Postprint: Allostatic Load Status and Associated Factors in Pregnant Women Across Different Trimesters

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Abstract

Background: Allostatic load (AL) serves as an objective indicator for evaluating chronic stress and is associated with adverse pregnancy outcomes. Currently, there are few longitudinal studies analyzing the influencing factors of AL in pregnant women.

Objective: To investigate the status of AL and its influencing factors in pregnant women during different periods of pregnancy.

Methods: This study employed a prospective research design. Using convenience sampling, 152 women in early pregnancy ($\leq$ 14 weeks), mid-pregnancy (23-27 weeks), and late pregnancy (30-34 weeks) underwent questionnaire surveys, physical examinations, and laboratory tests from November 2021 to November 2022. The Edinburgh Postnatal Depression Scale (EPDS) was used to assess depressive emotions during pregnancy. Referencing previous studies, AL total scores were calculated using relevant assessment indicators from the metabolic, cardiovascular, and immune systems, with AL $\geq$ 3 points serving as the criterion for high AL during different periods of pregnancy. Multivariate Logistic regression analysis was used to explore the influencing factors of AL in early, mid, and late pregnancy.

Results: Among the 152 pregnant women, the mean AL total scores in early, mid, and late pregnancy were $(2.06\$\pm1.68), (2.07\pm1.84), and (2.07\pm\$1.68)$, respectively. In early, mid, and late pregnancy, 52 (34.0%), 54 (35.3%), and 50 (32.7%) women were in a high AL state (AL total score $\geq$ 3 points), respectively. Multivariate Logistic regression analysis results showed that occupation {commercial and service industry workers [OR=0.229, 95%CI (0.062, 0.845), P=0.027], clerical staff [OR=0.164, 95%CI (0.051, 0.528), P=0.002], professional technicians [OR=0.278, 95%CI (0.099, 0.784), P=0.015]}, unemploy-

ment [OR=5.516, 95%CI (1.044, 29.144), P=0.044], and depressive emotions [OR=6.241, 95%CI (1.403, 27.757), P=0.016] were influencing factors of AL in early pregnancy women. Age [OR=1.098, 95%CI (1.002, 1.202), P=0.045] and early pregnancy AL [OR=9.965, 95%CI (4.402, 22.561), P=0.000] were influencing factors of AL in mid-pregnancy women. Sleep duration in late pregnancy [≥ 9 h/d: OR=0.176, 95%CI (0.044, 0.703), P=0.014], early pregnancy AL [OR=4.697, 95%CI (1.852, 11.908), P<0.001], and mid-pregnancy AL [OR=9.426, 95%CI (3.728, 23.834), P<0.001] were influencing factors of AL in late pregnancy women.

Conclusion: Over 30% of women were at a high AL level during different stages of pregnancy, and the influencing factors varied. Occupation, unemployment status, and depressive emotions were influencing factors of AL in early pregnancy women; age and early pregnancy AL status were influencing factors of AL in mid-pregnancy women; sleep duration in late pregnancy and AL status in early/mid-pregnancy were influencing factors of AL in late pregnancy women. Earlier attention and timely intervention for AL during pregnancy would be beneficial in reducing the risk of high AL in pregnant women as pregnancy progresses.

Full Text

Abstract

Background: Allostatic load (AL) serves as an objective indicator for evaluating chronic stress and is associated with adverse pregnancy outcomes. However, longitudinal studies analyzing the influencing factors of AL among pregnant women remain scarce.

Objective: To investigate the status of AL and its influencing factors in pregnant women across different trimesters.

Methods: This prospective study employed convenience sampling to recruit 152 pregnant women between November 2021 and November 2022. Participants underwent questionnaire surveys, physical examinations, and laboratory tests during the first ($ $14 weeks), second (23–27 weeks), and third (30–34 weeks) trimesters. The Edinburgh Postpartum Depression Scale (EPDS) was used to assess depressive symptoms during pregnancy. Based on previous research, AL total scores were calculated using biomarkers from metabolic, cardiovascular, and immune systems, with AL ≥ 3 defined as the threshold for high AL across trimesters. Multivariate logistic regression analysis was used to explore influencing factors of AL in each trimester.

