This work is licensed under a Creative Commons Attribution 4.0 International License.

Scand J Work Environ Health. 2025;51(5):355–369. doi:10.5271/sjweh.4236

The effects of prenatal psychosocial work stress on adverse pregnancy outcomes: A comprehensive systematic review and meta-analysis

by Wubet Taklual Admas, MPH,[1,2] Ai Ni Teoh, PhD,[1] Gi Kunchana Chonu, PhD [1]

Admas WT, Teoh AN, Chonu GK. The effects of prenatal psychosocial work stress on adverse pregnancy outcomes: A comprehensive systematic review and meta-analysis. *Scand J Work Environ Health*. 2025;51(5):355–369.

Objective Psychosocial work stress is a predictor of adverse pregnancy outcomes. However, there is limited comprehensive and conclusive evidence available on the associations between psychosocial work stress and adverse pregnancy outcomes. This systematic review and meta-analysis paper addressed this gap by synthesizing the available evidence.

Methods Studies were retrieved from six electronic databases that include pregnant mothers as study population, psychosocial work stress as variable exposure, and adverse pregnancy outcomes – including pregnancy loss, gestational hypertension and diabetes mellitus, preterm birth, low birth weight, and low fetal growth – as the outcomes of interest. The quality and certainty of evidence were assessed. Depending on the study characteristics, either a fixed or random effect model was employed. Heterogeneity was assessed using I^2 statistics, and further subgroup and sensitivity analysis was employed as appropriate.

Results A total of 26 studies (N=1 346 686) were included. Psychosocial work stress decreased birth weight by 77.09 grams, increased the occurrence of preeclampsia by 50%, and preterm birth by 18% with moderate certainty of evidence, and increased the chance of pregnancy loss by 20% with low certainty of evidence. With a low grading scale, low birth weight and small-for-gestational-age had no significant association with psychosocial work stress.

Conclusions Psychosocial work-stress increased the risks of pre-eclampsia, preterm birth, and pregnancy loss, and decreased fetus weight. Therefore, occupational therapists, employers, policy makers, and relevant stakeholders should work together to minimize the impact of psychosocial work-stress on the mother and baby.

Key terms birth weight; fetal growth; gestational hypertension; occupational hazard; pre-eclampsia; pregnancy loss; preterm.

Adverse pregnancy outcomes are unfavorable physiologic outcomes that occur during pregnancy, labor, and post-natal period on the mother and her fetus (1). These include pregnancy loss (miscarriage and stillbirth), preterm birth (PTB), low birth weight (LBW), small-for-gestational-age (SGA), hypertensive disorder of pregnancy (HDP), and gestational diabetes mellitus (GDM) (2). Adverse pregnancy outcomes are the leading causes of maternal and child morbidity and mortality (1). It contributed more than a third of maternal mortality (1) and three-fourths of neonatal mortality (3). Research shows that these outcomes are higher in Southeast Asia and Sub-Saharan African countries (1, 4).

Mothers who experience adverse pregnancy outcomes are at higher risks of developing psychosocial health problems, cardiovascular diseases, diabetes mellitus, and kidney disease later in life (5–8), while their surviving child is more likely to have neurodevelopmental disorders that may last into adulthood (9–13). Therefore, addressing and identifying the predictors of these unfavorable outcomes is critical to promoting mothers' and their children's short-term and long-term health.

Evidence has shown that work stress is one of the predictors of adverse pregnancy outcomes (14–19), which leads to different acute and chronic health problems (20–23). Work stress includes physical (eg, heavy physical work-load, whole-body vibration, etc.) (18, 24) and environmental stress (eg, noise-exposure, heat-

1 James Cook University, School of Social and Health Sciences, Singapore.
2 Debre Tabor University, College of Health Sciences, Department of Public Health, Ethiopia.

Correspondence to: Wubet Taklual Admas, Debre Tabor University, College of Health Sciences, Department of Public Health, Ethiopia. [E-mail: wubtak21@gmail.com]

exposure, etc.) (19, 25) in workplace settings and stress arises from high job demands, low decisional latitude, limited social and organizational support, job insecurity, role ambiguity, organizational imbalance, bullying, and inadequate rewards, which are collectively referred to as psychosocial work stress (PSWS) (20, 21, 23). The physical or environmental aspects of work stress have been investigated in the previous systematic reviews and are linked to adverse pregnancy outcomes (18, 19, 24, 26, 27). However, the psychosocial aspect of work stress (PSWS) is rarely studied.

More than 90% of pregnant women continue working during pregnancy, and many of them work until delivery due to financial necessity and job demand (28). Often, they work under similar conditions to those of non-pregnant workers (29, 30). In many countries, there is no legal protection for pregnant mothers in the workplace, and employers fail to offer special accommodations such as lighter workloads or flexible schedules (31, 32).

Although 47.4% of employed individuals are women in the global labor market (33), they are more prone to PSWS and its detrimental effects, primarily because they are more vulnerable to work-life and work-family imbalance, role overload including a second shift at home, and vocational strain (34, 35). Physiological stress arising from physical and hormonal changes associated with pregnancy may further aggravate the effect of PSWS on pregnant mothers (36).

Studies investigating the effects of PSWS on pregnancy outcomes report inconsistent findings, making it difficult to draw firm conclusions. While some studies showed that PSWS contributes to adverse pregnancy outcomes, including HDP (17, 37), pregnancy loss (14), PTB (38–40), LBW (14, 15, 41), and SGA (16, 42), other studies have found no significant associations (43–50). The inconsistent findings were mainly due to variations in study design, sample sizes, types of stressors, and duration of exposure. They highlight the necessity to consolidate the available evidence to understand the impact of PSWS on pregnancy outcomes.

Therefore, this systematic review and meta-analysis paper aimed to fill this gap by consolidating the available evidence on the associations between PSWS and adverse pregnancy outcomes, including HDP, pre-eclampsia, GDM, pregnancy loss, PTB, LBW, and SGA. The results are crucial for advising employers, occupational therapists, and clinicians, and making policy recommendations for relevant stakeholders. The overall impacts are crucial for achieving Sustainable Development Goal (SDG) 3 in reducing maternal mortality to<70 per 100 000 live births and neonatal mortality to <12 per 1000 live births by the end of 2030 (51).

Methods

The systematic review and meta-analysis was performed following the updated Preferred Reporting Items for Systematic Review and Meta-analysis (PRISMA) guideline reporting (52). The review protocol was registered in PROSPERO (CRD42024592293).

Search strategy

A comprehensive literature search was employed using six electronic databases including SCOPUS, PsycINFO, CINAHL, PubMed, Cochrane Library, and Science Citation Index Expanded without restricting countries and publication years. To ensure adequate coverage, we used Google Scholar for grey literature search and additional search through the reference lists of the studies. A broad range of keywords, controlled vocabulary terms, and Medical Subject Headings for each database were used. Boolean operators (OR, AND, NOT) were applied for precision and accuracy (see supplementary material, www.sjweh.fi/article/4236, file 1).

Inclusion and exclusion criteria

We selected research studies that examined PSWS and adverse pregnancy outcomes based on the PICO framework (53): (i) Population (singleton pregnant mothers engaged in paid employment); (ii) Intervention (PSWS); (iii) Comparator (singleton pregnant mothers in paid employment without or with low PSWS); and (iv) Outcomes (HDP, pre-eclampsia, GDM, pregnancy loss, LBW, PTB, and SGA). In this review, studies conducted using both observational and interventional designs were included. Case reports, case series, conference proceedings, reviews, editorials, commentaries, government reports, non-human studies, and studies published in languages other than English were excluded. In addition, studies on pregnant mothers exposed to other nonwork-related psychosocial stress, physical workload, or other environmental factors were excluded, if psychosocial work factors were not specifically identified as exposure variables as described below.

Exposure

PSWS is the exposure variable, measured using different models in the studies reviewed in this paper. These include the Job Demand–Control (JDC) model, the Job Demand–Resource (JDR) model, and the Effort–Reward Imbalance (ERI) model. Karasek (54) developed and validated the JDC model. According to this model, job demand is defined as emotional and cognitive load, including tight deadlines, prolonged working hours, and

task complexity. Job control refers to decision-making authority, task management, skill utilization without external influence, and the presence of flexible working conditions. The model identifies four job types: low strain job (low job demand with high control), active job (high job demand with high control), passive job (low job demand with low control), and high strain job (high job demand with low control) (54).

Bakker & Demerouti (55) developed the JDR model. According to the model, job resources include support from supervisors and colleagues, team cohesion, teamwork, skill development opportunities, and access to training programs. According to the JDR model, individuals facing high job demands and low job resources are considered experiencing high job strain (55).

Siegrist (56) proposed the ERI model, in which work effort refers to the demands placed on an employee, while reward encompasses the employee's expectations for compensation in the form of rewards, promotion, or job security. When an employee expends high effort but receives low reward, it results in job stress (56).

