Changes in physical activity across pregnancy among Chinese women: a longitudinal cohort study

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Abstract

Background Sufficient physical activity (PA) during pregnancy is beneficial for a woman's health; however, the PA levels of Chinese women at different pregnancy stages are not clear. The aim of our study was to investigate PA changes during pregnancy and the association of population characteristics with PA change among Chinese women. Methods Data were obtained from 2485 participants who were enrolled in the multicentre prospective Chinese Pregnant Women Cohort Study. PA level was assessed in early pregnancy (mean=10, 5-13 weeks of gestation) and again in mid-to-late pregnancy (mean=32, 24-30 weeks of gestation) using the International Physical Activity Questionnaire short form (IPAQ-SF). Sufficient PA (≥600 MET min/week) in early pregnancy and insufficient PA in mid-to-late pregnancy indicated decreasing PA. Insufficient PA in early pregnancy and sufficient PA in mid-to-late pregnancy indicated increasing PA. The associations between demographic, pregnancy and health characteristics and PA changes were examined by multivariable logistic regression. Results Total energy expenditure for PA increased significantly from early (median=396 MET min/week) to mid-to-late pregnancy (median=813 MET min/week) (P<0.001), and 55.25% of the participants eventually had sufficient PA. Walking was the dominant form of PA. Women with sufficient PA levels in early pregnancy were more likely to have sufficient PA in mid-to-late pregnancy (OR=1.897, 95% CI: 1.583-2.274). Women in West China and those in Central China were most and least likely, respectively, to have increasing PA (OR=1.387, 95% CI: 1.078-1.783 vs. OR=0.721, 95% CI: 0.562-0.925). Smoking was inversely associated with increasing PA (OR=0.480, 95% CI: 0.242-0.955). Women with higher educational levels were less likely to have decreasing PA (OR=0.662, 95% CI: 0.442-0.991). Conclusions PA increased as pregnancy progressed, and walking was the dominant form of PA among Chinese women. Further research is needed to better understand correlates of PA change.

Methods

Study design and population

The CPWCS population was conveniently sampled from pregnant women who received early pregnancy evaluations within a certain month from July 2017 to November 2018 in 14 maternal and child healthcare hospitals and 10 academic hospitals located in 15 provinces of China (Supplementary Fig. 1). All the 24 hospitals were public hospitals, and the cost of perinatal health care was largely covered by the government maternity insurance program. The inclusion criteria were as follows: (1) age 16 years or above, (2) pregnancy 12 weeks, as estimated based on the last menstrual period; (3) permanent resident of the study recruitment district; (4) regular antenatal inspection with the intention of delivering in the study recruitment hospital; and (5) capable of online completion of the PA assessment. The exclusion criteria were as follows: (1) serious chronic diseases, including hypertension, diabetes, heart disease, renal disease, or other diseases that would restrict PA during pregnancy; and (2) multiple pregnancy. Written informed consent was obtained from all participants, and the study was approved by the ethics review committee of Peking Union Medical College (HS-1345).

Data on population characteristics were obtained at the initial recruitment clinic visit in early pregnancy. The PA level was assessed twice, with the first assessment conducted in early pregnancy at the recruitment clinic visit and the second conducted in mid-to-late pregnancy at a prenatal clinic visit after 24 weeks of gestation.
Among 4750 women meeting the inclusion criteria, 102 were excluded due to serious chronic diseases and 32 due to multiple gestation. A total of 1,994 declined to participate. Fifty participants could not recall their PA over the previous 7 days at the first PA assessment. A total of 2572 women completed the first PA assessment in early pregnancy. Seventy-five had a miscarriage or pregnancy termination between the two assessments. Twelve participants could not recall PA at the second PA assessment. A total of 2485 women with both PA information in early and mid-to-late pregnancy were finally included in the data analysis of the present study (Fig. 1).

