Project title: Occupational Activity and Pregnancy Outcomes: A Meta-analysis.

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Summary for general public audience

Summary of the report

Women of reproductive age make up a significant proportion of the workforce and approximately 90% of pregnant women remain employed during pregnancy. Yet the impact of different types of occupational activity including prolonged standing, shift work and physically demanding work on maternal/fetal health outcomes is poorly understood.

The Canada Labour Code requires that women immediately contact their health care provider to seek clinical guidance to establish if any aspect of their occupational activities carry a risk to either the mothers or fetus. Although clinicians play a critical role in the decisions regarding prenatal occupational activity, recent data suggest that there is wide variability in employment recommendations, in part due to a lack of authoritative recommendations. The goal of this project was to conduct a systematic review and meta-analysis examining the impact of various types of occupational activity on maternal/fetal health outcomes including (but not limited to) birth weight, preeclampsia, miscarriage and preterm delivery. We conducted two meta-analyses (104 observational studies, N=929,425 women) linking occupational physical activities to maternal and fetal health found an increased risk for adverse pregnancy outcomes among the pregnant workers whose jobs require working long hours, shift work, or heavy physical effort (heavy lifting, prolonged standing, prolonged working, prolonged bending, and heavy workload). The data revealed increased odds of preterm delivery with rotating shift work (14%), fixed night shifts (22%), long working hours (22%), heavy lifting (16%), prolonged standing (12%) and a heavy workload (23%); as well as increased odds of miscarriage with fixed night shifts (28%), long working hours (38%) and heavy lifting (31%). Occupational physical activities were also associated with increased risk of the following: small baby in newborns, low birth weight baby, gestational hypertension, and preeclampsia. We measured the relationship between the quantity of working hours and standing hours and its overall effect on the preterm delivery, found that women working more than 55.5 hours per week (versus 40) or standing more than 2.5 hours per day (versus no standing) had a 10% increase in the odds of having a preterm delivery.

This project extended our understanding of the potential risks of occupational activity on the health of a pregnant woman and her baby, which make a meaningful contribution towards healthy and safe workplaces in Alberta.

Four key points

- Rotating shift work, fixed night shifts, working >40 hours per week, lifting ≥100kg total per day, standing >4h/day and a heavy physical workload increased the odds of preterm delivery by 14%, 22%, 22% , 31%, 11%, and 23% respectively.
- Fixed night shifts, working >40 hours per week, and lifting >11kg per time increased the odds of miscarriage by 28%, 38%, and 35% respectively.
- Women working more than 55.5 hours per week had a 10% increase in the odds of having a preterm delivery compared to working 40 hours per week.
- Women standing more than 2.5 hours per day at work had a 10% increase in the odds of having a preterm delivery compared to no standing at work.

Key points for:

- Decision makers: Decision making on occupational directives or workplace design for the prevention of adverse pregnancy outcomes should be informed.

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- Practitioners: Should emphasize the potential harm of certain occupational activities to pregnant patients.
- Workers/employers: Some excessive occupational physical activities should be avoided if circumstances allow.

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List of acronyms, abbreviations