Results: Among the 152 participants, mean AL total scores were $(2.06\$\pm1.68), (2.07\pm1.84), and (2.07\pm\$1.68)$ in the first, second, and third trimesters, respectively. High AL status (AL total score $ 3)$ was observed in 52 (34.0 $9 h/d: OR=0.176, 95%CI(0.044,0.703), P=0.014], first-trimester AL [OR=4.697, 95%CI(1.852,11.908), P<0.001], and second-trimester AL [OR=9.426, 95%CI(3.728,23.834), P<0.001] were influencing factors for AL in the

third trimester.

Conclusion: Over 30% of women exhibited high AL levels during different stages of pregnancy, with varying influencing factors across trimesters. Occupation, unemployment status, and depressive symptoms affected first-trimester AL; age and first-trimester AL status influenced second-trimester AL; and third-trimester sleep duration along with AL status in early and mid-pregnancy affected third-trimester AL. Earlier attention and timely intervention for AL during pregnancy may help reduce the risk of high AL as pregnancy progresses.

Keywords: Pregnancy; Chronic stress; Allostatic load; Psychological distress; Biomarkers; Root cause analysis

Introduction

Pregnancy itself represents a chronic and intense stressor. Pregnant women experience chronic physiological, psychological, and social stress, including hormonal changes and sleep quality alterations induced by pregnancy, multiple social role pressures, and negative emotions [1]. Allostatic load (AL) is a composite index representing physiological dysregulation across neuroendocrine, immune, cardiovascular, and metabolic systems, reflecting the cumulative wear and tear experienced by the body under chronic stress [2]. This accumulated physiological dysregulation is associated with adverse pregnancy outcomes such as low birth weight, preterm birth, and preeclampsia [3-5].

Current research has examined AL influencing factors in various populations, including university students, elderly individuals, and cancer patients, with studies controlling for confounding factors identifying depression [6], sleep [7], and occupational level [8] as independent influencing factors. However, investigations focusing on pregnant women remain insufficient, with only a few foreign studies exploring influencing factors of AL during pregnancy, all of which are cross-sectional. MORRISON et al. [9] analyzed a nationally representative sample and found race and education as influencing factors for AL in pregnant women, but their analysis only included demographic factors without examining psychosocial influences. HUX et al. [10] reported that perceived stress, depression, socioeconomic status, and age were not associated with AL in pregnant women, though they included psychosocial factors, their study only surveyed women in early pregnancy (10-14 weeks). Therefore, longitudinal studies are necessary to investigate AL status across different pregnancy periods and analyze the effects of socioeconomic, psychological, and behavioral factors on AL to enable early identification of high-risk populations and their risk factors for timely intervention and promotion of maternal and infant health.

Methods

Study Design and Participants

This prospective study employed convenience sampling to recruit 152 pregnant women from the obstetrics outpatient clinics of the 901 Hospital of the Joint Logistic Support Force of the Chinese People' s Liberation Army and Jin' an Maternal and Child Health Care Hospital in Lu' an between November 2021 and November 2022. Participants were surveyed during the first ($ $14 weeks), second (23-27 weeks), and third (30-34 weeks) trimesters through questionnaires, physical examinations, and laboratory tests. Inclusion criteria were: (1) age $ $18 years; (2) natural conception with singleton pregnancy; (3) receiving prenatal care and delivering at the study hospitals; (4) clear thinking and normal expression; (5) informed consent. Exclusion criteria included: (1) pre-existing medical conditions such as heart disease, hypertension, or diabetes; (2) history of severe psychiatric illness. The study was approved by the Ethics Committee of Anhui Medical University (approval number: s20210076).

AL Assessment

Based on previous studies [11-13], biomarkers from the following physiological systems were used to assess AL: metabolic system (high-density lipoprotein, total cholesterol, body mass index, fasting glucose, and waist circumference); cardiovascular system (systolic and diastolic blood pressure); and immune system (high-sensitivity C-reactive protein). Except for high-density lipoprotein, where the lower quartile indicated high risk, all other markers used the upper quartile as the high-risk threshold. High risk was scored as "1"and low risk as "0" , with scores summed to obtain the total AL score. Based on literature review, a total AL score of 3 or above was used as the high-risk threshold [14]. Since cardiovascular, metabolic, neuroendocrine, and inflammatory systems undergo physiological changes during pregnancy [10], high-risk thresholds for biomarkers in different trimesters were calculated based on the quartile values specific to each trimester.