**Data collection procedures**

**Population characteristics**

Population characteristics that are biologically plausible or historically reported to be associated with PA were considered as correlates investigated in our study. Demographic, pregnancy and health characteristics were obtained at the recruitment clinic visit. Demographic characteristics included age, residential region, ethnicity, educational level, annual household income and occupation. Residential regions were categorized into East, Central and West China according to the Chinese Health Statistics Yearbook. Pregnancy characteristics included parity and pregnancy plan. Smoking or drinking was defined as a history of smoking or drinking. According to the IPAQ-SF, TEE on PA ≥600 MET min/week is defined as “moderate level” [36], and WHO recommends a minimum of 600 MET min/week PA to realize a health benefit [17]. Therefore, we defined PA with TEE ≥600 MET min/week as sufficient PA and PA with TEE <600 MET min/week as insufficient PA. Sufficient PA in early pregnancy and insufficient PA in mid-to-late pregnancy indicated decreasing PA. Insufficient PA in early pregnancy and sufficient PA in mid-to-late pregnancy indicated increasing PA.

**Statistical analysis**

The population characteristics of all women included in the study are described. Categorical data are expressed as frequencies and percentages. Continuous data are expressed as means, standard deviations (SDs), medians and interquartile ranges (IQRs). TEE on PA, energy expenditure on each type of PA, and the proportion of energy expenditure on each type of PA to TEE on PA were compared between early and mid-to-late pregnancy using the Wilcoxon signed-rank test. The proportions of women with sufficient PA levels were compared between early and mid-to-late pregnancy using McNemar’s test. Multivariable logistic regression was used to calculate the odds ratios (OR) and 95% confidence intervals (CI) to address the following: (1) associations between population characteristics and sufficient PA in mid-to-late pregnancy among all women included in the study, (2) associations between population characteristics and increasing PA among the subset of women with insufficient PA levels in early pregnancy, and (3) associations between population characteristics and decreasing PA among the subset of women with sufficient PA levels in early pregnancy. *P* values <0.05 were considered statistically significant. SPSS 22.0 (IBM, Armonk, NY, USA) was used for statistical analysis.

**Results**

Data on population characteristics were obtained at the recruitment clinic visit at a mean gestational age of 10 weeks, ranging from 5 to 13. The characteristics of 2485 women who had both PA information in early and mid-to-late pregnancy and 2056 women who failed to complete the PA assessment (with 1994 declining to participate and 62 being unable to recall PA) are compared in Table 1. Compared with those failing to complete the PA assessment, women completing the PA assessment were more likely to be located in East China or
have a university education or above, a higher medium income, a manual occupation, a nulliparous status, or a planned pregnancy (Table 1). The population characteristics by residential region are shown in Supplementary Table 1. There were significant differences in age, ethnicity, educational level, annual household income, occupation, parity and history of drinking between the three regional groups (Supplementary Table 1).

[Insert Table 1 here]

**Change in PA across pregnancy**

PA was assessed in early pregnancy at a mean gestational age of 10 weeks, ranging from 5 to 13, and reassessed in mid-to-late pregnancy at a mean gestational age of 32 weeks, ranging from 24 to 40. Table 2 shows that TEE on PA and energy expenditure on each type of PA increased significantly from early to mid-to-late pregnancy (P<0.001). The largest proportion of PA across pregnancy comprised walking (median, 100%). The proportion of women with sufficient PA levels also increased significantly from 32.72% to 55.25% from early to mid-to-late pregnancy (P<0.001). Among 1672 women with insufficient PA levels in early pregnancy, 836 (50.00%) remained insufficient, and 836 (50.00%) had increasing PA. Among 813 women with sufficient PA levels in early pregnancy, 537 (66.05%) maintained sufficient PA, and 276 (33.95%) had decreasing PA (see Fig. 2).

