group 25–29, among unemployed people and manual workers, individuals with an income less than 40,000 RMB or those with at least one child, women having a normal body mass index before pregnancy, in active non-smokers before pregnancy, mothers with gestational diabetes and those without health conditions. An inverse association between occupational physical activity and risk of depressive symptoms was also observed for women attaining senior/technical/secondary

Table 2
Associations between subtypes of physical activity and antenatal depressive symptoms.

Type of physical activity (MET-hours/week)	n (%)	EPDS score[a]			EPDS ≥ 13[a]		
		Regression coefficient	95% CI	*p*	Odds ratio	95% CI	*p*
Total physical activity							
Continuous[b]		0.06	(-0.14, 0.26)	0.55	1.04	(0.90, 1.20)	0.59
Low (≤102.2)	484 (33.7)	–	–	–	1	–	–
Medium (> 102.2 to 168.6)	472 (32.9)	0.16	(-0.31, 0.63)	0.51	1.17	(0.84, 1.64)	0.35
High (> 168.6)	479 (33.4)	0.11	(-0.38, 0.59)	0.67	0.95	(0.66, 1.36)	0.78
Sedentary-intensity physical activity							
Continuous[b]		−0.01	(-0.22, 0.20)	0.95	0.95	(0.81, 1.11)	0.49
Low (≤37.7)	472 (32.9)	–	–	–	1	–	–
Medium (> 37.7 to 80.4)	484 (33.7)	0.24	(-0.23, 0.71)	0.32	1.03	(0.74, 1.43)	0.87
High (> 80.4)	479 (33.4)	−0.07	(-0.58, 0.44)	0.80	0.92	(0.63, 1.35)	0.68
Light-intensity physical activity							
Continuous[b]		−0.02	(-0.21, 0.17)	0.86	1.00	(0.87, 1.16)	0.96
Low (≤26.2)	479 (33.4)	–	–	–	1	–	–
Medium (> 26.2 to 52.7)	471 (32.8)	−0.17	(-0.64, 0.30)	0.47	0.96	(0.69, 1.34)	0.82
High (> 52.7)	485 (33.8)	−0.12	(-0.58, 0.35)	0.62	0.85	(0.61, 1.20)	0.36
Moderate-intensity physical activity							
Continuous[b]		0.13	(-0.06, 0.32)	0.19	1.11	(0.97, 1.27)	0.12
Low (≤18.0)	515 (35.9)	–	–	–	1	–	–
Medium (> 18.0 to 37.1)	465 (32.4)	−0.08	(-0.54, 0.38)	0.75	0.98	(0.69, 1.38)	0.89
High (> 37.1)	455 (31.7)	0.30	(-0.17, 0.76)	0.21	1.34	(0.96, 1.87)	0.08
Vigorous-intensity physical activity							
Continuous[b]		0.19	(0.00, 0.39)	0.05	1.13	(1.00, 1.27)	0.05
None	1324 (92.3)	–	–	–	1	–	–
Yes (> 0)	111 (7.7)	0.56	(-0.15, 1.28)	0.12	1.58	(0.99, 2.51)	0.05
Household/care-giving physical activity							
Continuous[b]		0.09	(-0.11, 0.28)	0.37	1.12	(0.98, 1.28)	0.08
Low (≤19.8)	491 (34.2)	–	–	–	1	–	–
Medium (> 19.8 to 41.0)	462 (32.2)	0.14	(-0.33, 0.60)	0.57	1.11	(0.79, 1.57)	0.53
High (> 41.0)	482 (33.6)	−0.07	(-0.54, 0.40)	0.77	1.01	(0.71, 1.43)	0.96
Occupational physical activity							
Continuous[b]		**−0.26**	**(-0.47, -0.05)**	**0.02**	**0.78**	**(0.65, 0.94)**	**< 0.01**
None	885 (61.7)	–	–	–	1	–	–
Low (≤73.0)	284 (19.8)	−0.31	(-0.83, 0.22)	0.26	0.85	(0.57, 1.25)	0.41
High (> 73.0)	266 (18.5)	**−0.72**	**(-1.27, -0.16)**	**0.01**	**0.57**	**(0.37, 0.94)**	**0.03**
Sports and exercise							
Continuous[b]		0.16	(-0.03, 0.35)	0.11	1.13	(0.99, 1.28)	0.06
None	213 (14.8)	–	–	–	1	–	–
Low (≤13.6)	543 (37.8)	0.34	(-0.24, 0.93)	0.25	1.31	(0.83, 2.07)	0.24
High (> 13.6)	679 (47.3)	0.46	(-0.11, 1.03)	0.12	1.54	(0.99, 2.39)	0.06
Transportation physical activity							
Continuous[b]		0.15	(-0.04, 0.34)	0.11	1.09	(0.96, 1.25)	0.19
Low (≤7.0)	534 (37.2)	–	–	–	1	–	–
Medium (> 7.0 to 15.8)	433 (30.2)	−0.21	(-0.67, 0.26)	0.38	1.02	(0.73, 1.44)	0.90
High (> 15.8)	468 (32.6)	0.28	(-0.18, 0.74)	0.23	1.18	(0.85, 1.64)	0.33