Outcome variables

In this review, seven key outcomes were included: HDP, pre-eclampsia, GDM, pregnancy loss, PTB, LBW, and SGA. To ensure consistency across studies, standard operational definitions were applied to each outcome: (i) *Hypertensive disorder of pregnancy (HDP)* – blood pressure ≥140/90 mmHg after 20 weeks of gestation without proteinuria (57); (ii) *Pre-eclampsia* – high blood pressure (≥140/90 mmHg) after 20 weeks of gestation and with either proteinuria or a sign of organ dysfunction (57); (iii) *Gestational diabetes mellitus (GDM)* – Development of glucose intolerance after 20 weeks; glucose level ≥92 mg/dL (5.1 mmol/L) in fasting or one hour after a meal ≥180 mg/dL (10.0 mmol/L) or two hours after a meal ≥153 mg/dL (8.5 mmol/L) (58); (iv) *Pregnancy loss* – A combination of miscarriage and stillbirth are considered pregnancy loss in this review; (v) *Miscarriage (spontaneous abortion)* – Pregnancy ended with ≤20 weeks of gestation (59); (vi) *Stillbirth/fetal loss*: Fetal death that occurs after 20 weeks of gestation; (vii) *Low birth weight (LBW)*

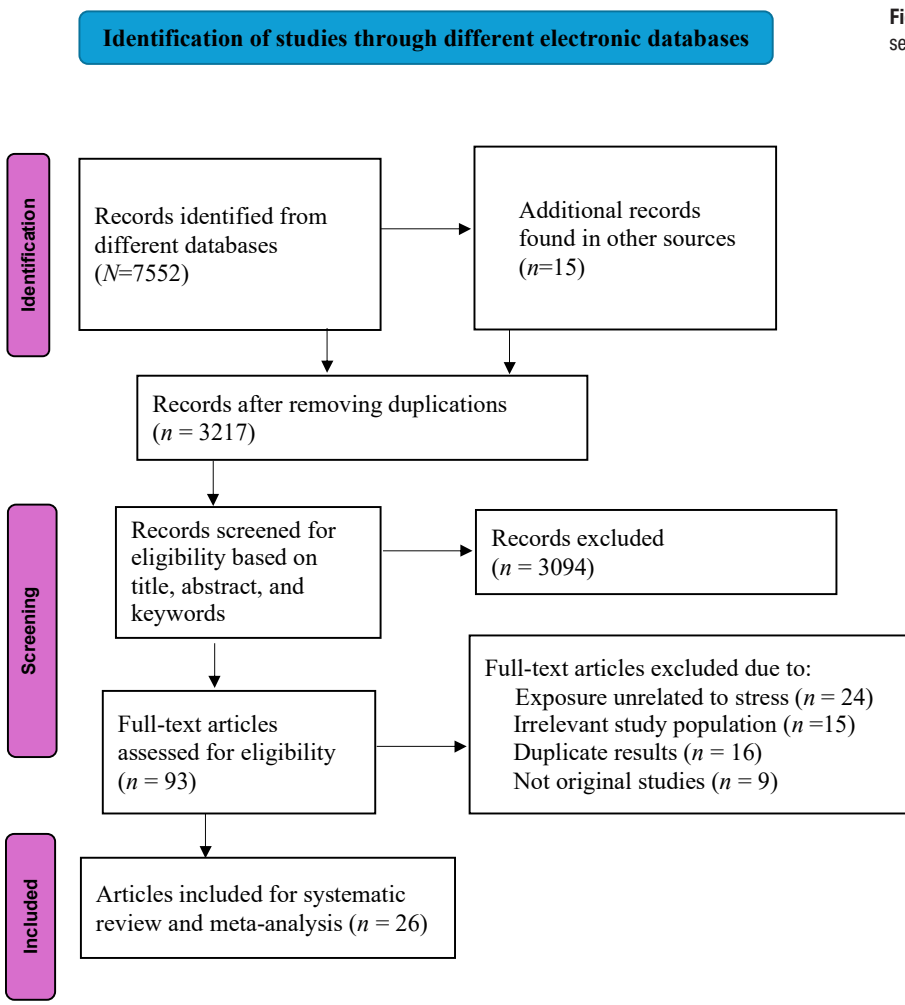

Figure 1. PRISMA flow diagram for studies selection process.

– Birth weight lower than 2500 grams (60); *Small-for-gestational-age (SGA)* – Birth weight below 10th percentile for gestational age based on sex; (viii) *Preterm birth (PTB)* – Giving birth before 37 weeks of gestation (60).

Study selection

All articles retrieved from electronic databases were exported to EndNote 21 for duplication removal. Two authors conducted initial titles and abstract screening using a structured checklist. Studies that met the selection criteria by either reviewer were eligible for full-text screening. The same reviewers did full-text screening following the inclusion and exclusion criteria. Any discrepancies between the reviewers were resolved through discussions and, in cases of irreconcilable differences, a third reviewer made the final decision. The study selection process was presented in the PRISMA diagram (see figure 1).

Data extraction

After developing a structured data abstraction format, a pilot test was conducted on a few randomly selected articles to ensure that the form included all relevant information to answer the review question and was user-friendly. Two authors extracted the data independently, and discrepancies were resolved through discussions. Extracted data included study characteristics (authors, years of publications, countries, study designs, and period), participant characteristics (study population and sample sizes), exposure variables (exposure variable measurement, durations of exposure, and proportions of exposed participants), outcomes (HDP, pre-eclampsia, GDM, pregnancy loss, PTB, birthweight, and SGA), results (proportions of outcomes of interest, effect estimates, controlling confounders), and other important information (see table 1).

Study quality assessment (risk of bias)

Methodological quality of the included studies was assessed using the Joanna Briggs Institute (JBI) evaluation tool (61). The JBI checklist consists of several domains specific to the study design. It includes 13 criteria for cohort studies, 10 for case–control studies, and 8 for cross-sectional studies. No trials or interventional studies were found among the included studies. According to the JBI checklist, studies were categorized into three levels of risk based on the percentage of criteria marked as "yes." Those scoring ≥70% were considered low risk, 50–69% medium risk, and <50% high risk (62). Two independent reviewers evaluated each study, and any differences were resolved through discussions (see supplementary file 2).

Certainty of evidence assessment

We used the Grade Recommendations Assessment Development and Evaluation (GRADE) system to evaluate the quality of the evidence into four levels of certainty: high, moderate, low, and very low. Initial ratings start at "high" for randomized controlled trials and "low" for observational studies. The quality of evidence can be downgraded or upgraded based on eight specific factors. Factors that downgrade the ratings are risk of bias, inconsistent results, indirectness, imprecision, and publication bias. On the other hand, factors that upgrade the grading score are the magnitude of effect size, residual plausible confounders, and dose-response (63, 64).

When rating the GRADE factors, the risk of bias is deemed serious if more than half of the studies are rated a high risk of bias. Indirectness is a serious concern if over half of the studies show substantial deviations from the PICO framework. Inconsistency is classified as serious if the I^2 statistics are >50%. Publication bias is a concern if there is asymmetry in the funnel plot or if the Egger test yields statistically significant results. Imprecision is categorized as serious if the total sample size of the included studies does not meet the Optimal Information Size criteria, or if the confidence intervals (CI) contain null values (24). The quality of the evidence is upgraded in the presence of large magnitude effects (risk ratio >2 or <0.5), limiting a plausible residual bias, or a dose–response relationship (24).

Data analysis

The extracted data from the Excel sheet was imported into STATA version 18 for further analyses, regardless of the sample size. Odds ratios (OR) were used as effect sizes. The natural logarithm of the OR along with their 95% CI and corresponding standard errors were calculated for the meta-analysis. Dichotomous and continuous variables were analyzed separately. When heterogeneity was low or absent, study characteristics were similar in qualitative assessments, and there were five or more studies, we employed a fixed effects model with the inverse-variance method. In other cases, we used a random effects model with the restricted maximum-likelihood approach. Variability between the studies was evaluated using I^2 statistics and Q-test. Based on I^2 statistics, heterogeneity is defined as low (0–24%), medium (25–75%), or high (>75%). If the I^2 statistic was >50%, further subgroup analysis and sensitivity analyses were employed. Publication bias was assessed using the regression-based Egger test, and if detected, a non-parametric trim-and-fill analysis was employed. Statistical significance was defined at $P<0.05$.

Results

Search results

We retrieved 7552 articles from six electronic databases and 15 articles from the Google search engine. After removing duplicates, we screened 3217 articles based on their titles and abstracts for eligibility. After excluding ineligible articles based on the PICO framework, 93 articles were included for full-text screening. Of these, 67 studies were excluded for reasons specified in figure 1. Finally, 26 articles met the criteria and were included in the systematic review and meta-analysis.

Study characteristics

This systematic review and meta-analysis included 26 studies without time period restriction from 9 countries: 9 studies were based in USA (15, 37, 38, 40, 43, 65–68), 6 in Denmark (14, 44, 45, 47, 50, 69), 3 in Canada (17, 39, 70), 3 in the Netherlands (42, 48, 49), and 1 each in Spain (71), Sweden (46), Mexico (72), Korea (41), and Thailand (16). All included studies used an observational study design: 18 prospective cohort studies (15, 16, 37, 41–50, 65–69), 6 case–control (14, 17, 38, 39, 70, 71), and 2 cross-sectional study design (40, 72). These studies involved a total of 1 368 127 pregnant mothers with sample sizes ranging from 67 to 1 102 230. Regarding participant characteristics, 21 studies recruited pregnant women from the general population, 2 studies focused specifically on healthcare workers (37, 67), 1 on primigravid women (17), 1 on nulliparous women (65), and 1 on female commercial and clerical workers (14) (see table 1). Moreover, all studies controlled the effects of confounding variables.