Table 2. Comparison of PA between early and mid-to-late pregnancy among Chinese pregnant women (n = 2485)

| PA indicators | Early pregnancy | Mid-to-late pregnancy | P value |
|---------------|----------------|-----------------------|---------|
|               | Mean (SD) | Median (IQR) | Mean (SD) | Median (IQR) |       |
| TEE on PA (MET min/week) | 791.93 (1057.56) | 396.00 (66.00, 1152.00) | 1193.14 (1283.51) | 813.00 (356.40, 1411.00) | < 0.001 |
| High-intensity PA |                      |                       |         |             |
| Energy expenditure (MET min/week) | 43.24 (327.85) | 0.00 (0.00, 0.00) | 86.16 (506.34) | 0.00 (0.00, 0.00) | < 0.001 |
| Proportion due to TEE on PA (%) | 2.46 (11.79) | 0.00 (0.00, 0.00) | 2.96 (12.54) | 0.00 (0.00, 0.00) | < 0.001 |
| Medium-intensity PA |                      |                       |         |             |
| Energy expenditure (MET min/week) | 73.02 (316.18) | 0.00 (0.00, 0.00) | 124.45 (429.27) | 0.00 (0.00, 0.00) | < 0.001 |
| Proportion due to TEE on PA (%) | 5.39 (16.04) | 0.00 (0.00, 0.00) | 7.03 (17.09) | 0.00 (0.00, 0.00) | < 0.001 |
| Walking |                      |                       |         |             |
| Energy expenditure (MET min/week) | 675.66 (862.19) | 396.00 (49.50, 990.00) | 982.53 (929.47) | 693.00 (297.00, 1386.00) | < 0.001 |
| Proportion due to TEE on PA (%) | 92.15 (20.83) | 100.00 (100.00, 100.00) | 90.00 (22.06) | 100.00 (100.00, 100.00) | < 0.001 |

Note: The Wilcoxon signed-rank test was used to compare PA indicators between early and mid-to-late pregnancy. A P value <0.05 was considered significant.

**Association of population characteristics and PA change**

Table 3 shows that women in West China (OR=1.247, 95% CI: 1.012-1.537; P=0.038) were most likely and that women in Central China (OR=0.747, 95% CI: 0.609-0.916; P=0.005) were least likely to have sufficient PA in mid-to-late pregnancy. Women with a smoking history (OR=0.551, 95% CI: 0.315-0.964; P=0.037) were less likely, and women with sufficient PA levels in early pregnancy (OR=1.897, 95% CI: 1.583-2.274; P<0.001) were more likely to have sufficient PA in mid-to-late pregnancy. Table 4 shows that in the subset of women with insufficient PA levels in early pregnancy, women in West China (OR=1.387, 95% CI: 1.078-1.783; P=0.011) were most likely, and women in Central China (OR=0.721, 95% CI: 0.562-0.925; P=0.010) were least likely to increase PA across their pregnancies. Women with a smoking history (OR=0.480, 95% CI: 0.242-0.955; P=0.036) were less likely to increase PA across their pregnancies. In the subset
of women with sufficient PA levels in early pregnancy, women with educational levels of university or above (OR=0.662, 95% CI: 0.442-0.991; *P*=0.045) were less likely to decrease PA across their pregnancies.

Discussion

To our knowledge, this is the first multicentre longitudinal cohort study to investigate changes in PA across pregnancy in a Chinese population. We found that PA levels increased from early to mid-to-late pregnancy and that more than half of the women eventually had sufficient PA as recommended. Walking was the dominant form of PA. Women with sufficient PA levels in early pregnancy were more likely to maintain or achieve sufficient PA across their pregnancies. PA levels varied in different regions of China, with women in the West being most likely and those in the Central being least likely to have sufficient and increasing PA. Habitual smoking was inversely associated with sufficient and increasing PA. Women with higher educational levels were less likely to decrease PA across the pregnancy.

Our study found that the proportion of pregnant women achieving the recommended PA level increased from 32.72% in early pregnancy to 55.25% in mid-to-late pregnancy. Studies investigating PA levels at different pregnancy stages are limited. In contrast to our study, studies of western populations showed that PA decreased or remained unchanged as pregnancy progressed [37, 38]. Regarding studies with Chinese populations, the proportion of women achieving the recommended level remained at a low level of 11% across the pregnancies of urban women from Tianjin [24] and increased from 53.8% in the first trimester to 61.4% in the third trimester among women from Chengdu [25]. But both of these studies were cross-sectional, and the changes in PA were concluded from different subsets of women. Our study was a multicentre study, and PA was surveyed in the same sample of women longitudinally at different pregnancy stages, resulting in a better representation of the Chinese population and in less bias. However, a large proportion of eligible women declined to participate or could not recall PA when being surveyed. We found that women who completed the PA assessment were more likely to have the characteristics that were reported to be positively associated with PA, such as a higher educational level. There may be a potential bias in that the population included in the final analysis consisted of those with a higher PA level. This may be part of the reason why our population had increasing PA across the pregnancy.