BMI: Body mass index

PTD: Preterm delivery

h/wk: hours/week

LBW:low-birth-weight

SGA: small-for-gestational age

Intrauterine Growth Restriction : IUGR

Kg: kilogram

ORs: odds ratio

95% CI: 95% confidence interval

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Introduction

Women of reproductive age make up a significant proportion of the workforce and approximately 90% of women remain employed during pregnancy[1]. Data from the sixth European Working Conditions Survey (2016) showed that more than 15% of women worked over 41 hours per week, 21% of women were exposed to shift work, and 14% of women were engaged in night work[2]. At the same time, many women engage in physically demanding work including carrying heavy loads (23%) or working in a tiring or painful position (43%)[3]. Although definitions vary across sources, long working hours are defined as work beyond the standard hours of work[4], whereas shift work is defined as employment in any work schedule that is not a regular daytime schedule[5]. Recent studies have found that long working hours and shift work may be associated with an increased risk of adverse pregnancy outcomes, including preterm delivery (PTD) and miscarriage[6, 7]. Plausible physiological mechanisms linking altered sleep patterns and long working hours to adverse pregnancy outcomes have also started to emerge. It has been suggested that prolonged disruption of circadian rhythms as a result of shift work trigger neuroendocrine adaptations that may affect fetal growth and timing of parturition[6], and that raised noradrenaline levels from long working hours may increase uterine contractility and the risk of preterm labour and miscarriage[8, 9]. In addition, emerging evidence suggests that physically demanding work may be associated with adverse pregnancy outcomes including miscarriage and PTD [10-12]. The increased risk of adverse outcomes has been hypothesized to result from reduced maternal blood pressure and/or blood flow to the uteroplacental unit resulting in increased uterine contractility and impaired fetal growth [13, 14].

Up to 2013, meta-analyses examining the relationship between occupational activities and pregnancy outcomes reported conflicting findings[15-20]. In the subsequent six years, additional studies have provided evidence that may clarify the link between occupational activities with adverse pregnancy outcomes. Given the increasing number of women in the labor force worldwide (from 1.29 billion in 2013 to 1.36 billion in 2017)[21], synthesis of this new evidence is needed.

The purpose of this review was to evaluate the impact of occupational activities during pregnancy on maternal and fetal health outcomes and to establish whether a dose-response relationship exists between the occupational exposures and these important health outcomes.

Methodology

This review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines on systematic reviews and meta-analyses [22], and was registered with the International Prospective Register of Systematic Reviews (PROSPERO) (Registration no. CRD42018094400).

Information sources

A structured search of MEDLINE, EMBASE, Cochrane Library, CINAHL, ClinicalTrials.gov, Science Citation Index Expanded and Conference Proceedings Citation Index-Science up to March 15, 2019 was performed by a research librarian. The search strategies were peer reviewed by another experienced research librarian. Collaborator-nominated papers were accepted for consideration, and the reference lists of included papers and relevant systematic reviews were screened for additional, relevant papers. We also conducted forward and backward citation tracking, hand-searched Google scholar and obtained expert recommendations for additional relevant studies. Language restrictions were not applied. The studies published in languages other than English, Spanish, Chinese or French deemed to be potentially relevant were translated by using Google Translate.

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Eligibility criteria

Study design

Primary studies of any design were eligible, except case studies, narrative or systematic reviews and meta-analyses. We also excluded letters, commentaries, editorials and abstracts.

Population

The population of interest was pregnant women (any trimester) who engaged in paid work. Some studies have suggested that paid employment and unpaid work may have different psychological, social, and biological factors that may affect health risk[23-25]. To prevent bias, we only included studies with pregnant women (any trimester) who engaged in paid work.

Exposure

The exposures of interest included: rotating shift work, fixed night shifts, long working hours, high lifting intensity (≥11 kilograms [kg] at one time)[26], high lifting volume (lifting ≥100 kg total per day), prolonged standing (≥4 hours per day)[27], prolonged walking (≥4 hours per day)[27], prolonged bending (≥1 hour per day) and a heavy physical workload. Rotating shift work was defined as working hours that rotate or change according to a set schedule[28]. Fixed night shift was defined as typical working period between 11:00pm to 11:00am[29]. Long working hours was defined as working more than 40 hours per week, implying either greater than a 5-day work week and/or longer than an 8-hour work day. The cut-off is also consistent with the standard hours of work (40 hours in a week) under the U.S. Department of labor[30] and Canada Labour Code[4]. A heavy physical workload was defined if the job requires heavy physical effort or physical exertion. The cut-off of these exposures were selected based upon published criteria in the literature in pregnant or general population.

In the event studies reported odds ratios for categories of physically demanding work that were different than the above cut-offs, effect estimates were grouped with the nearest conventional category (by rounding up).

Comparison

Eligible comparators were fixed day shift or "standard" working hours. Fixed day shift was defined as typical working period between 8:00-18:00. Standard working hours was defined as ≤40 working hours per week, or the nearest cut-off reported by the studies. Eligible comparators for the physically demanding work were no exposures to the above listed components of physically demanding work.