All studies used PSWS as an exposure variable and evaluated it using the JDC model. However, 2 studies used the ERI model (37, 67), and 4 used the JDR model (39, 43, 46, 70) as an additional PSWS assessment method (39, 43, 46, 70). In 17 studies, exposure time was measured as experiencing PSWS from the first trimester of pregnancy (15, 16, 37, 42–50, 66–69), and the rest were measured as experiencing PSWS at any time during pregnancy. Only 1 study assessed preconception stress before 9 weeks of pregnancy (15). The proportion of pregnant mothers exposed to high PSWS was 4.2–36% across studies.

Risk of bias and certainty of evidence assessment

Quality assessment showed that 18 studies had a low risk of bias (14, 15, 38–40, 42–44, 47–50, 65, 66, 68, 71, 72), while 8 exhibited a medium risk of bias (14, 16, 37, 41, 45, 46, 67, 69, 70). Common sources of bias in cohort studies were differences between study groups and populations (15, 16, 39–45, 47–50, 66, 68–72), failure to address incomplete follow-ups (16, 37, 41, 45, 50, 67, 69), a lack of explanation for incomplete follow-ups (15, 16, 41, 44, 69), use of inappropriate statistical analysis (16, 37, 41, 67, 68), and invalid and unreliable measurement of outcomes (37, 41, 67). The risks of bias found in case–control studies were non-matching groups other than the presence of outcomes of interest (17, 38, 39, 70, 71) and inconsistent criteria for identifying cases and controls (70, 71). In cross-sectional studies, the primary source of bias was the absence of specific criteria for selecting study participants (40) (see supplementary file 2).

The GRADE assessment was conducted for seven pregnancy outcomes, with evidence ratings ranging from very low to medium. All the studies included were observational, starting with a baseline of a low rate. Two outcomes were downgraded to very low; three outcomes were upgraded to medium, and two outcomes remained unchanged. Downgrading was due to inconsistency (N=2), imprecision (N=1), and publication bias (N=2). The upgrade was driven by a large effect size and contracting residual confounders (see supplementary file 3)

Maternal complications

Gestational hypertension. Six studies examined the association between PSWS and HDP (N=1 111 813) (17, 37, 46, 48, 66, 70). However, one study was excluded from the meta-analysis due to differences in the exposure variable measurement (37). Although an outlier was observed in the qualitative assessment and the forest plot among the included studies, there was no evidence of publication bias detected (β_1=0.4, P=0.45). In addition, retaining the outlier did not significantly alter the pooled effect, and therefore it was included in the final analysis (46) (see supplementary figure S1). With a low certainty of evidence, the final pooled effect showed no significant relationship between high PSWS and HDP [OR 1.02 (95% CI 0.99–1.05)].

Pre-eclampsia. Six studies examined the relation between PSWS and pre-eclampsia (N=1 111 936) (17, 46, 48, 65, 66, 70). Among the studies, one study accounted for 99.3% of the total weight, significantly influencing the overall effect size during the sensitivity analysis (46). Due to its substantial impact on the pooled estimate and identified methodological issues, this study was excluded from the final meta-analysis. A subsequent analysis was conducted using the remaining five studies (17, 48, 65, 66, 70). With a medium quality of evidence, the analysis revealed the significant association between PSWS and pre-eclampsia [OR 1.5 (95% CI 1.06–2.13)]. No publication bias was detected (β_1=0.93, P=0.49) (see supplementary figure S2).

Table 1. Details of the included studies in the review. [AHR=adjusted hazard ratio; AOR=adjusted odds ratio; ARR=adjusted relative risk; BP=blood pressure, CI=confidence interval; COR=crude odds ratio; ERI=effort–reward imbalance; GDM=gestational diabetes mellitus; HDP=hypertensive disorder of pregnancy; JDC=job demand–control; LBW=low birth weight; LSS=low social support; NA=not applicable; P=proportion; PTB=preterm birth; SE=standard error; SGA=small- for-gestational-age; SS=social support; Wks=wks]

Author (year), country	Study design & period	Study population	Exposure variable & measurement	Time of exposure measurement & duration of exposure	Sample size & women exposed to high job strain (P)	Outcomes of interest & outcome measurement	Women who develop outcomes of interest (P)	Main finding (95% CI)
Brandt et al (1992) (14), Denmark	Case–control. 1983–1985	Commercial and clerical female workers	Job strain e valuated by the JDC model using Karasek's scale	After childbirth with a recall period of 2.5–4.5 years, exposed any time during pregnancy	N=2490, 31.16%	Spontaneous abortion before 28 wks of gestation	45.18%	High job strain AOR=1.28 (1.05–1.57)
					N=1786 29.05%	Congenital malformation	23.57%	High job strain AOR=1.23 (0.93–1.63)
					N=1727 29.76%	PTB=delivery before 36 wks of gestation	20.96%	High job strain AOR=1.03 (0.77–1.39)
					N=1712 30.54%	LBW=birth weight is less than 2500 g	20.26%	High job strain AOR=1.46 (1.05–2.04)
					N=1980 29.54%	SGA=birthweight in the lowest 5th percentile	31.06%	High job strain AOR=1.08 (0.83–1.40)
					N=1493 29.7	Still birth and death in the 1st year of life	8.57%	High job strain AOR=1.42 (0.90–2.24)
Breet et al (1997) (38), USA	Case–control, 1988–1991	African American and Caucasian	Job strain evaluated by the JDC model using Karasek's scale	After 6 months of childbirth. Duration of exposure=>30 wks & 4–29 wks	N=398 35.43%	PTB=give birth before 37 completed wks	36.18%	High strain job among >30 wks of exposure (AOR=1.8 (1.1–3.1) and high strain job among < 30 wks of exposure (AOR=1.0 (0.5–2.0)
Ceron-Mireles et al (1996) (72), Mexico	Cross-sectional, 1992	General population	Job strain evaluated by the JDC model using Karasek's scale	Immediately afterchildbirth. Exposed ≥ 3 months during pregnancy	N=2320 22.76%	PTB=Give birth before 37 completed wks	11.81%	High job strain COR=1.16 (0.90–1.50)
					N=2309 22.74%	SGA=below the 10th percentile of weight for a given GA	10.91%	High job strain COR=1.23 (0.95–1.60)
Croteau et al (2007) (39), Canada	Case–control, 1997–1999	General population	Job strain evaluated by the JDC model using Karasek's scale	Within 32 days of childbirth	N=962 (within 24 wks of gestation) 41.68%	PTB=Give birth before 37 completed wks	15.38%	High job strain with minimal social support within 24 wks of pregnancy only AOR=1.0 (0.7–1.3)
					N=483 (late 24 wks of gestation) 33.75%	PTB=Give birth before 37 completed wks	13.87%	High job strain with minimal social support late 24 wks of pregnancy AOR=1.2 (0.8–1.8)
					N=2627 (throughout pregnancy 25.96%	PTB=Give birth before 37 completed wks	16.94%	High job strain with minimal social support throughout pregnancy AOR=1.4 (1.1–1.8)
Escriba-Agüir et al (2001) (71), Spain	Case–control, 1994–1995	General population	Job demand, evaluated using the job demand model	Within two days after delivery	N=572 20.98%	PTB=birth before 37 wks of gestation	39.86%	High strain job AOR=1.4 (0.95–2.26)
Fenster et al (1995) (43), USA	Prospective, 1990–1991	General population	Job strain evaluated by the JDC model using the Karasek's scale and social support	Within 13 wks of conception	N=3953 8.4%	Miscarriage= pregnancy ended ≤20 wks of gestation	9.9%	High job strain AOR=1.18 (0.81–1.71). Low social support AOR=0.91 (0.72–1.16)
Haelterman et al (2007) (70), Canada	Case–control 1997–1999	General population	Job strain evaluated by the JDC model using Karasek's scale and social support	Within 30 days of delivery	N=4538 23.94%	Preeclampsia=BP ≥140/90 mmHg with albuminuria.	2.25%	High job strain AOR=1.7 (0.8–3.3)
						HDP=BP ≥140/90 mmHg without albuminuria	2.23%	High job strain AOR=1.0 (0.6–1.9)
Henriksen et al (1994) (44), Denmark	Prospective 1989–1991	General population	Job strain evaluated by the JDC model using Karasek's scale	16th and 30th wks of gestation	N=3407 24.89%	SGA=birthweight below the 10th percentile	9.1%	High job strain AOR=1.1(0.7–1.6)
						PTB=give birth before 37 complete wks	3.96%	High strain job AOR=1.3(0.7–2.2)
Homer et al (1990) (15), USA	Prospective, 1979–1983	General population	Job strain evaluated by the JDC model using Karasek's scale	9wks before pregnancy and during pregnancy	N=780 33.6%	LBW=birthweight less than 2500 grams	6.25%	High job strain with low motivation to work RR=8.0 (1.3–37)
						PTB=Give birth before 38 completed wks	3.4%	High job strain with low motivation to work RR=8.4 (1.4–50.2)