Our findings were consistent with those of one previous study using the IPAQ-SF, namely, that PA with medium or higher intensity contributed less to TEE during pregnancy [22]. Our study found that walking was the dominant form of PA. In this study, walking included all walking, namely, walking related to occupation, transportation, the household, exercise and leisure. Walking is the form of moderate-intensity PA indicated by the WHO recommendation and the form of exercise recommended by the American College of Obstetricians and Gynaecologist (ACOG) during pregnancy [1, 2, 17]. Chinese culture holds tight to traditional concepts of not walking fast, not running and not jumping during pregnancy, but walking is not restricted [30]. Therefore, it may be more reasonable and easier for prenatal healthcare providers to encourage women to walk appropriately to meet the sufficient level of 600 MET min/week than to persuade them to participate in other forms of PA.

It has been well documented that prepregnancy PA habits are strongly associated with PA levels during pregnancy [37, 38]. Our study found that women with sufficient PA levels at baseline were more likely to maintain or achieve sufficient PA across their pregnancies, further validating the fact that a good lifestyle is beneficial in the long term.

There were significant differences in the population characteristics among the three regional groups. Women in West China were more likely to have features favouring PA, such as a higher educational level, employment with a manual occupation and nulliparity, which may explain why they were more likely to have sufficient and increasing PA. The higher proportion of individuals of non-Han ethnicity may also play a role. More studies are required to clarify the regional difference in PA.

Among the other correlates investigated, a history of smoking was inversely associated with sufficient and increasing PA. The findings were consistent with other study data showing that smokers had a more sedentary lifestyle [39]. The combined risk of smoking and low PA levels may make women more vulnerable to adverse pregnancy outcomes.

A recent systematic review revealed that younger age, higher educational level, higher income, employment, nulliparity, and normal weight were positively associated with PA during pregnancy, but the correlations were weak [37]. However, our study found that except for educational level, these factors were not associated with changes in PA across pregnancy. In our study, women with higher educational level tended to maintain sufficient PA throughout the whole pregnancy.

There were several limitations in our study. First, the study might have bias due to the self-report measure used to assess PA. Second, the generalization of our results may be limited to convenience sampling. Third, our study population may have a higher PA level since only those who agreed to participate and could recall PA were finally included in the analysis. Fourth, the large time frame within which PA was surveyed (especially the second survey) was partly responsible for the large range of PA level. The difference in the time interval between two PA assessments may have an influence on the result of the PA change across the pregnancy. Finally, our study did not include discomfort during pregnancy and subjective factors, such as self-efficacy or perceived behavioural control, which might influence PA [29, 40]. Further analyses that include these factors as determinants of PA are needed.

Conclusions
To our knowledge, our study is the first multicentre longitudinal cohort study to investigate changes in PA across pregnancy among Chinese women. Our findings indicated that PA increased as pregnancy progressed, and that walking was the dominant form of PA. Further research is needed to better understand correlates of PA change and develop appropriate interventions for PA to improve maternal health among Chinese women.

**Abbreviations**

ACOG: American College of Obstetricians and Gynecologists; BMI: Body mass index; CI: Confidence interval; CPWCS: Chinese Pregnant Women Cohort Study; IPAQ-SF: International Physical Activity Questionnaire short form; IQR: Interquartile range; MET: Metabolic equivalent task; OR: Odds ratio; PA: Physical activity; SD: Standard deviation; TEE: Total energy expenditure; WHO: World Health Organization

**Declarations**

*Ethics approval and consent to participate*

The study was approved by the ethics review committee of Peking Union Medical College Hospital, the leading centre (HS-1345). Written informed consent was obtained from each participant.

*Consent for publication*

Not applicable

*Availability of data and materials*

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

*Competing interests*

The authors declare that they have no competing interests.