Blood pressure was measured using a pulse electronic sphygmomanometer (model: MJ150f). Height, weight, and waist circumference were measured with participants wearing light clothing without shoes. Fasting glucose, high-density lipoprotein, total cholesterol, and high-sensitivity C-reactive protein were measured using Beckman Coulter AU5800 and Hitachi 7600-020 automatic biochemical analyzers.

Questionnaire Survey

General and Obstetric Information: A self-designed questionnaire collected general and obstetric information including age, education level, occupational status, unemployment in the past year, nighttime sleep duration, and primipara status. Occupational status was categorized according to Chinese social class into seven levels: high-level professionals or managers, professional and

technical personnel, office staff, self-employed individuals, business service employees, migrant workers, and unemployed [15]. For unemployed individuals, pre-unemployment occupation was recorded. Sleep duration was categorized as <9 h/d and $ $9 h/d [16].

Depressive Symptoms: The Edinburgh Postnatal Depression Scale (EPDS) was used to screen for depressive symptoms during pregnancy. This 10-item scale uses a 4-point scoring method (0-3 points), with total scores ranging from 0-30, where higher scores indicate more severe depression. SU et al. [17] recommended 12/13 as the optimal cutoff for EPDS in screening depression during pregnancy, a method validated and applied domestically [18]. Therefore, this study used 12 points as the cutoff for identifying depressive symptoms in pregnant women.

Statistical Analysis

SPSS 24.0 software was used for statistical analysis. Normally distributed continuous variables were described as ($\bar{x}\pm s$), and categorical variables were described as frequencies and percentages. Independent samples t-tests and ^{2} tests or continuity-corrected ^{2} tests were used to compare continuous and categorical variables between groups, respectively. To prevent loss of important variables, the significance level was set at α=0.10 for univariate analysis. Variables with statistical significance in univariate analysis (P<0.1) were entered as independent variables into binary logistic regression models for each trimester, with AL status as the dependent variable, to screen for influencing factors of AL during different pregnancy periods, with significance level set at α=0.05.

Results

Participant Characteristics

The mean age of participants was (29.6$±$4.5) years. Education level: 21.7% (33/152) had technical secondary school or junior high school education or below, 39.5% (60/152) had high school or college education, and 38.8% (59/152) had bachelor' s degree or above. Occupational level: 17.1% (26/152) were unemployed, 2.6% (4/152) were migrant workers, 15.1% (23/152) were business service employees, 6.6% (10/152) were self-employed, 25.7% (39/152) were office staff, 30.3% (46/152) were professional and technical personnel, and 2.6% (4/152) were high-level professionals or managers. Unemployed individuals accounted for 5.9% (9/152), and primiparas accounted for 57.9% (88/152).

AL Levels Across Trimesters

Mean AL total scores were $(2.06\$\pm1.68), (2.07\pm1.84), and (2.07\pm\$1.68)$ in the first, second, and third trimesters, respectively. High AL status (AL total score $ $3) was observed in 52 (34.0%), 54 (35.3%), and 50 (32.7%) women across the three trimesters, indicating that a substantial proportion of pregnant women

experienced high levels of chronic stress during pregnancy. These results are slightly higher than the 31.47% reported by MORRISON et al. [9] in a survey of American pregnant women (using AL total score >4). Previous studies have identified associations between AL and factors such as race [19], living environment [20], and socioeconomic status [8], which may explain differences between our findings and those from American populations. Additionally, variations in biomarkers and calculation methods across studies may contribute to these differences, highlighting the need for more accurate and unified AL assessment methods to facilitate comparisons between studies.

Univariate Analysis of AL Influencing Factors

Significant differences between high and low AL groups were observed for occupational level, unemployment status, and depressive symptoms in the first trimester (P<0.10). In the second trimester, age, first-trimester depressive symptoms, and first-trimester AL status showed significant differences (P<0.10). In the third trimester, third-trimester nighttime sleep duration, first-trimester depressive symptoms, and high AL status in both first and second trimesters showed significant differences (P<0.1) .

Multivariate Analysis of AL Influencing Factors

Multivariate logistic regression models were established for each trimester using variables with statistical significance in univariate analysis (P<0.1) as independent variables and AL status as the dependent variable .