Continues

Table 1. Continued

Author (year), country	Study design & period	Study population	Exposure variable & measurement	Time of exposure measurement & duration of exposure	Sample size & women exposed to high job strain (P)	Outcomes of interest & outcome measurement	Women who develop outcomes of interest (P)	Main finding (95% CI)
Klonoff-Cohen et al (1996) (65), USA	Case–control, 1987	Nulliparous women	Job strain evaluated by the JDC model using Karasek's scale	1 year after pregnancy	N=123 30.89%	Preeclampsia=BP ≥140/90 mmHg with proteinuria	56.1%	High job strain compared with other workers AOR=2.1 (0.7–6.2). High job strain compared with non–workers AOR=3.1 (1.2–7.8)
Landsbergis et al (1996) (66), USA	Prospective 1987–1989	General population	Job strain evaluated by the JDC model using Karasek's scale	13, 28, & 36 wks of gestation	N=575 5%	Preeclampsia=BP ≥140/90 mmHg with proteinuria	1.9%	High job strain AOR=1.6 (0.3–10.3)
						HDP=BP ≥140/90 mmHg without albuminuria	2.78	High job strain AOR=1.7 (0.3–8.9)
Larsen et al (2013) (45), Denmark	Prospective, not mentioned	General population	Job strain evaluated by the JDC model using Karasek's scale	1st or 2nd trimester of pregnancy	N=48 890 6.83%	PTB=give birth before 37 completed wks	4.86%	High job strain AOR=0.98 (0.82 –1.16). High job strain with low social support AOR=1.39 (0.86 –2.23)
						SGA=birthweight below the 10th percentile	9%	High job strain AOR=1.01 (0.89 – 1.14) High job strain with low social support AOR=1.06 (0.73–1.53)
Larsen et al (2014) (69), Denmark	Prospective-Not stated	General population	Job strain evaluated by the JDC model using Karasek's scale	1st or 2nd trimester of pregnancy	N=60 386 6.7%	All congenital malformations	5.1%	High job strain AOR=0.99 (0.85–1.15)
Lee et al (2011) (41), Korea	Prospective, not stated	General population	Job strain evaluated by the JDC model using Karasek's scale and ERI model	1st trimester	N=310 NA	LBW measured in continues variables	NA	High job strain using JDC isn't significantly associated (b(SE)=–33.39 (61.03). ERI doesn't affect birth weight after adjustment
Lissåker et al (2022) (46), Sweden	Prospective, 1994–2014	General population	Job strain evaluated by job exposure matrix using Karasek's scale and JD-R (the information collected on job specific).	Starting 1st trimester	N=1 080 850 24.2% (JDC) 23.3% (LSS)	Preeclampsia=BP ≥140/90 mmHg with proteinuria	3% 2.71% (LSS)	High job strain with ARR=1.02 (0.98–1.06) Low social support ARR=0.92 (0.89–0.96)
						HDP=BP ≥140/90 mmHg without albuminuria	3.97% 3.67% (LSS)	High job strain with ARR=1.02 (0.99–1.05) Low social support ARR=0.93 (0.90–0.96)
						GDM: Fasting glucose ≥ 92 mg/dl	0.8% 0.7% (LSS)	High job strain with ARR=1.0 (0.94–1.07) Low social support ARR=0.91 (0.85–0.98)
Marcoux et al (1999) (17), Canada	Case–control, 1986	Primigravida women	Job strain evaluated by the JDC model using Karasek's scale	Within one month of delivery	N=730 20.27%	Preeclampsia=BP ≥140/90 mmHg with proteinuria	17.53%	High job strain AOR=2.1 (1.1–4.1)
						HDP=BP ≥140/90 mmHg without albuminuria	27.53%	High job strain AOR=1.3 (0.8–2.2)
Meyer et al (2016) (37), USA	Prospective, study period not stated	Health care workers	Job strain evaluated by the JDC model using Karasek's scale and ERI	Repeated measurement in each trimester	N=61 14% (ERI) 21% (JDC)	HDP=NA (only systolic BP assessed)	NA	High ERI B(SE)=8.8 (2.7) P=0.001 High job strain B(SE)=3.3(2.3) P=0.1
Meyer et al (2017) (67), USA	Prospective, study period not stated	Health care workers	Job strain evaluated by the JDC model using Karasek's scale and ERI	Repeated measurement in each trimester	N=55 14% (ERI) 21% (JDC)	Birth weight measure continues	NA	High ERI B(SE)= 317(280g), P=0.26 High job strain B(SE)=7(167g), P=0.87
Meyer et al (2007) (40), USA	Cross-sectional, 2000	General Population	Job strain evaluated by the JDC model using Karasek's scale	Any time during pregnancy	N=26,408 19.34%	LBW=birth weight <2500 g	5.5%	High job strain AOR=1.11 (0.92–1.34)
						PTB=delivery before 37 wks gestation	8.3%	High job strain AOR=1.17 (1.00–1.36)
Oths, et al (2001) (68), USA	Prospective, 1993–1996	General population	Job strain evaluated by the JDC model using Karasek's scale	14 and 28 wks of gestation	N=480 36%	Birth weight (continuous in grams)	NA	Work in high job strain has unadjusted difference in Birth weight 190g (95%CI 48-333)
Sejbaek et al (2018) (47), Denmark	Prospective, 1996–2002	General population	Job strain evaluated by the JDC model using Karasek's scale	During the first or second trimester pregnancy	N=47582 8.2%	SGA=birthweight below the 10th percentile	8.1%	High job strain AOR=1.01 (0.90–1.13)
						LGA=birthweight above the 90th percentile	12.43%	High job strain AOR=1.16 (1.07–1.26)

Continues

Table 1. Continued

Author (year), country	Study design & period	Study population	Exposure variable & measurement	Time of exposure measurement & duration of exposure	Sample size & women exposed to high job strain (P)	Outcomes of interest & outcome measurement	Women who develop outcomes of interest (P)	Main finding (95% CI)
Tuntiseranee et al (1998) (16), Thailand	Prospective, 1994–1995	General population	Job strain evaluated by the JDC model using Karasek's scale	At 17 and 32 wks of gestation	N=1797 NA	PTB=delivery before 37 wks gestation	4.9%,	High job strain AOR=0.7(0.2–2.3)
						SGA=birthweight below the 10th percentile	2.7%,	High job strain AOR=12.7(3.1–51.8)
Vollebregt et al (2007) (48), Netherland	Prospective, 2003–2004	Nulliparous	Job strain evaluated by the JDC model using Karasek's scale	Before 24 wks of gestation	N=3679 5.65%	Preeclampsia=BP ≥140/90 mmHg with proteinuria	3.5%	High job strain AOR=1.61 (0.75–3.49)
						HDP=BP ≥140/90 mmHg without albuminuria	4.4%	High job strain AOR=1.03 (0.48–2.20)
Vrijkotte et al (2021) (49), Netherland	Prospective, 2003–2004	General population	Job strain evaluated by the JDC model using Karasek's scale	Before 24 wks of gestation	N=4865 6.7%	PTB=delivery before 37 wks gestation	5.2%	High job strain AOR=1.02 (0.60–1.76)
Vrijkotte et al (2009) (42), Netherland	Prospective, 2003–2004	General population	Job strain evaluated by the JDC model using Karasek's scale	Before 24 wks of gestation	N=7096 P=4.2%	Birth weight (continuous in grams	NA	High job strain B(SE)=–72 (26), P value=<0.01
						SGA=below the 10th percentile for gestational age	NA	High job strain AOR=1.5 (1.1–2.1)
Zhu, et al (2004) (50), Denmark	Prospective, 1998–2001	General population	Job strain evaluated by the JDC model using Karasek's scale	Before 25 wks of gestation	N=41 769 P=7.76%	Miscarriage=A fetal loss before 28 wks	1.15%	High job strain AHR=1.00 (0.68 –1.46)
						Stillbirth=fetal death ≥28 wks	0.32%	High job strain AHR=0.85 (0.40 –1.82)

Gestational diabetes mellitus. A single prospective study conducted in Sweden among the general population (N=1 102 230) reported an exposure rate of 24.2%, using both the JDC and JDR models (46). The prevalence of GDM was 0.8% in the JDC model and 0.7% in the JDR model. After adjusting for confounding variables, PSWS measured using the JDC model had no significant association with GDM [ARR=1 (95% CI 0.94–1.07)]. PSWS measured using the JDR model showed a protective effect [ARR=0.91 (95% CI 0.85–0.98)].

Obstetric outcomes

Pregnancy loss. Three studies (N=48 212) examined the association between PSWS and pregnancy loss (14, 43, 50). With a low certainty of evidence, the pooled effect showed the significant association between high PSWS and pregnancy loss [OR 1.20 (95% CI 1.04–1.40)] (see supplementary figure S3). Both qualitative and statistical assessments indicated no evidence of publication bias (β_1= -1.65, *P*=0.17).

Preterm birth. Eleven studies (N=91 791) examined the relationship between PSWS and PTB (14–16, 38–40, 44, 45, 49, 71, 72). However, two studies were excluded from the meta-analysis due to differing operational definitions of the outcome (14, 15). The remaining nine studies (N=89 284) were included in the meta-analysis. With a medium certainty of evidence, the pooled effect indicated that high PSWS has a significant association with PTB [OR 1.18 (95% CI 1.05–1.34)] (see supplementary figure S4). No evidence of publication bias was identified (β_1=0.41, *P*=0.58).

Further analyses were conducted based on study designs and exposure durations. Based on the study designs, the pooled effects of cross-sectional (40, 72), case–control (14, 38, 39, 71), and prospective (15, 16, 44, 45, 49) studies were [OR 1.17 (95% CI 1.02–1.33)], [OR 1.45 (95% CI 1.19–1.77)], and [OR 1 (95% CI 0.85–1.17)], respectively (see supplementary figure S5). Additional sub-group analyses based on the exposure durations of PSWS during pregnancy were also performed; comparing exposure at any time during pregnancy [OR 1.19 (95% CI 1.02–1.33)] to exposure throughout pregnancy [OR 1.20 (95% CI 0.96–1.50)] (see supplementary figure S6).