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*Authors' contributions*

YL, LM, and YJ conceptualized and designed the study; SM collected the data; YF performed the statistical analyses; and YL drafted the manuscript. All authors have approved the final version of the paper for publication.

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Tables

Table 1. Comparison of population characteristics between women who completed and failed to complete the PA assessment
| Characteristics                      | Women who completed both PA assessments in early and mid-to-late pregnancy (n=2585) | Women failed to complete the PA assessment (n=2056) | P value |
|--------------------------------------|------------------------------------------------------------------------------------|---------------------------------------------------|---------|
| **Demographic characteristics**      |                                                                                    |                                                   |         |
| Age (years)                          |                                                                                    |                                                   | 0.058   |
| <25                                  | 314 (12.64)                                                                        | 299 (14.27)                                       |         |
| 25-29                                | 1274 (51.27)                                                                       | 991 (48.20)                                       |         |
| 30-34                                | 638 (25.67)                                                                        | 568 (27.63)                                       |         |
| ≥35                                  | 259 (10.42)                                                                         | 198 (9.63)                                        |         |
| Residential region                   |                                                                                    |                                                   | <0.001  |
| East                                 | 936 (37.67)                                                                         | 556 (27.04)                                       |         |
| Central                              | 770 (30.99)                                                                         | 795 (38.67)                                       |         |
| West                                 | 779 (31.35)                                                                         | 705 (34.29)                                       |         |
| Ethnicity                            |                                                                                    |                                                   | 0.213   |
| Han                                  | 2345 (94.37)                                                                        | 1922 (93.48)                                      |         |
| Minority                             | 140 (5.63)                                                                          | 134 (6.52)                                        |         |
| Educational level                    |                                                                                    |                                                   | <0.001  |
| High school or below                 | 700 (28.17)                                                                         | 757 (36.82)                                       |         |
| University or above                  | 1785 (71.83)                                                                        | 1299 (63.18)                                      |         |
| Annual household income (RMB Yuan)   |                                                                                    |                                                   | 0.003   |
| Low income (<80,000)                 | 553 (22.25)                                                                         | 518 (25.19)                                       |         |
| Lower medium income (80,000-109,999) | 679 (27.32)                                                                         | 608 (29.57)                                       |         |
| Higher medium income (110,000-199,999)| 485 (19.52)                                                                         | 333 (16.20)                                       |         |
| High income (>200,000)               | 768 (30.91)                                                                         | 597 (29.04)                                       |         |
| Occupation                           |                                                                                    |                                                   | <0.001  |
| Unemployed                           | 592 (23.82)                                                                         | 548 (26.68)                                       |         |
| Manual occupation                    | 1375 (55.33)                                                                        | 1001 (48.73)                                      |         |
| Non-manual occupation                | 518 (20.85)                                                                         | 505 (24.59)                                       |         |
| Pregnancy characteristics            |                                                                                    |                                                   | <0.001  |
| Parity                               |                                                                                    |                                                   |         |
| Nulliparity                          | 1517 (61.05)                                                                        | 1109 (53.94)                                      |         |
| Multiparity                          | 968 (38.95)                                                                         | 947 (46.06)                                       |         |
| Pregnancy planning                   |                                                                                    |                                                   | <0.001  |
| Planned                              | 1849 (74.41)                                                                        | 1406 (68.39)                                      |         |
| Unplanned                            | 636 (25.59)                                                                         | 650 (31.61)                                       |         |
| Health characteristics               |                                                                                    |                                                   | 0.855   |
| Pre-pregnancy BMI (kg/m²)            |                                                                                    |                                                   |         |
| <18.5                                | 325 (13.08)                                                                         | 275 (13.38)                                       |         |
| 18.5-23.9                            | 1595 (64.19)                                                                        | 1327 (64.54)                                      |         |
| ≥24                                  | 565 (22.74)                                                                         | 454 (22.08)                                       |         |
| History of smoking                   |                                                                                    |                                                   | 0.334   |
| No                                   | 2424 (97.55)                                                                        | 1996 (97.08)                                      |         |
| Yes                                  | 61 (2.45)                                                                           | 60 (2.92)                                         |         |
Table 3. Associations between population characteristics and sufficient PA in mid-to-late pregnancy

| History of drinking | 0.088 |
|---------------------|-------|
| No                  | 2356 (94.81) | 1925 (93.63) |
| Yes                 | 129 (5.19)   | 131 (6.37)   |

Note: The chi-square test was used to compare the population characteristics between women who completed both PA assessments and those who failed to complete the PA assessment. A $P$ value <0.05 was considered significant, and significant values are marked with bold text.