Outcomes

Relevant outcomes were PTD (<37 weeks of gestation), low birth weight (LBW, birthweight<2,500g), SGA (a weight below the 10th percentile for the gestational age), miscarriage (or spontaneous abortion, defined as loss of a fetus prior to 20 weeks of gestation)[31], stillbirth (a fetal death occurring after 20 completed weeks of pregnancy)[32], gestational hypertension (a new-onset elevated blood pressure [≥140/90 mmHg] after 20 weeks of gestation without proteinuria or end-organ involvement) and preeclampsia (the development of hypertension with evidence of end-organ effects or proteinuria after 20 weeks of pregnancy)[33], intrauterine growth restriction (IUGR, failure of the fetus to attain its expected fetal growth [< 10th percentile] at any gestational age)[34], and gestational diabetes mellitus (GDM, any degree of glucose intolerance with onset or first recognition during pregnancy as defined by the criteria used by the study)[35]. The definitions of miscarriage, gestational hypertension, preeclampsia,

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IUGR and GDM that were used for inclusion were based on the regional standards in place at the time of each study.

Study selection and data extraction

Titles and abstracts of articles identified by the search were assessed by two independent reviewers. Studies meeting eligibility criteria by at least one reviewer were selected for full text review. Two independent reviewers examined all full text articles for eligibility. If there was a discrepancy between reviewers, eligibility was decided based on discussion between the reviewers and by decision of a third reviewer when needed. Data were extracted by two reviewers independently. For each primary study, the most recent or complete publication was selected; however, relevant data from all publications related to each unique study were extracted. Study characteristics (e.g., study period, study design, country) and population characteristics (e.g., number of participants, age, pre-pregnancy body mass index [BMI], parity), exposure (e.g., work schedules, weekly working hours, frequency and intensity of lifting, standing, walking, bending, volume of heavy workload) and clinical outcomes (e.g., PTD, LBW, SGA, miscarriage, gestational hypertension, preeclampsia, IUGR, stillbirth, and GDM) were extracted (see online supplement table 1). If data were not available for extraction, attempts were made to contact the corresponding authors for additional information.

Quality of assessment and GRADE

Two reviewers independently assessed the quality of the studies. The Cochrane Risk of Bias Tool (version 1) was used for randomized controlled trials (RCT). We assessed study quality of prospective cohort, case-control, and cross-sectional studies using Joanna Briggs Institute Critical Appraisal of Evidence Effectiveness tool[36]. Risk of bias across studies was rated as 'serious' when studies with the greatest influence on the pooled result (contributing >50% of the weight of the pooled estimate in forest plots) presented 'high' risk of bias.

The Grading of Recommendations Assessment, Development and Evaluation (GRADE) tool[37] was used to assess the certainty of the evidence across each outcome. Evidence from RCTs began with a 'high' certainty of evidence rating and was downgraded if there were concerns of risk of bias, indirectness, inconsistency, or imprecision. Evidence from all observational studies began with a 'low' certainty rating. The initial "low" rating was upgraded when there was evidence for large magnitude of effect, evidence of dose-response, counteracting plausible residual bias or confounding[38]. Inconsistency across studies was considered serious when heterogeneity was high ($I^2 \geq 50\%$) or when only one study was assessed (I^2 unavailable). Imprecision was considered serious when the 95% confidence interval (CI) crossed the line of no effect. Imprecision was not considered serious when only one study was assessed, because the study would have already been downgraded for inconsistency for this reason. Finally, publication bias was assessed via funnel plots when more than 10 studies were included in the forest plot. Publication bias was not downgraded when there were fewer than 10 studies. The GRADE assessment is presented in online supplementary tables.

Data synthesis

All statistical analyses were conducted using Review Manager v5.3 (Cochrane Collaboration, Copenhagen, Denmark).