Fetal outcomes

Birth weight. Seven studies examined the link between PSWS and birth weight. However, their data contains both dichotomous and continuous outcomes. Hence, the studies with categorical and continuous outcomes were analyzed separately.

Firstly, three studies with dichotomous outcomes were included in an analysis (N=28 900) (14, 15, 40). The pooled effect showed non-significant association between PSWS and LBW [OR 2.30 (95% CI 0.70–7.60)], with a very low certainty of evidence (see supplementary figure S7). In addition, a significant publication bias (β_1=11.87, P=0.002) and heterogeneity (I^2=97.5%) were detected. This is because of the small number of studies, and variations in study designs and sample

sizes. The non-parametric trim-and-fill analysis did not identify any imputed studies, indicating potential bias. Although the outlier was observed in the forest plot (15), a sensitivity analysis was not performed due to the small number of studies.

Secondly, four studies with the continuous birth weight variable were included (N=7941). All of which employed a prospective cohort study design. With medium certainty of evidence, the pooled effect showed that a significant association between high PSWS and birth weight [*b*= -77.09 (95% CI -121.18– -33.01)] (see supplementary figure S8). No evidence of publication bias was detected (β_1=-0.2, P=0.82).

Small-for-gestational-age. Seven studies assessed the relationship between PSWS and SGA (N=113 061) (14, 16, 42, 44, 45, 47, 72). Except for one cross-sectional study (72), all were prospective cohort studies. One study was excluded from the meta-analysis due to a different measurement of the outcome (14). With a very low certainty of evidence, the pooled effect indicated no association between PSWS and SGA [OR 1.15 (95% CI 0.98–1.35)] (see supplementary figure S9). Although publication bias was detected (β_1=3.4, *P*=0.0042), no significant difference was observed between the observed and imputed results [OR 1.022 (95% CI 0.612–1.708)]. Additionally, a stepwise sensitivity analysis indicated that the study done by Tuntiseranee was a potential source of bias (16), but a removal of the study did not change the pooled effect. Hence it was retained in the analysis.

After a thorough qualitative assessment of the study characteristics, a subgroup analysis was conducted to identify potential sources of heterogeneity (I^2=63.36%). The analysis was stratified by sample size, having a sample size ≤5000 (16, 44, 72) [OR 2.22 (95% CI 0.55–8.94)] and having a sample size >5000 (42, 45, 47) [OR 1.09 (95% CI 0.90–1.32)] (see supplementary figure S10). Even though neither subgroup showed statistical significance, the studies having sample sizes ≤5000 demonstrated a stronger association.

Discussion

The effects of PSWS have been largely overlooked, despite its significance as a critical occupational and public health issue, particularly for pregnant women who are already under considerable physiological stress. The present review is one of the first to synthesize the available empirical data on the associations between PSWS and a range of adverse pregnancy outcomes. The results showed that PSWS had a significant effect on birth weight, pre-eclampsia, PTB, and pregnancy loss. These findings are consistent with previous systematic review results focusing on the physical and environmental aspects of work stress, which examined the effects of shift work, long working hour, prolonged standing, heavy physical work load and occupational noise on adverse pregnancy outcomes (18, 19, 24, 26, 27).

Preeclampsia is a serious complication during pregnancy that poses a threat to mothers' health and fetal outcomes (73, 74). Our meta-analysis showed that PSWS was associated with an increased risk of pre-eclampsia by approximately 50% with a medium certainty of evidence. This is consistent with other systematic reviews showing that psychological factors increased the risk for pre-eclampsia (36, 75, 76).

A significant but weak association was detected between PSWS and pregnancy loss. This may be due to the included studies in this meta-analysis being limited, and their exposure rates were >10% indicating insufficient statistical power for the analysis. An optimal exposed to non-exposed ratio may be used in future studies to improve the findings.

Preterm birth is another adverse pregnancy outcome that showed a significant 18% increase in occurrence among pregnant women experiencing high PSWS in the present review. Likewise, other review papers also reported significant links between stress and pre-term birth (18, 24, 36). The finding was further stratified by study design, which revealed that only non-prospective studies showed a significant association. This might be due to recall bias and higher exposure rates in cross-sectional and case–control designs as compared to prospective studies.

In addition, we found that PSWS was associated with reduced birth weight with a medium certainty of evidence. Despite the small number of studies, all of them showed strong effects and had good methodological quality, which makes this finding highly reliable and useful for practical applications. In addition, a non-significant association was found between PSWS and LBW. This might be due to high heterogeneity in study designs and sample sizes. In particular, in the same analysis, the sample size of the study that showed a non-significant association (40) was 10 times larger than those in the studies with significant association (14, 15). However, other review studies found significant associations between psychological factors (eg, depression (77) and prenatal stressful conditions (78, 79) and LBW. To conclude, mitigating PSWS among pregnant mothers may be crucial in improving birth weight and avoiding further complications.

In the present review, overall, the associations between PSWS and adverse pregnancy outcomes were rather weak. It is noteworthy that all the studies included in the review were conducted in developed nations, where most enabling factors are readily available, such as regular occupational health checkups and access to

other necessary services. The detrimental effects of PSWS on pregnant women in developing countries could be aggravated by the limited availability of these enabling factors and socio-demographic disparities (80–83). According to the ILO report and other evidence, lower and middle-income countries (LMIC) fail to provide flexible maternity leave, relaxed work environments, and screening for pregnant mothers for PSWS by occupational therapists (29). All these factors contribute to a higher prevalence of PSWS (20, 21, 23) and amplify its impact on pregnant mothers. This suggests that the impacts of PSWS might be more concerning in these countries. Usually, in LMIC, attention is often focused on other significant predictors of maternal and child mortality and morbidity, like biomedical determinants, and quality and equity of health care, but overlooked psychosocial risk factors (84, 85). Therefore, investigating the effects of PSWS in LMIC could provide critical insights into its impact on pregnancy outcomes.

Although the link between PSWS and adverse pregnancy outcomes was weak, all included studies adjusted for confounders using multivariable analysis except the Meyer et al study (37). Some also used stratification (38) and matching (17, 37, 48, 67) to minimize residual confounding effects. All these methods strengthen the validity of the observed associations across studies.

PSWS is linked to adverse pregnancy outcomes (pre-eclampsia, pregnancy loss, PTB and LBW) through three primary biological pathways: elevated cortisol levels through the hypothalamus-pituitary-adrenal axis activation, sympathetic nervous system activation, and increased production of pro-inflammatory cytokines (IL-1β and TNF-α) (36, 78, 86, 87). These pathways synergistically or individually affect pregnancy outcomes in three ways. First, an increased production of catecholamines leads to vasoconstriction, endothelial damage, and reduced nitric oxide production, all of which affect blood vessel elasticity. These lead to hypertension in pregnancy, restricting blood flow and hence nutrients to the uterus and placenta, which results in low birth weight and pregnancy loss (36, 78, 86, 87). Second, the disruption of the immune balance leads to inappropriate responses against embryos and disrupts the uterine environment which may result in miscarriage (78, 86). Third, increased production of oxytocin and prostaglandin hormones stimulate cervical ripening and increase uterine contractility that may initiate early labor (36, 78, 86).

PSWS affects pregnancy outcomes not only through biological factors but also a combination of psychological and behavioral responses. Women who are under stress are more engaged in unhealthy behaviors, such as smoking and alcohol consumption, to cope with stress (88–90). This unhealthy coping behavior can further increase the risks of adverse pregnancy outcomes (91–94). Pregnant mothers under stress may also develop depression, anxiety, and loneliness (95–97), all of which are known risk factors for adverse pregnancy outcomes (77, 98–102).

The findings of this review highlight that PSWS may contribute to adverse pregnancy outcomes. Therefore, to mitigate its impacts, employers and managers should consider measures such as reducing workload, flexible working hours and decision-making, flexible maternity leave, and creating a supportive work environment for pregnant women. Clinicians and occupational therapists should pay comparable attention to PSWS screening as other risk screening services during antenatal care. Relevant stakeholders should endorse psychosocial working conditions in occupational health and safety precautions for pregnant mothers. Finally, further research using a robust methodological approach is needed to strengthen or change the direction of the association between PSWS and adverse pregnancy outcomes, especially in LMIC where there has been a lack of evidence so far.

Study limitations

The authors noted the following limitations: first, all the studies included were from high- and upper-middle-income countries, which makes it difficult to generalize the findings to LMIC. Second, there are methodological concerns, where 84% of the included cohort studies had suboptimal exposed-to-non-exposed ratios, which may compromise the validity and reliability of the results. All the studies were observational, which limits the ability to establish causality. Additionally, some studies assessed JDC with a single question each (45, 50, 69), limiting the JDC model's components and failing to fully capture its framework. Similarly, Lissåker's study used a job exposure matrix to evaluate PSWS based on job codes (46), but it was not validated in PSWS evaluation models. Third, the number of studies included in each outcome category was small, which could reduce the statistical power to detect significant effects and may introduce publication bias. Fourth, some studies used administrative data routinely collected by clinics, which has inherent limitations as secondary data (45–47, 50). Fifth, we excluded non-English studies and may have missed important information and introduce publication bias. Sixth, based on the GRADE evaluation of the certainty of evidence for the seven outcomes of interest rated the majority as low or very low. This suggests that the need for more evidence to sufficiently support clinical considerations and policy recommendations. Therefore, given the above-mentioned limitations, the results should be interpreted with caution.