* Bonferroni correction was applied for multiple testing.

a Women who completed the PA assessment were more likely to be located in East compared with Central ($P<0.001$) or West China ($P<0.001$).

b Women who completed the PA assessment were more likely to have a higher medium income than a lower medium income ($P=0.001$) or a low income ($P=0.003$).

c Women who completed the PA assessment were more likely to be employed with a manual occupation than unemployed ($P=0.001$) or employed with a non-manual occupation ($P<0.001$).
| Characteristics                              | Sufficient PA in mid-to-late pregnancy (n=1373) | N (%) | OR (95%CI) | P value |
|---------------------------------------------|-----------------------------------------------|-------|------------|---------|
| Demographic characteristics                |                                               |       |            |         |
| Age (years)                                 |                                               |       |            |         |
| <25                                         | 158 (11.51)                                   | 1.00  |            |         |
| 25-29                                       | 730 (53.17)                                   | 1.212 (0.922, 1.592) | 0.168 |
| 30-34                                       | 342 (24.91)                                   | 1.068 (0.783, 1.457) | 0.677 |
| ≥35                                         | 143 (10.42)                                   | 1.186 (0.808, 1.743) | 0.384 |
| Residential region                          |                                               |       |            |         |
| East                                        | 527 (38.38)                                   | 1.000 |            |         |
| Central                                     | 368 (26.80)                                   | 0.747 (0.609, 0.916) | 0.005 |
| West                                        | 478 (34.81)                                   | 1.247 (1.012, 1.537) | 0.038 |
| Ethnicity                                   |                                               |       |            |         |
| Han                                         | 1296 (94.39)                                  | 1.000 |            |         |
| Minority                                    | 77 (5.61)                                     | 0.976 (0.677, 1.408) | 0.898 |
| Educational level                           |                                               |       |            |         |
| High school or below                        | 371 (27.02)                                   | 1.000 |            |         |
| University or above                         | 1002 (72.98)                                  | 1.023 (0.818, 1.279) | 0.842 |
| Annual household income (RMB Yuan)          |                                               |       |            |         |
| Low income (<80,000)                        | 295 (21.49)                                   | 1.000 |            |         |
| Lower medium income (80,000-109,999)        | 359 (26.15)                                   | 0.950 (0.745, 1.211) | 0.680 |
| Higher medium income (110,000-199,999)      | 288 (20.98)                                   | 1.185 (0.901, 1.557) | 0.224 |
| High income (>200,000)                      | 431 (31.39)                                   | 1.096 (0.853, 1.409) | 0.472 |
| Occupation                                  |                                               |       |            |         |
| Unemployed                                  | 316 (23.02)                                   | 1.000 |            |         |
| Manual occupation                           | 756 (55.06)                                   | 0.888 (0.702, 1.124) | 0.324 |
| Non-manual occupation                       | 301 (21.92)                                   | 1.089 (0.838, 1.415) | 0.525 |
| Pregnancy characteristics                   |                                               |       |            |         |
| Parity                                      |                                               |       |            |         |
| Nulliparity                                 | 856 (62.35)                                   | 1.000 |            |         |
| Multiparity                                 | 517 (37.65)                                   | 0.926 (0.759, 1.131) | 0.452 |
| Pregnancy planning                         |                                               |       |            |         |
| Planned                                     | 1038 (75.60)                                  | 1.000 |            |         |
| Unplanned                                   | 335 (24.40)                                   | 0.938 (0.773, 1.139) | 0.520 |
| Health characteristics                      |                                               |       |            |         |
| Prepregnancy BMI (kg/m2)                    |                                               |       |            |         |
| <18.5                                       | 183 (13.33)                                   | 1.069 (0.829, 1.377) |       |
| 18.5-23.9                                   | 883 (64.31)                                   | 1.000 |            | 0.608  |
| ≥24                                         | 307 (22.36)                                   | 1.035 (0.842, 1.272) | 0.746  |
| History of smoking                          |                                               |       |            |         |
| No                                          | 1349 (98.25)                                  | 1.000 |            |         |
| Yes                                         | 24 (1.75)                                     | 0.551 (0.315, 0.964) | 0.037  |
| History of drinking                         |                                               |       |            |         |
| No                                          | 1304 (94.97)                                  | 1.000 |            |         |
| Yes                                         | 69 (5.03)                                     | 1.046 (0.714, 1.531) | 0.819  |
Table 4. Associations between population characteristics and increasing or decreasing PA across pregnancy