OR and corresponding 95% CIs were used to assess the association between the clinical outcomes and work exposures. Significance was set at $p<0.05$. Inverse-variance weighting was applied to obtain ORs using a random-effects model. For observational studies, sensitivity analyses were performed to evaluate whether the effects were different between adjusted ORs versus crude ORs for the outcomes of interest. If adjusted data were available, we calculated the natural logarithms of the effect measure

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and corresponding standard errors; otherwise, we included the unadjusted estimate. Heterogeneity between the studies was assessed using the I^2 statistic. In the case of I^2 >50%, heterogeneity was explored further with subgroup and sensitivity analyses. If data were not suitable for meta-analysis, authors were contacted to obtain additional information and were synthesized narratively if authors were unable to provide additional data. The 95% prediction intervals were also calculated for the distribution of true effects[39].

In order to identify a clinically meaningful difference in pregnancy outcomes with work activities, a dose-response meta-regression was carried out by weighted no-intercept regression of log OR with a random effects for study, using the drmeta command in STATA 14.2[40]. A random effects maximum likelihood approach was used for both linear and quadratic models on the log odds ratios. A likelihood ratio test was used to determine non-linearity. As an accepted cut-point for a clinically meaningful increase does not exist in the literature, an increase of 10% was chosen based on expert opinion.

Results

The literature search identified 3305 unique citations, with 108 observational studies (N=929,425 women) included in this systematic review. A PRISMA diagram of the search and study selection results is shown in Figure 1. Eight corresponding authors were sent letters requesting additional information or clarification of data from eight studies[41-48]. Three author responded to the emails[42, 45, 46]. However, no additional data were obtained for the meta-analysis.

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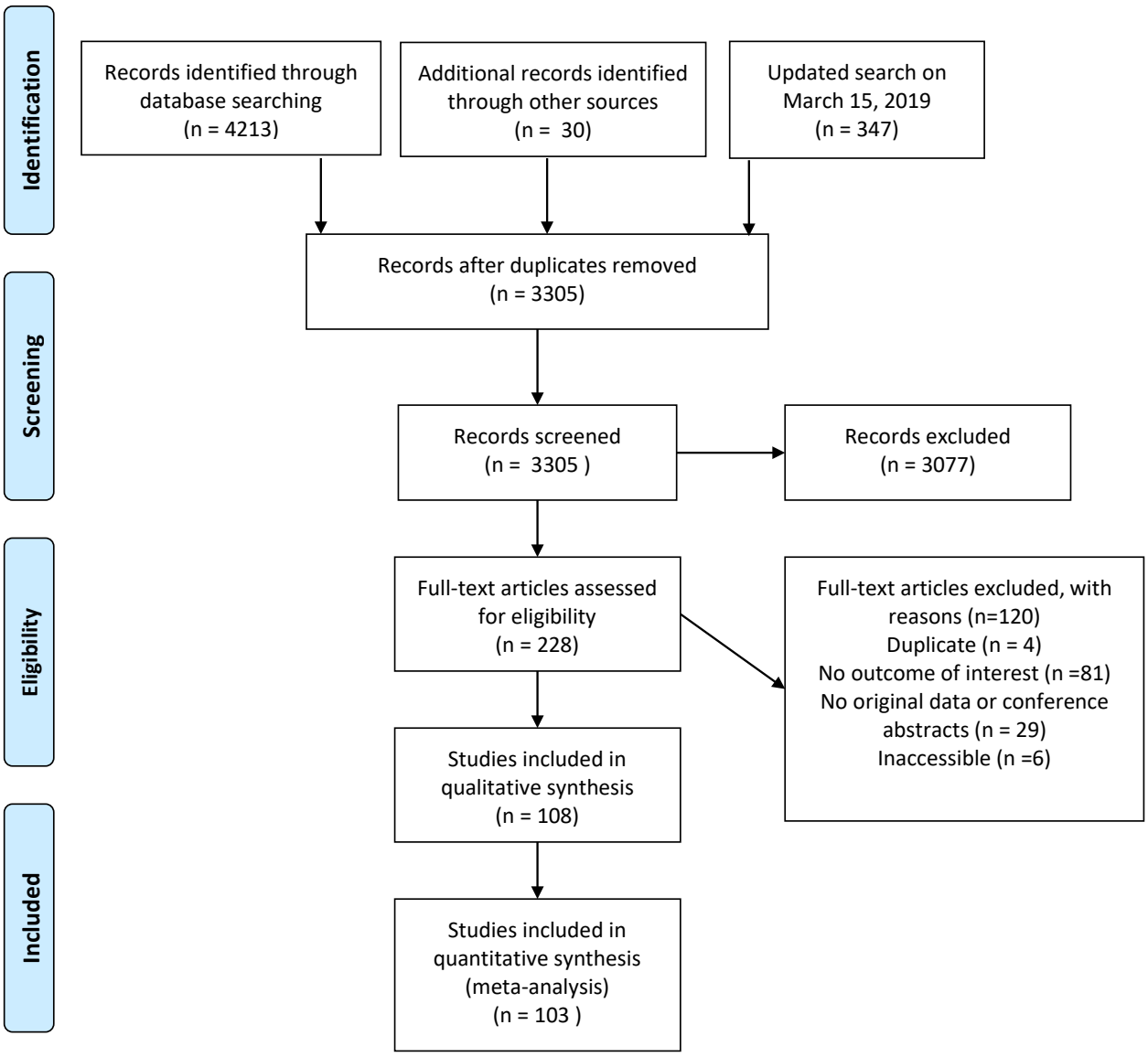