First Trimester: Compared with unemployed pregnant women, business service employees [OR=0.229, 95%CI(0.062,0.845), P=0.027], office staff [OR=0.164, 95%CI(0.051,0.528), P=0.002], and professional and technical personnel [OR=0.278, 95%CI(0.099,0.784), P=0.015] had lower likelihood of high AL. Compared with non-unemployed individuals, those who experienced unemployment in the past year had higher likelihood of high AL [OR=5.516, 95%CI(1.044,29.144), P=0.044]. Compared with those without depressive symptoms, those with depressive symptoms had higher likelihood of high AL [OR=6.241, 95%CI(1.403,27.757), P=0.016] .

Second Trimester: Older age was associated with higher likelihood of high AL [OR=1.098, 95%CI(1.002,1.202), P=0.045]. Compared with those with low AL in the first trimester, those with high AL in the first trimester had higher likelihood of high AL in the second trimester [OR=9.965, 95%CI(4.402,22.561), P<0.001] .

Third Trimester: Compared with sleep duration <9 h/d, sleep duration $ $9 h/d in the third trimester was associated with lower likelihood of high AL [OR=0.176, 95%CI(0.044,0.703), P=0.014]. Compared with low AL in the first trimester, high AL in the first trimester increased the likelihood of high AL in the third trimester [OR=4.697, 95%CI(1.852,11.908), P<0.001]. Similarly,

high AL in the second trimester increased the likelihood of high AL in the third trimester [OR=9.426, 95%CI(3.728,23.834), P<0.001] .

Discussion

Influencing Factors of AL in the First Trimester

Occupational level, unemployment status, and depressive symptoms emerged as key factors influencing first-trimester AL. Social class in this study was categorized based on access to organizational, economic, and cultural resources, with unemployment and being jobless representing the lowest social class [15]. Multivariate analysis showed that higher occupational classes—including business service employees, office staff, and professional and technical personnel—had lower likelihood of high AL compared with unemployed individuals. Previous research indicates that individuals with higher socioeconomic status have better resources and knowledge to improve health and cope with financial difficulties, adverse work environments, and stressful life events [21], whereas pressure from living at the bottom of the social hierarchy forces individuals into excessive stress, lipid metabolism disorders, sustained elevated blood glucose, and chronic inflammatory responses [22]. MCCRORY et al. [8] reported that older adults with higher occupational levels in professional or managerial positions had lower AL scores compared with those in lower occupational levels in unskilled or semi-skilled positions. Unemployment can lead to economic constraints, reduced social connections, and increased health-damaging behaviors [23], representing a chronic stressor that can persist for weeks, months, or even longer [24]. Under chronic stress, sustained activation of the hypothalamic-pituitary-adrenal axis causes cumulative wear and tear on physiological systems, leading to elevated AL [2,23].

Our findings also revealed that only depressive symptoms in the first trimester affected AL, while depression was not associated with AL in the second and third trimesters, suggesting that AL in early pregnancy may be more susceptible to depressive symptoms. Previous studies have supported the association between depression and AL in Black women, White men, and older adults [25-27]. However, HUX et al. [10] found that depression was not an influencing factor for AL in American women at 10-14 weeks of pregnancy. These inconsistent findings may be related to differences in study countries and depression assessment tools. Research has indicated that depression is associated with hypothalamic-pituitary-adrenal axis dysfunction and multi-system physiological dysregulation [27], and that depression during pregnancy is linked to increased risks of adverse pregnancy outcomes such as preterm birth and low birth weight [28-30], which are also associated with AL [3-5]. This suggests that AL, as a measure of chronic stress, may represent a biological mechanism linking depression during pregnancy to adverse pregnancy outcomes.

Influencing Factors of AL in the Second Trimester

Age and first-trimester AL status were identified as influencing factors for second-trimester AL. Our study found that older pregnant women had higher likelihood of high AL in the second trimester, reflecting the cumulative wear and tear experienced by physiological systems. Previous studies have identified age as an independent influencing factor for AL among female employees [31], adolescents [20], and farm workers [32]. With increasing age, lipid metabolism and immune system functions related to AL decline [33]. Research has shown that compared with younger individuals, older individuals have more difficulty recovering from stressful events due to age-related declines in physiological resilience [34]. Additionally, our study demonstrated that high AL in the first trimester was a risk factor for high AL in the second trimester, indicating that attention and timely intervention for individuals with high AL in early pregnancy could help reduce the risk of high AL in mid-pregnancy.