| PA level in early pregnancy | Count (Percentage) | OR (95% CI) | P-value |
|----------------------------|--------------------|-------------|---------|
| Insufficient               | 836 (60.89)        | 1.000       |         |
| Sufficient                 | 537 (39.11)        | 1.897 (1.583, 2.274) | < 0.001 |

Note: OR was adjusted for the rest of the variables in the table. A P value <0.05 was considered significant, and significant values are marked with bold text.
### Characteristics

| Characteristics | Insufficient PA in early pregnancy (n=1674) | Sufficient PA in early pregnancy (n=813) |
|----------------|---------------------------------------------|----------------------------------------|
|                | OR (95% CI) | P value | OR (95% CI) | P value |
|                | n (%)       | n (%)    |          |          |
| **Demographic characteristics** |                           |                           |
| Age (years)    |                           |                           |
| <25            | 103 (12.32) | 122 (14.59) | 1.00 | 0.178 | 34 (12.32) | 55 (10.24) | 1.00 |
| 25-29          | 442 (52.87) | 405 (48.44) | 1.251 (0.904, 1.731) | 1.000 | 139 (50.36) | 28(53.63) | 0.911 (0.542, 1.530) | 0.724 |
| 30-34          | 204 (24.40) | 218 (26.08) | 1.105 (0.763, 1.601) | 0.598 | 78 (28.26) | 138 (25.70) | 1.103 (0.615, 1.978) | 0.742 |
| ≥35            | 87 (10.41) | 91 (10.89) | 1.107 (0.699, 1.754) | 0.664 | 25 (9.06) | 56 (10.43) | 0.775 (0.375, 1.601) | 0.491 |
| Residential region |                           |                           |
| East           | 309 (36.96) | 309 (36.96) | 1.00 | 0.010 | 100 (36.23) | 218 (40.60) | 1.00 |
| Central        | 215 (25.72) | 308 (36.84) | 0.721 (0.562, 0.925) | 1.387 (1.078, 1.783) | 0.011 | 82 (29.71) | 166 (30.91) | 1.048 (0.716, 1.532) | 0.811 |
| West           | 312 (37.32) | 219 (26.20) | 1.387 (1.078, 1.783) | 0.011 | 82 (29.71) | 166 (30.91) | 1.048 (0.716, 1.532) | 0.811 |
| Ethnicity      |                           |                           |
| Han            | 788 (94.26) | 790 (94.50) | 1.00 | 0.799 | 259 (93.84) | 508 (94.60) | 1.00 |
| Minority       | 48 (5.74) | 46 (5.50) | 0.944 (0.606, 1.471) | 17 (6.16) | 29 (5.40) | 1.084 (0.558, 2.106) | 0.811 |
| Educational level |                           |                           |
| Senior school or below | 244 (29.19) | 245 (29.31) | 1.00 | 0.348 | 84 (30.43) | 127(23.65) | 1.00 |
| University or above | 592 (70.81) | 591 (70.69) | 0.879 (0.671, 1.150) | 192 (69.57) | 410(76.35) | 0.662 (0.442, 0.991) | 0.045 |
| Annual household income (RMB Yuan) |                           |                           |
| Low income (<80,000) | 183 (21.89) | 196 (23.44) | 1.00 | 0.910 | 62 (22.46) | 112(20.86) | 1.00 |
| Lower medium income (80,000-109,999) | 226 (27.03) | 239 (28.59) | 1.017 (0.759, 1.353) | 1.345 (0.964, 1.875) | 0.081 | 55 (19.93) | 110(20.48) | 1.086 (0.669, 1.763) | 0.740 |