Figure 1. Study flow diagram

Thirty studies examined specific occupational groups, including midwives [49, 50], nurses[51-57], cleaners [58], flight attendants [59], physicians[60], cosmetologists[61, 62], lawyers[63], veterinarians[64, 65], hospital administrators/workers[57, 66-68], military personnel[11, 69-71], and textile workers[72-77], while the other 75 studies assessed the general population. All studies reported occupational exposures assessed by self-report (questionnaires or interviews). Twenty-three studies reported pregnancy outcomes assessed by self-report[49, 52-56, 58, 60, 63-65, 73, 74, 76-85], 85 studies described pregnancy outcomes assessed by medical records, hospital reports, or birth certificates.

Quality of evidence and GRADE

All the included studies were observational studies, which began with a 'low' certainty assessment. No studies were upgraded, and the most common reasons for downgrading the certainty of evidence were

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(1) serious risk of bias, (2) inconsistency, and (3) imprecision. Overall, the certainty of evidence ranged from 'low' to 'very low' (see online supplement tables). Common sources of bias were performance bias and detection bias, which included imprecise measurement of both the exposure and outcomes. No evidence of publication bias was observed.

Obstetrical outcomes

Preterm delivery

Overall, there was 'low' certainty evidence from 15 observational studies (n=26,677) regarding the association between rotating shift work and PTD[50, 52, 74, 86-97]. The pooled estimate demonstrated that working a rotating shift was associated with a 13% increase in the odds of PTD compared with working a day shift (OR=1.13, 95% CI: 1.00 to 1.28, I^2=31). There was 'low' certainty evidence from 14 studies (n=39,714)[43, 50, 52, 55, 69, 81, 84, 86, 87, 90, 92, 93, 96, 98] showing that working a fixed night shift was associated with 21% increase in the odds of PTD compared with working a day shift (OR=1.21, 95% CI: 1.03 to 1.42, I^2=36%; see Figure 2). There was 'low' certainty evidence from 25 studies (n=66,184) regarding the association between working long hours and PTD[43, 50, 52, 55, 60, 65, 78, 84, 86, 87, 90, 92, 93, 95, 96, 98-107]. Overall, working long hours was associated with a 21% increase in the odds of PTD compared with working regular hours (OR=1.21, 95% CI: 1.11 to 1.33, I^2=30%; see Figure 3). The one study that was not included in the pooled estimate because the data could not be converted into a useable form indicated that working 16-32 h/week was associated with a 47% decrease in the odds of PTD compared with working >32 h/week (n=2264, OR=0.53, 95% CI: 0.33 to 0.86)[41].