Concluding remarks

The current review shows that PSWS is evidently associated with pre-eclampsia, pregnancy loss, and preterm birth and reduces infant birth weight. Therefore, it is essential that occupational therapists, employers, and other concerned stakeholders work collaboratively to address and prevent this critical occupational and public health issue.

Conflict of interest

The authors declare no competing interests.

References

1. WHO. Trends in maternal mortality 2000 to 2020: estimates by WHO, UNICEF, UNFPA, World Bank Group and UNDESA/Population Division. WHO; 2023. Report No: 9240068759. Available from: https://www.who.int/publications/i/item/9789240068759.

2. Kramer MS. The epidemiology of adverse pregnancy outcomes: an overview. J Nutr 2003 May;133(5 Suppl 2):1592S–6S. https://doi.org/10.1093/jn/133.5.1592S.

3. Ballot DE, Chirwa T, Ramdin T, Chirwa L, Mare I, Davies VA et al. Comparison of morbidity and mortality of very low birth weight infants in a Central Hospital in Johannesburg between 2006/2007 and 2013. BMC Pediatr 2015 Mar;15:20. https://doi.org/10.1186/s12887-015-0337-4.

4. Mahtab S, Madhi SA, Baillie VL, Els T, Thwala BN, Onyango D et al.; CHAMPS Consortium. Causes of death identified in neonates enrolled through Child Health and Mortality Prevention Surveillance (CHAMPS), December 2016 -December 2021. PLOS Glob Public Health 2023 Mar;3(3):e0001612. https://doi.org/10.1371/journal.pgph.0001612.

5. Quist-Nelson J, Meng ML, Stuart JJ, Fuller M, Rogers U, Pencina M et al. Adverse pregnancy outcomes and the development of short-term maternal cardiovascular disease risk factors. Am J Obs Gyn. 2023;228(1):S497. https://doi.org/10.1016/j.ajog.2022.11.854.

6. Crump C, Sundquist J, McLaughlin MA, Dolan SM, Govindarajulu U, Sieh W et al. Adverse pregnancy outcomes and long term risk of ischemic heart disease in mothers: national cohort and co-sibling study. BMJ 2023 Feb;380:e072112. https://doi.org/10.1136/bmj-2022-072112.

7. Sederholm Lawesson S, Swahn E, Pihlsgård M, Andersson T, Angerås O, Bacsovics Brolin E et al. Association between history of adverse pregnancy outcomes and coronary artery disease assessed by coronary computed tomography angiography. JAMA 2023 Feb;329(5):393–404. https://doi.org/10.1001/jama.2022.24093.

8. Unger E, Makarova N, Borof K, Schlieker P, Reinbold CV, Aarabi G et al. Association of adverse pregnancy outcomes with cardiovascular risk profiles in later life: Current insights from the Hamburg City Health Study (HCHS). Atherosclerosis 2024 Sep;396:118526. https://doi.org/10.1016/j.atherosclerosis.2024.118526.

9. Adane AA, Mishra GD, Tooth LR. Maternal preconception weight trajectories, pregnancy complications and offspring's childhood physical and cognitive development. J Dev Orig Health Dis 2018 Dec;9(6):653–60. https://doi.org/10.1017/S2040174418000570.

10. Adane AA, Mishra GD, Tooth LR. Diabetes in pregnancy and childhood cognitive development: a systematic review. Pediatrics 2016 May;137(5):e20154234. https://doi.org/10.1542/peds.2015-4234.

11. Cozzani M, Aradhya S, Goisis A. The cognitive development from childhood to adolescence of low birthweight children born after medically assisted reproduction-a UK longitudinal cohort study. Int J Epidemiol 2021 Nov;50(5):1514–23. https://doi.org/10.1093/ije/dyab009.

12. Roffman JL, Sipahi ED, Dowling KF, Hughes DE, Hopkinson CE, Lee H et al. Association of adverse prenatal exposure burden with child psychopathology in the Adolescent Brain Cognitive Development (ABCD) Study. PLoS One 2021 Apr;16(4):e0250235. https://doi.org/10.1371/journal.pone.0250235

13. Glover V, O'Donnell KJ, O'Connor TG, Fisher J. Prenatal maternal stress, fetal programming, and mechanisms underlying later psychopathology-A global perspective. Dev Psychopathol 2018 Aug;30(3):843–54. https://doi.org/10.1017/S095457941800038X.

14. Brandt LP, Nielsen CV. Job stress and adverse outcome of pregnancy: a causal link or recall bias? Am J Epidemiol 1992 Feb;135(3):302–11. https://doi.org/10.1093/oxfordjournals.aje.a116284.

15. Homer CJ, James SA, Siegel E. Work-related psychosocial stress and risk of preterm, low birthweight delivery. Am J Public Health 1990 Feb;80(2):173–7. https://doi.org/10.2105/AJPH.80.2.173.

16. Tuntiseranee P, Geater A, Chongsuvivatwong V, Koranantakul O. The effect of heavy maternal workload on fetal growth retardation and preterm delivery. A study among southern Thai women. J Occup Environ Med 1998 Nov;40(11):1013–21. https://doi.org/10.1097/00043764-199811000-00013.

17. Marcoux S, Bérubé S, Brisson C, Mondor M. Job strain and pregnancy-induced hypertension. Epidemiology 1999 Jul;10(4):376–82. https://doi.org/10.1097/00001648-199907000-00007.

18. Cai C, Vandermeer B, Khurana R, Nerenberg K, Featherstone R, Sebastianski M et al. The impact of occupational activities during pregnancy on pregnancy outcomes: a systematic review and metaanalysis. Am J Obstet Gynecol 2020 Mar;222(3):224–38. https://doi.org/10.1016/j.ajog.2019.08.059.

19. Vincens N, Persson Waye K. Occupational and environmental noise exposure during pregnancy and rare health outcomes of offspring: a scoping review focusing on congenital anomalies and perinatal mortality. Rev Environ Health 2022 May;38(3):423–38. https://doi.org/10.1515/reveh-2021-0166.

20. EASH. Psychosocial risks and work-related stress: risk assessment. 2013. Available from: https://oshwiki.osha.europa.eu/en/themes/psychosocial-risks-and-work-related-stress-risk-assessment.

21. WHO. Occupational health: Stress at the workplace. WHO;19 October 2020. Available from: https://www.who.int/news-room/questions-and-answers/item/ccupational-health-stress-at-the-workplace.

22. Niedhammer I, Bertrais S, Witt K. Psychosocial work exposures and health outcomes: a meta-review of 72 literature reviews with meta-analysis. Scand J Work Environ Health 2021 Oct;47(7):489–508. https://doi.org/10.5271/sjweh.3968.

23. Madsen IE, Rugulies R. Understanding the impact of psychosocial working conditions on workers' health: we have come a long way, but are we there yet? Scand J Work Environ Health 2021 Oct;47(7):483–7. https://doi.org/10.5271/sjweh.3984.

24. Adane HA, Iles R, Boyle JA, Gelaw A, Collie A. Maternal Occupational Risk Factors and Preterm Birth: A Systematic Review and Meta-Analysis. Public Health Rev 2023 Oct;44:1606085. https://doi.org/10.3389/phrs.2023.1606085.

25. Lakhoo DP, Brink N, Radebe L, Craig MH, Pham MD, Haghighi MM et al.; Heat-Health Study Group; HIGH Horizons Study Group. A systematic review and meta-analysis of heat exposure impacts on maternal, fetal and neonatal health. Nat Med 2025 Feb;31(2):684–94. https://doi.org/10.1038/s41591-024-03395-8.

26. Cai C, Vandermeer B, Khurana R, Nerenberg K, Featherstone R, Sebastianski M et al. The impact of occupational shift work and working hours during pregnancy on health outcomes: a systematic review and meta-analysis. Am J Obstet Gynecol 2019 Dec;221(6):563–76. https://doi.org/10.1016/j.ajog.2019.06.051.

27. Croteau A. Occupational lifting and adverse pregnancy outcome: a systematic review and meta-analysis. Occup Environ Med 2020 Jul;77(7):496–505. https://doi.org/10.1136/oemed-2019-106334.

28. Laughlin L. Maternity leave and employment patterns: 2006–2008. Current population report, P70-128. Washington, DC: US Census Bureau. 2011. Available from: https://www2.census.gov/library/publications/2011/demo/p70-128.pdf.

29. ILO. Maternity and paternity at work: law and practice across the world. Laura A NC, Katherine G, editor. International Labour Office. – Geneva: ILO, 2014. Available from: https://www.ilo.org/sites/default/files/wcmsp5/groups/public/@dgreports/@dcomm/@publ/documents/publication/wcms_242615.pdf.

30. Andersen DR, Momsen AH, Pedersen P, Maimburg RD. Reflections on workplace adjustments for pregnant employees: a qualitative study of the experiences of pregnant employees and their managers. BMC Pregnancy Childbirth 2022 Jun;22(1):456. https://doi.org/10.1186/s12884-022-04749-1.

31. ILO. World Employment and Social Outlook: Trends 2021. Geneva; 2021. Available from: https://www.ilo.org/global/research/global-reports/weso/trends2022/WCMS_834081/lang--en/index.htm.

32. Tucker JJ, Heydemann SD. Pregnant Workers Need Accommodations for Safe and Healthy Workplaces. Oct,2021. Available from: https://nwlc.org/wp-content/uploads/2021/11/Pregnant-Workers-by-the-Numbers-2021-v4.pdf.