Influencing Factors of AL in the Third Trimester

Third-trimester sleep duration and high AL status in both first and second trimesters emerged as influencing factors for third-trimester AL. Previous studies have shown an inverse relationship between sleep duration and AL [7,35]. Our findings also indicated that sleep duration $ $9 h/d in the third trimester was associated with lower AL levels, reflecting the protective effect of adequate sleep on physiological systems in late pregnancy. Research has demonstrated that sleep duration during pregnancy is associated with multiple physiological systems, including inverse relationships with body mass index [36], blood glucose [37], C-reactive protein [38], and systolic and diastolic blood pressure [39]. Furthermore, our study showed that high AL in both early and mid-pregnancy were risk factors for high AL in late pregnancy. Therefore, attention to sleep duration in the third trimester and timely intervention for high AL in early and mid-pregnancy may help reduce the risk of high AL in late pregnancy.

Conclusion

Over 30% of women exhibited high AL levels during the first, second, and third trimesters, with varying influencing factors across pregnancy stages. Occupation, unemployment status, and depressive symptoms influenced first-trimester AL; age and first-trimester AL status affected second-trimester AL; and third-trimester sleep duration along with AL status in early and mid-pregnancy influenced third-trimester AL. Earlier attention and timely intervention for high AL during pregnancy may help reduce the risk of high AL as pregnancy progresses. Addressing maternal age and occupational status, improving depressive symptoms in early pregnancy, and optimizing sleep status in late pregnancy may help reduce physiological system wear and promote maternal and infant health. This study utilized biological data reflecting objective stress to longitudinally investigate AL and its influencing factors across pregnancy stages, providing new practical preventive measures for adverse pregnancy outcomes. However,

the findings are limited to two hospitals in Anhui Province, affecting generalizability, and socioeconomic, psychological, and behavioral factors were assessed through self-report, which is susceptible to recall bias and social desirability effects.

References

[1] MA T T. A case-control study on the association between perinatal psychosocial stress in pregnant women and congenital heart disease in offspring [D]. Fuzhou: Fujian Medical University, 2016.

[2] MCEWEN B S. Protective and damaging effects of stress mediators [J]. N Engl J Med, 1998, 338(3): 171-179. DOI: 10.1056/NEJM199801153380307.

[3] HUX V J, ROBERTS J M. A potential role for allostatic load in preeclampsia [J]. Matern Child Health J, 2015, 19(3): 591-597. DOI: 10.1007/s10995-014-1543-7.

[4] HUX V J, CATOV J M, ROBERTS J M. Allostatic load in women with a history of low birth weight infants: the national health and nutrition examination survey [J]. J Womens Health (Larchmt), 2014, 23(12): 1039-1045. DOI: 10.1089/jwh.2013.4572.

[5] OLSON D M, SEVERSON E M, VERSTRAETEN B S, et al. Allostatic load and preterm birth [J]. Int J Mol Sci, 2015, 16(12): 29856-29874. DOI: 10.3390/ijms161226209.

[6] JUSTER R P, SASSEVILLE M, GIGUÈRE C É, et al. Elevated allostatic load in individuals presenting at psychiatric emergency services [J]. J Psychosom Res, 2018, 115: 101-109. DOI: 10.1016/j.jpsychores.2018.10.012.

[7] ZHANG D, WU X Y, TAO S M, et al. Association between sleep duration, chronotype and allostatic load among college students [J]. Modern Preventive Medicine, 2021, 48(17): 3182-3186.

[8] MCCRORY C, FIORITO G, CHEALLAIGH C N, et al. How does socioeconomic position (SEP) get biologically embedded? A comparison of allostatic load and the epigenetic clock(s) [J]. Psychoneuroendocrinology, 2019, 104: 64-73. DOI: 10.1016/j.psyneuen.2019.02.018.

[9] MORRISON S, SHENASSA E D, MENDOLA P, et al. Allostatic load may not be associated with chronic stress in pregnant women, NHANES 1999-2006 [J]. Ann Epidemiol, 2013, 23(5): 294-297. DOI: 10.1016/j.annepidem.2013.03.006.