CI, confidence interval; EPDS, Edinburgh Postnatal Depression Scale.
[a] All models were adjusted for age, education level, occupation before pregnancy and annual household income.
[b] Per one standard deviation increment.

school level, manual workers, parous or pre-pregnancy normal-weight women, mothers without active smoking before pregnancy or health conditions. However, no significant interaction was found for the aforementioned maternal characteristics in either linear or logistic regression models (data not shown for brevity).

4. Discussion

In this large prospective cohort study of Chinese women, we assessed total and domain-specific physical activity levels during early pregnancy, and depressive symptoms at their third trimester. Our antenatal depression prevalence of 17.5%, based on the EPDS cut-off score of 13, was within the estimated rates of 7.3% and 35.9% using 14 and 9 respectively as cut-off points to indicate depression status in a previous Chinese study (Lau et al., 2011). Moreover, the total energy expenditure was also comparable between our cohort and another study in China (Zhang et al., 2014) (mean 149.1 versus 142.9 MET-hours/week). Based on the American College of Obstetrics and Gynaecology guideline which recommended healthy pregnant women to spend at least 150 min per week on moderate-intensity aerobic activity, less than half of our participants (n = 714, 49.6%) engaged in sport/exercise activities for more than 7.5 MET-hours per week.

With the exception of work activity, we found no association between physical activity subtypes during early pregnancy and antenatal depressive symptoms, which was somewhat consistent with a recent study of 820 Latina women on domain-specific physical activity (Szegda et al., 2018). On the contrary, a multiethnic cohort study involving 1144 Asian women reported a significantly lower risk of probable antenatal depression among those who performed sufficient levels of total physical activity (≥600 MET-minutes/week) (Padmapriya et al., 2016). The discrepancy in findings may be due to differences in characteristics of the underlying populations, as well as other instruments (instead of PPAQ and EPDS) used to assess physical activity exposure and the antenatal depression outcome.

The apparent inverse association between occupational physical activity and antenatal depression can be attributed to the less demanding nature of work for Chinese pregnant women, when compared to the general population whose work stress may lead to higher risk of

depressive symptoms (McKercher et al., 2009). Observational studies in the general population have also shown employees with less mental health problems reported a higher level of physical activity, given a similar stress level (Gerber, Jonsdottir, Lindwall, & Ahlborg, 2014). One possible explanation is that a higher fitness level enables individuals to cope with stress more effectively. In addition, good social support and interpersonal relationships are known to be protective against antenatal depression (Rashid & Mohd, 2017), while unemployment has been reported to be associated with a higher risk of antenatal depression (Biaggi, Conroy, Pawlby, & Pariante, 2016). Women who remain physically active at work with colleagues during early pregnancy may be beneficial towards their subsequent mental well-being, although more research is needed to confirm our finding and to understand the biological mechanism.

The strengths of this study include a large sample size, the prospective study design, and the administration of validated instruments by trained nurses via face-to-face interviews. The EPDS score was modelled as both continuous and binary outcomes, confirming the sensitivity of our analyses. However, several limitations should be taken into consideration. First, information was lacking on history of major depression, a risk factor for antenatal depression (Castro e Couto et al., 2016), resulting in potential overestimation of the antenatal depression prevalence. Second, both physical activity and depressive symptoms were assessed by self-reported questionnaires, which may lead to non-differential misclassification of both the exposure and outcome variables. Future studies should consider using objective measurements of physical activity and adopting the clinical diagnosis of depression, in order to confirm the apparent relationship between physical activity and depression during pregnancy. Third, same as other observational studies, residual confounding cannot be ruled out despite controlling for plausible confounding factors of antenatal depression in the regression analyses. Finally, our study participants were recruited from district hospitals in Western China, so that the findings may not be generalizable to other regions of China.

In conclusion, the present large prospective cohort study of Chinese women suggested that being active at work during early pregnancy is associated with a reduced risk of antenatal depression during the third trimester of pregnancy. The finding has important implication for improving the maternal mental health in China.

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Declarations of interest

None.

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Appendix A. Supplementary data

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