33. ILO. World Employment and Social Outlook Trends. 2023. https://doi.org/10.54394/SNCP1637.

34. Gilbert-Ouimet M, Brisson C, Vézina M. Psychosocial work stressors, high family responsibilities, and psychological distress among women: A 5-year prospective study. Am J Ind Med 2020 Feb;63(2):170–9. https://doi.org/10.1002/ajim.23070.

35. Machín-Rincón L, Cifre E, Domínguez-Castillo P, Segovia-Pérez M. I am a leader, I am a mother, I can do this! The moderated mediation of psychological capital, work–family conflict, and having children on well-being of women leaders. Sustainability 2020;12(5):2100. https://doi.org/10.3390/su12052100.

36. Traylor CS, Johnson JD, Kimmel MC, Manuck TA. Effects of psychological stress on adverse pregnancy outcomes and nonpharmacologic approaches for reduction: an expert review. Am J Obstet Gynecol MFM 2020 Nov;2(4):100229. https://doi.org/10.1016/j.ajogmf.2020.100229.

37. Meyer JD, Muntaner C, O'Campo P, Warren N. Longitudinal Assessment of Effort-Reward Imbalance and Job Strain Across Pregnancy: A Preliminary Study. Matern Child Health J 2016 Jul;20(7):1366–74. https://doi.org/10.1007/s10995-016-1933-0.

38. Brett KM, Strogatz DS, Savitz DA. Employment, job strain, and preterm delivery among women in North Carolina. Am J Public Health 1997 Feb;87(2):199–204. https://doi.org/10.2105/AJPH.87.2.199.

39. Croteau A, Marcoux S, Brisson C. Work activity in pregnancy, preventive measures, and the risk of preterm delivery. Am J Epidemiol 2007 Oct;166(8):951–65. https://doi.org/10.1093/aje/kwm171.

40. Meyer JD, Warren N, Reisine S. Job control, substantive complexity, and risk for low birth weight and preterm delivery: an analysis from a state birth registry. Am J Ind Med 2007 Sep;50(9):664–75. https://doi.org/10.1002/ajim.20496.

41. Lee BE, Ha M, Park H, Hong YC, Kim Y, Kim YJ et al. Psychosocial work stress during pregnancy and birthweight. Paediatr Perinat Epidemiol 2011 May;25(3):246–54. https://doi.org/10.1111/j.1365-3016.2010.01177.x.

42. Vrijkotte TG, van der Wal MF, van Eijsden M, Bonsel GJ. First-trimester working conditions and birthweight: a prospective cohort study. Am J Public Health 2009 Aug;99(8):1409–16. https://doi.org/10.2105/AJPH.2008.138412.

43. Fenster L, Schaefer C, Mathur A, Hiatt RA, Pieper C, Hubbard AE et al. Psychologic stress in the workplace and spontaneous abortion. Am J Epidemiol 1995 Dec;142(11):1176–83. https://doi.org/10.1093/oxfordjournals.aje.a117576.

44. Henriksen TB, Hedegaard M, Secher NJ. The relation between psychosocial job strain, and preterm delivery and low birthweight for gestational age. Int J Epidemiol 1994 Aug;23(4):764–74. https://doi.org/10.1093/ije/23.4.764.

45. Larsen AD, Hannerz H, Juhl M, Obel C, Thulstrup AM, Bonde JP et al. Psychosocial job strain and risk of adverse birth outcomes: a study within the Danish national birth cohort. Occup Environ Med 2013 Dec;70(12):845–51. https://doi.org/10.1136/oemed-2013-101453.

46. Lissåker C, Hemmingsson T, Kjellberg K, Lindfors P, Selander J. Occupational stress and pregnancy-related hypertension and diabetes: results from a nationwide prospective cohort. Scand J Work Environ Health 2022 Apr;48(3):239–47. https://doi.org/10.5271/sjweh.4004.

47. Sejbaek CS, Bay H, Larsen AD, Kristensen P, Schlünssen V, Andersen AN et al. Combined exposure to lifting and psychosocial strain at work and adverse pregnancy outcomes-A study in the Danish National Birth Cohort. PLoS One 2018 Sep;13(9):e0201842. https://doi.org/10.1371/journal.pone.0201842.

48. Vollebregt KC, van der Wal MF, Wolf H, Vrijkotte TG, Boer K, Bonsel GJ. Is psychosocial stress in first ongoing pregnancies associated with pre-eclampsia and gestational hypertension? BJOG 2008 Apr;115(5):607–15. https://doi.org/10.1111/j.1471-0528.2008.01665.x.

49. Vrijkotte T, Brand T, Bonsel G. First trimester employment, working conditions and preterm birth: a prospective population-based cohort study. Occup Environ Med 2021 Sep;78(9):654–60. https://doi.org/10.1136/oemed-2020-107072

50. Zhu JL, Hjollund NH, Andersen AM, Olsen J. Shift work, job stress, and late fetal loss: The National Birth Cohort in Denmark. J Occup Environ Med 2004 Nov;46(11):1144–9. https://doi.org/10.1097/01.jom.0000145168.21614.21.

51. UN. Progress towards the Sustainable Development Goals (SDG) Report of the Secretary-General. In: UN, editor. 27 July 2023 – 24 July 2024. Available from: https://unstats.un.org/sdgs/files/report/2024/SG-SDG-Progress-Report-2024-advanced-unedited-version.pdf.

52. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021 Mar;372(71):n71. https://doi.org/10.1136/bmj.n71.

53. Capili B. How does research start? Am J Nurs 2020 Oct;120(10):41–4. https://doi.org/10.1097/01.NAJ.0000718644.96765.b3.

54. Karasek R, Brisson C, Kawakami N, Houtman I, Bongers P, Amick B. The Job Content Questionnaire (JCQ): an instrument for internationally comparative assessments of psychosocial job characteristics. J Occup Health Psychol 1998 Oct;3(4):322–55. https://doi.org/10.1037/1076-8998.3.4.322.

55. Bakker AB, Demerouti E. The job demands-resources model: state of the art. J Manag Psychol 2007;22(3):309–28. https://doi.org/10.1108/02683940710733115.

56. Siegrist J. Effort-reward imbalance model. Stress: Concepts, cognition, emotion, and behavior: Elsevier; 2016. p. 81–6.

57. Bello NA, Zhou H, Cheetham TC, Miller E, Getahun D, Fassett MJ, et al. Prevalence of hypertension among pregnant women when using the 2017 American College of Cardiology/American Heart Association blood pressure guidelines and association with maternal and fetal outcomes. JAMA network open. 2021;4(3):e213808-e.

58. Bulletins-Obstetrics C. ACOG practice bulletin no. 190: gestational diabetes mellitus. Obstet Gynecol 2018 Feb;131(2):e49–64. https://doi.org/10.1097/AOG.0000000000002501.

59. Griebel CP, Halvorsen J, Golemon TB, Day AA. Management of spontaneous abortion. Am Fam Physician 2005 Oct;72(7):1243–50.

60. WHO. WHO Recommendations on Interventions to Improve Preterm Birth Outcomes. Geneva. WHO Press. 2014. Available from: https://iris.who.int/bitstream/handle/10665/183037/9789241508988_eng.pdf?sequence=1.

61. Aromataris EM, editor. JBI Manual for Evidence Synthesis. JBI,2020. https://doi.org/10.46658/JBIMES-20-01.

62. Adane HA, Iles R, Boyle JA, Collie A. Maternal occupational risk factors and preterm birth: protocol for a systematic review and meta-analysis. PLoS One 2023 Jul;18(7):e0283752. https://doi.org/10.1371/journal.pone.0283752.

63. Malmivaara A. Methodological considerations of the GRADE method. Taylor & Francis; 2015. p. 1-5. Doi: https://doi.org/10.3109/07853890.2014.969766.

64. Schünemann HJ. Brożek J, Guyatt G, Oxman A. GRADE Handbook for Grading Quality of Evidence and Strength of Recommendations. The GRADE Working Group.2013. Available from: https://gdt.gradepro.org/app/handbook/handbook.html.

65. Klonoff-Cohen HS, Cross JL, Pieper CF. Job stress and preeclampsia. Epidemiology 1996 May;7(3):245–9. https://doi.org/10.1097/00001648-199605000-00005.

66. Landsbergis PA, Hatch MC. Psychosocial work stress and pregnancy-induced hypertension. Epidemiology 1996 Jul;7(4):346–51. https://doi.org/10.1097/00001648-199607000-00002.

67. Meyer JD, O'Campo P, Warren N, Muntaner C. Association of Birthweight With Maternal Trajectories of Effort-Reward Imbalance and Demand-Control Across Pregnancy. J Occup Environ Med 2017 Feb;59(2):169–76. https://doi.

org/10.1097/JOM.0000000000000932.

68. Oths KS, Dunn LL, Palmer NS. A prospective study of psychosocial job strain and birth outcomes. Epidemiology 2001 Nov;12(6):744–6. https://doi.org/10.1097/00001648-200111000-00025.

69. Larsen AD, Hannerz H, Thulstrup AM, Bonde JP, Obel C, Hougaard KS. Psychosocial job strain and risk of congenital malformations in offspring--a Danish National cohort study. BJOG 2014 Jun;121(7):830–8. https://doi.org/10.1111/1471-0528.12612.