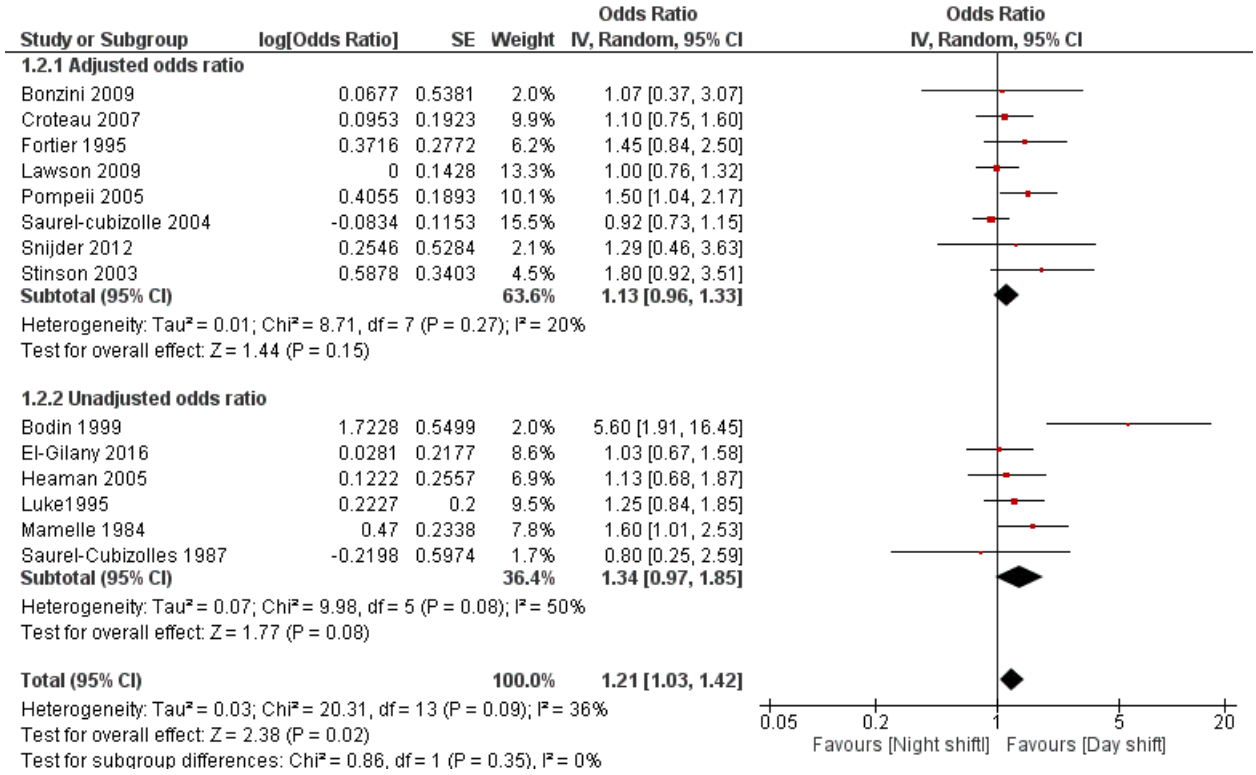

Figure 2. Effects of fixed night shift compared with day shift on odds of preterm delivery. Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounders and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