[10] HUX V J, ROBERTS J M, OKUN M L. Allostatic load in early pregnancy is associated with poor sleep quality [J]. Sleep Med, 2017, 33: 85-90. DOI: 10.1016/j.sleep.2016.09.001.

[11] BU S S, LI Y H. Physical activity is associated with allostatic load: evidence from the National Health and Nutrition Examination Survey [J]. Psychoneuroen-

docrinology, 2023, 154: 106294. DOI: 10.1016/j.psyneuen.2023.106294.

[12] ALLEN A M, WANG Y J, CHAE D H, et al. Racial discrimination, the superwoman schema, and allostatic load: exploring an integrative stress-coping model among African American women [J]. Ann N Y Acad Sci, 2019, 1457(1): 104-127. DOI: 10.1111/nyas.14188.

[13] BARRETT E S, VITEK W, MBOWE O, et al. Allostatic load, a measure of chronic physiological stress, is associated with pregnancy outcomes, but not fertility, among women with unexplained infertility [J]. Hum Reprod, 2018, 33(9): 1757-1766. DOI: 10.1093/humrep/dey261.

[14] HILL M, OBENG-GYASI E. The association of cytomegalovirus IgM and allostatic load [J]. Diseases, 2022, 10(4): 70. DOI: 10.3390/diseases10040070.

[15] LU X Y. Analysis of ten social strata in contemporary Chinese society [J]. Study and Practice, 2002(3): 55-63, 1. DOI: 10.19624/j.cnki.cn42-1005/c.2002.03.017.

[16] National Health Commission. Healthy China Action (2019-2030) [EB/OL]. (2019-07-15) [2023-03-08]. http://www.gov.cn/xinwen/2019-07/15/content_{5409694}.htm.

[17] SU K P, CHIU T H, HUANG C L, et al. Different cutoff points for different trimesters? The use of Edinburgh Postnatal Depression Scale and Beck Depression Inventory to screen for depression in pregnant Taiwanese women [J]. Gen Hosp Psychiatry, 2007, 29(5): 436-441. DOI: 10.1016/j.genhosppsych.2007.05.005.

[18] SHI P X, REN H, LI H, et al. Maternal depression and suicide at immediate prenatal and early postpartum periods and psychosocial risk factors [J]. Psychiatry Res, 2018, 261: 298-306. DOI: 10.1016/j.psychres.2017.12.085.

[19] JACKSON J S, KNIGHT K M, RAFFERTY J A. Race and unhealthy behaviors: chronic stress, the HPA axis, and physical and mental health disparities over the life course [J]. Am J Public Health, 2010, 100(5): 933-939. DOI: 10.2105/AJPH.2008.143446.

[20] THEALL K P, DRURY S S, SHIRTCLIFF E A. Cumulative neighborhood risk of psychosocial stress and allostatic load in adolescents [J]. Am J Epidemiol, 2012, 176(Suppl 7): S164-S174. DOI: 10.1093/aje/kws185.

[21] ELO I T. Social class differentials in health and mortality: patterns and explanations in comparative perspective [J]. Annu Rev Sociol, 2009, 35: 553-572. DOI: 10.1146/annurev-soc-070308-115929.

[22] ZHANG Y J, SHI H P. Socioeconomic status and metabolism [C]// Chinese Anti-Cancer Association, Editorial Department of Medical Reference News –Nutrition Channel of Ministry of Health, Guangzhou Anti-Cancer Association Tumor Nutrition and Support Therapy Professional Committee, Editorial

Department of Chinese General Surgery Literature (Electronic Edition). Proceedings of 2012 Guangzhou International Symposium on Tumor Nutrition and Support Therapy. Guangzhou, 2012: 168-171.

[23] SUMNER R C, GALLAGHER S. Unemployment as a chronic stressor: a systematic review of cortisol studies [J]. Psychol Health, 2017, 32(11): 1341-1360. DOI: 10.1080/08870446.2016.1247841.

[24] MILLER G E, CHEN E, ZHOU E S. If it goes up, must it come down? Chronic stress and the hypothalamic-pituitary-adrenocortical axis in humans [J]. Psychol Bull, 2007, 133(1): 25-45. DOI: 10.1037/0033-2909.133.1.25.