70. Haelterman E, Marcoux S, Croteau A, Dramaix M. Population-based study on occupational risk factors for preeclampsia and gestational hypertension. Scand J Work Environ Health 2007 Aug;33(4):304–17. https://doi.org/10.5271/sjweh.1147.

71. Escribá-Agüir V, Perez-Hoyos S, Saurel-Cubizolles MJ. Physical load and psychological demand at work during pregnancy and preterm birth. Int Arch Occup Environ Health 2001 Oct;74(8):583–8. https://doi.org/10.1007/s004200100259.

72. Cerón-Mireles P, Harlow SD, Sánchez-Carrillo CI. The risk of prematurity and small-for-gestational-age birth in Mexico City: the effects of working conditions and antenatal leave. Am J Public Health 1996 Jun;86(6):825–31. https://doi.org/10.2105/AJPH.86.6.825.

73. Fu R, Li Y, Li X, Jiang W. Hypertensive Disorders in Pregnancy: Global Burden From 1990 to 2019, Current Research Hotspots and Emerging Trends. Curr Probl Cardiol 2023 Dec;48(12):101982. https://doi.org/10.1016/j.cpcardiol.2023.101982.

74. Dimitriadis E, Rolnik DL, Zhou W, Estrada-Gutierrez G, Koga K, Francisco RP et al. Pre-eclampsia. Nat Rev Dis Primers 2023 Feb;9(1):8. https://doi.org/10.1038/s41572-023-00417-6.

75. Shay M, MacKinnon AL, Metcalfe A, Giesbrecht G, Campbell T, Nerenberg K et al. Depressed mood and anxiety as risk factors for hypertensive disorders of pregnancy: a systematic review and meta-analysis. Psychol Med 2020 Oct;50(13):2128–40. https://doi.org/10.1017/S0033291720003062.

76. Mustofa BN, Sulisetyowati DW, editors. Relationship between Antenatal Depression and Pre-Eclampsia (LITERATURE REVIEW). International Conference on Midwifery; 2021.

77. Fekadu Dadi A, Miller ER, Mwanri L. Antenatal depression and its association with adverse birth outcomes in low and middle-income countries: A systematic review and meta-analysis. PLoS One 2020 Jan;15(1):e0227323. https://doi.org/10.1371/journal.pone.0227323.

78. Ding X, Liang M, Wu Y, Zhao T, Qu G, Zhang J et al. The impact of prenatal stressful life events on adverse birth outcomes: A systematic review and meta-analysis. J Affect Disord 2021 May;287:406–16. https://doi.org/10.1016/j.jad.2021.03.083.

79. Littleton HL, Bye K, Buck K, Amacker A. Psychosocial stress during pregnancy and perinatal outcomes: a meta-analytic review. J Psychosom Obstet Gynaecol 2010 Dec;31(4):219–28. https://doi.org/10.3109/01674822X.2010.518776.

80. Daalderop LA, Lagendijk J, Steegers EA, El Marroun H, Posthumus AG. Psychological distress during pregnancy and adverse maternal and perinatal health outcomes: the role of socioeconomic status. Int J Gynaecol Obstet 2023 Dec;163(3):920–30. https://doi.org/10.1002/ijgo.14891.

81. Manasyan A, Saleem S, Koso-Thomas M, Althabe F, Pasha O, Chomba E et al.; EmONC Trial Group. Assessment of obstetric and neonatal health services in developing country health facilities. Am J Perinatol 2013 Oct;30(9):787–94. https://doi.org/10.1055/s-0032-1333409.

82. Afulani PA, Moyer C. Explaining disparities in use of skilled birth attendants in developing countries: a conceptual framework. PLoS One 2016 Apr;11(4):e0154110. https://doi.org/10.1371/journal.pone.0154110.

83. Kwesiga D, Tawiah C, Imam MA, Tesega AK, Nareeba T, Enuameh YA et al.; Every Newborn-INDEPTH Study Collaborative Group. Barriers and enablers to reporting pregnancy and adverse pregnancy outcomes in population-based surveys: EN-INDEPTH study. Popul Health Metr 2021 Feb;19 Suppl 1:15. https://doi.org/10.1186/s12963-020-00228-x.

84. Souza JP, Day LT, Rezende-Gomes AC, Zhang J, Mori R, Baguiya A et al. A global analysis of the determinants of maternal health and transitions in maternal mortality. Lancet Glob Health 2024 Feb;12(2):e306–16. https://doi.org/10.1016/S2214-109X(23)00468-0.

85. Kurjak A, Stanojević M, Dudenhausen J. Why maternal mortality in the world remains tragedy in low-income countries and shame for high-income ones: will sustainable development goals (SDG) help? J Perinat Med 2022 Jun;51(2):170–81. https://doi.org/10.1515/jpm-2022-0061.

86. Beijers R, Buitelaar JK, de Weerth C. Mechanisms underlying the effects of prenatal psychosocial stress on child outcomes: beyond the HPA axis. Eur Child Adolesc Psychiatry 2014 Oct;23(10):943–56. https://doi.org/10.1007/s00787-014-0566-3.

87. Vianna P, Bauer ME, Dornfeld D, Chies JA. Distress conditions during pregnancy may lead to pre-eclampsia by increasing cortisol levels and altering lymphocyte sensitivity to glucocorticoids. Med Hypotheses 2011 Aug;77(2):188–91. https://doi.org/10.1016/j.mehy.2011.04.007.

88. Azagba S, Sharaf MF. The effect of job stress on smoking and alcohol consumption. Health Econ Rev 2011 Sep;1(1):15. https://doi.org/10.1186/2191-1991-1-15.

89. Steptoe A, Wardle J, Lipsey Z, Mills R, Oliver G, Jarvis M et al. A longitudinal study of work load and variations in psychological well-being, cortisol, smoking, and alcohol consumption. Ann Behav Med 1998;20(2):84–91. https://doi.org/10.1007/BF02884453.

90. Fuentes-Leonarte V, Murcia-Hinarejos M, González-Galarzo MC, García AM, Rebagliato M. Occupational

determinants of continued smoking during pregnancy. INMA Valencia cohort study. 2012.

91. Bailey BA, Sokol RJ. Prenatal alcohol exposure and miscarriage, stillbirth, preterm delivery, and sudden infant death syndrome. Alcohol Res Health 2011;34(1):86–91.

92. Bayih WA, Belay DM, Ayalew MY, Tassew MA, Chanie ES, Feleke DG et al. The effect of substance use during pregnancy on neonatal outcomes in Ethiopia: A systematic review and meta-analysis. Heliyon 2021 Apr;7(4):e06740. https://doi.org/10.1016/j.heliyon.2021.e06740.

93. Delpisheh A, Brabin L, Brabin BJ. Pregnancy, smoking and birth outcomes. Womens Health (Lond Engl) 2006 May;2(3):389–403. https://doi.org/10.2217/17455057.2.3.389.

94. Odendaal HJ, Steyn DW, Elliott A, Burd L. Combined effects of cigarette smoking and alcohol consumption on perinatal outcome. Gynecol Obstet Invest 2009;67(1):1–8. https://doi.org/10.1159/000150597.

95. Clayborne ZM, Colman I, Kingsbury M, Torvik FA, Gustavson K, Nilsen W. Prenatal work stress is associated with prenatal and postnatal depression and anxiety: Findings from the Norwegian Mother, Father and Child Cohort Study (MoBa). J Affect Disord 2022 Feb;298 Pt A:548–54. https://doi.org/10.1016/j.jad.2021.11.024.

96. Tsai SY. Relationship of perceived job strain and workplace support to antenatal depressive symptoms among pregnant employees in Taiwan. Women Health 2019 Jan;59(1):55–67. https://doi.org/10.1080/03630242.2018.1434590.

97. Sanguanklin N, McFarlin BL, Finnegan L, Park CG, Giurgescu C, White-Traut R et al. Job strain and psychological distress among employed pregnant Thai women: role of social support and coping strategies. Arch Womens Ment Health 2014 Aug;17(4):317–26. https://doi.org/10.1007/s00737-013-0410-7.

98. Accortt EE, Cheadle AC, Dunkel Schetter C. Prenatal depression and adverse birth outcomes: an updated systematic review. Matern Child Health J 2015 Jun;19(6):1306–37. https://doi.org/10.1007/s10995-014-1637-2.

99. Jahan N, Went TR, Sultan W, Sapkota A, Khurshid H, Qureshi IA et al. Untreated depression during pregnancy and its effect on pregnancy outcomes: a systematic review. Cureus 2021 Aug;13(8):e17251. https://doi.org/10.7759/cureus.17251.

100. Ding XX, Wu YL, Xu SJ, Zhu RP, Jia XM, Zhang SF et al. Maternal anxiety during pregnancy and adverse birth outcomes: a systematic review and meta-analysis of prospective cohort studies. J Affect Disord 2014 Apr;159:103–10. https://doi.org/10.1016/j.jad.2014.02.027.

101. Grigoriadis S, Graves L, Peer M, Mamisashvili L, Tomlinson G, Vigod SN et al. Maternal anxiety during pregnancy and the association with adverse perinatal outcomes: systematic review and meta-analysis. J Clin Psychiatry 2018 Sep;79(5):813. https://doi.org/10.4088/JCP.17r12011.

102. Orr ST. Social support and pregnancy outcome: a review of the literature. Clin Obstet Gynecol 2004 Dec;47(4):842–55. https://doi.org/10.1097/01.grf.0000141451.68933.9f.

Received for publication: 7 January 2025