| Higher medium income (110,000-199,999) | 178 (21.29) | 142 (16.99) | 1.345 (0.964, 1.875) | 0.081 | 55 (19.93) | 110(20.48) | 1.086 (0.669, 1.763) | 0.740 |
| High income (>200,000) | 249 (29.78) | 259 (30.98) | 1.087 (0.801, 1.474) | 0.593 | 78 (28.26) | 182(33.89) | 0.896 (0.565, 1.419) | 0.639 |
| Occupation      |                           |                           |
| Unemployed      | 206 (24.64) | 217 (25.96) | 1.00 | 0.597 | 166 (60.14) | 310(57.73) | 1.221 (0.795, 1.876) | 0.362 |
| Manual occupation | 446 (53.35) | 453 (54.19) | 0.926 (0.696, 1.232) | 1.104 (0.809, 1.505) | 0.533 | 51 (18.48) | 117(21.79) | 0.978 (0.592, 1.616) | 0.931 |
| Non-manual occupation | 184 (22.01) | 166 (19.86) | 1.010 (0.809, 1.505) | 0.533 | 51 (18.48) | 117(21.79) | 0.978 (0.592, 1.616) | 0.931 |
| Pregnancy characteristics |                           |                           |
| Parity          |                           |                           |
| Nulliparity     | 527 (63.04) | 493 (58.07) | 1.00 | 0.297 | 168 (60.87) | 330(61.45) | 1.00 |
| Multiparity     | 309 (36.96) | 343 (41.03) | 0.881 (0.694, 1.118) | 108 (39.13) | 207(38.55) | 0.888 (0.613, 1.288) | 0.532 |
| Pregnancy planning |                           |                           |
| Planned         | 629 (75.24) | 614 (73.44) | 1.00 | 0.921 | 197 (71.38) | 409(76.16) | 1.00 |
| Unplanned       | 207 (24.76) | 222 (26.56) | 0.988 (0.781, 1.250) | 79 (28.62) | 128(23.84) | 1.218 (0.860, 1.725) | 0.266 |
| Health characteristics |                           |                           |
| Pre-pregnancy BMI (kg/m²) |                           |                           |
| <18.5           | 103 (12.32) | 111 (13.28) | 0.953 (0.701, 1.297) | 0.761 | 31 (11.23) | 80(14.90) | 1.709 (0.439, 1.143) | 0.158 |
| 18.5-23.9       | 534 (63.88) | 532 (63.64) | 1.00 | 0.359 | 65 (23.55) | 108(20.11) | 1.152 (0.787, 1.687) | 0.467 |
| ≥24             | 199 (23.80) | 193 (23.09) | 1.123 (0.877, 1.437) | 0.359 | 65 (23.55) | 108(20.11) | 1.152 (0.787, 1.687) | 0.467 |
| History of smoking |                           |                           |
| No              | 821 (98.21) | 806 (96.41) | 1.00 | 0.036 | 269 (97.46) | 528(98.32) | 1.00 |
| Yes             | 15 (1.79) | 30 (3.59) | 0.480 (0.242, 0.955) | 7 (2.54) | 9(1.68) | 1.446 (0.515, 4.061) | 0.484 |
|   | No | 791 (94.62) | 784 (93.78) | 1.000 | 268 (97.10) | 513(95.53) | 1.000 |
|---|---|---|---|---|---|---|---|
| Yes | 45 (5.38) | 52 (6.22) | 0.917 | 0.701 | 8 (2.90) | 24(4.47) | 0.615 | 0.253 |

Note: OR was adjusted for the rest of the variables in the table. A P value <0.05 was considered significant, and significant values are marked with bold text.

**Figures**

**Figure 1**
Flow chart of the study

**Figure 2**
The proportions of women with sufficient and insufficient PA levels in early and mid-to-late pregnancy

**Supplementary Files**
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- SupplementaryTable1.docx
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