[25] BEY G S, WARING M E, JESDALE B M, et al. Gendered race modification of the association between chronic stress and depression among Black and White U.S. adults [J]. Am J Orthopsychiatry, 2018, 88(2): 151-160. DOI: 10.1037/ort0000301.

[26] JUSTER R P, MARIN M F, SINDI S, et al. Allostatic load associations to acute, 3-year and 6-year prospective depressive symptoms in healthy older adults [J]. Physiol Behav, 2011, 104(2): 360-364. DOI: 10.1016/j.physbeh.2011.02.027.

[27] KOBROSLY R W, SEPLAKI C L, CORY-SLECHTA D A, et al. Multisystem physiological dysfunction is associated with depressive symptoms in a population-based sample of older adults [J]. Int J Geriatr Psychiatry, 2013, 28(7): 718-727. DOI: 10.1002/gps.3878.

[28] YUAN M, BEDELL S, VRIJER B D, et al. Highlighting the mechanistic relationship between perinatal depression and preeclampsia: a scoping review [J]. Womens Health Rep, 2022, 3(1): 850-866. DOI: 10.1089/whr.2022.0062.

[29] GRIGORIADIS S, VONDERPORTEN E H, MAMISASHVILI L, et al. The impact of maternal depression during pregnancy on perinatal outcomes: a systematic review and meta-analysis [J]. J Clin Psychiatry, 2013, 74(4): e321-341. DOI: 10.4088/JCP.12r07968.

[30] ARAUJO D M, VILARIM M M, SABROZA A R, et al. Depression during pregnancy and low birth weight: a systematic literature review [J]. Cad Saude Publica, 2010, 26(2): 219-227. DOI: 10.1590/s0102-311x2010000200002.

[31] VON THIELE U, LINDFORS P, LUNDBERG U. Self-rated recovery from work stress and allostatic load in women [J]. J Psychosom Res, 2006, 61(2): 237-242. DOI: 10.1016/j.jpsychores.2006.01.015.

[32] MCCLURE H H, JOSH SNODGRASS J, MARTINEZ C R Jr, et al. Stress, place, and allostatic load among Mexican immigrant farmworkers in Oregon [J]. J Immigr Minor Health, 2015, 17(5): 1518-1525. DOI: 10.1007/s10903-014-0066-z.

[33] JOHNSON A A, STOLZING A. The role of lipid metabolism in aging, lifespan regulation, and age-related disease [J]. Aging Cell, 2019, 18(6): e13048. DOI: 10.1111/acel.13048.

[34] PIAZZA J R, STAWSKI R S, SHEFFLER J L. Age, daily stress processes, and allostatic load: a longitudinal study [J]. J Aging Health, 2018, 30(10): 1589-1609. DOI: 10.1177/0898264318788493.

[35] CHEN X L, REDLINE S, SHIELDS A E, et al. Associations of allostatic load with sleep apnea, insomnia, short sleep duration, and other sleep disturbances: findings from the National Health and Nutrition Examination Survey 2005 to 2008 [J]. Ann Epidemiol, 2014, 24(8): 612-619. DOI: 10.1016/j.annepidem.2014.05.014.

[36] LI Q, MA S S, YU L J, et al. Association between sleep status in late pregnancy and 10-year cardiovascular disease risk among pregnant women in Hefei [J]. Journal of Hygiene Research, 2022, 51(5): 761-766. DOI: 10.19813/j.cnki.weishengyanjiu.2022.05.014.

[37] CASEY T, SUN H, BURGESS H J, et al. Delayed lactogenesis II is associated with lower sleep efficiency and greater variation in nightly sleep duration in the third trimester [J]. J Hum Lact, 2019, 35(4): 713-724. DOI: 10.1177/0890334419830991.

[38] HOLINGUE C, OWUSU J T, FEDER K A, et al. Sleep duration and C-reactive protein: associations among pregnant and non-pregnant women [J]. J Reprod Immunol, 2018, 128: 9-15. DOI: 10.1016/j.jri.2018.05.003.

[39] TANG Y, ZHANG J, DAI F, et al. Poor sleep is associated with higher blood pressure and uterine artery pulsatility index in pregnancy: a prospective cohort study [J]. BJOG, 2021, 128(7): 1192-1199. DOI: 10.1111/1471-0528.16591.

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Note: Figure translations are in progress. See original paper for figures.