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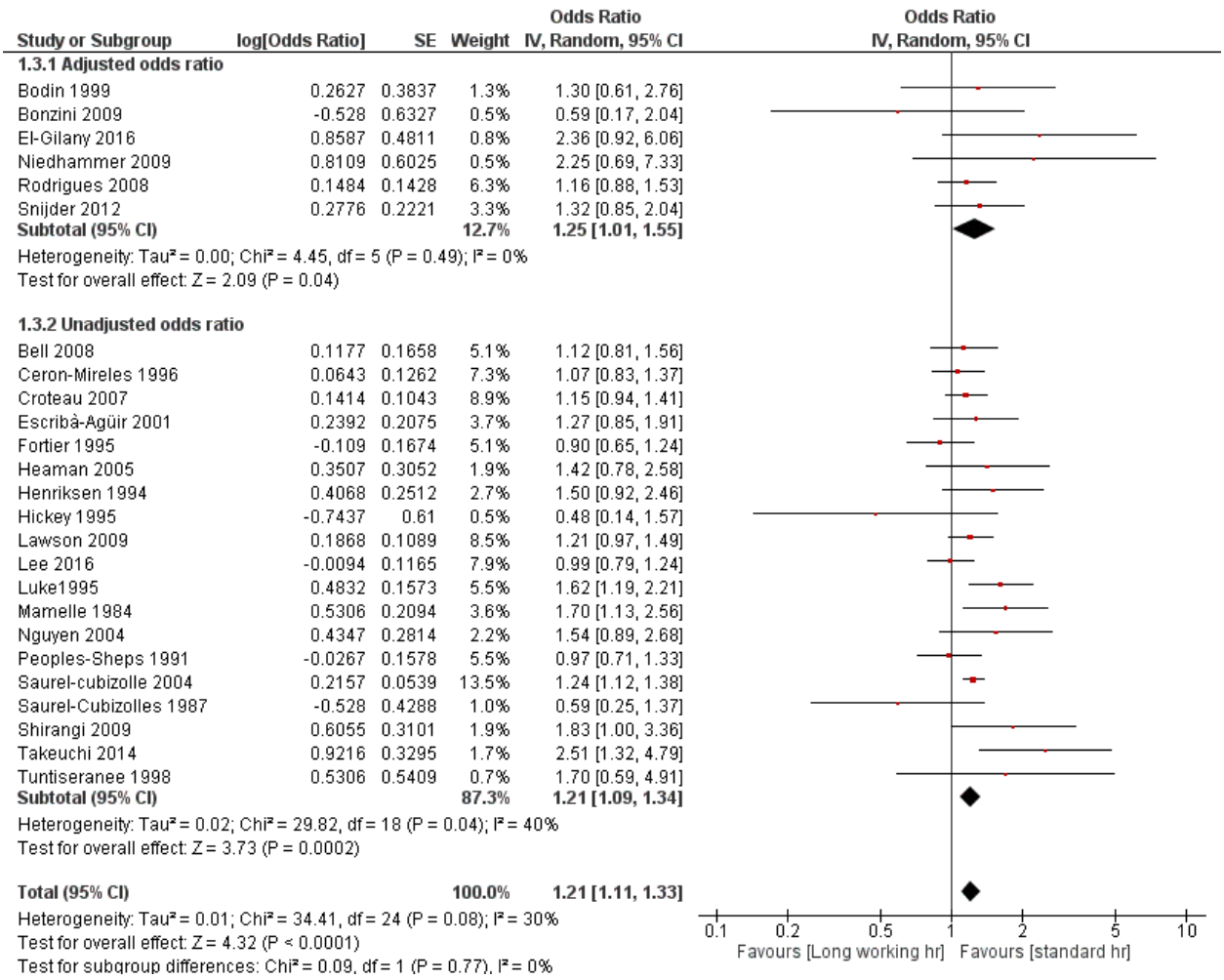

Figure 3. Effects of worked >40 h/week compared with worked ≤40 h/week on odds of preterm delivery. Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounders and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Twenty observational studies [11, 13, 43, 52, 81, 84, 86, 87, 90, 96, 98, 102, 107-114] (n=410,150 women) demonstrated that lifting ≥11 kg per time was not associated the odds of PTD, compared with lifting less weight or no weight (OR: 1.12, 95% CI: 0.97 to 1.29, I^2=55%; 'very low' certainty, downgraded from "low" to "very low" due to inconsistency). There was 'low' certainty evidence from five studies [13, 52, 81, 107, 111] showing that lifting ≥100 kg per day was associated with a 31% increase in the odds of PTD compared with lifting less weight or no weight (n=15,386; OR:1.31, 95% CI: 1.11 to 1.56, I^2=0%).

There was 'very low' certainty evidence from 28 studies [11, 43, 52, 55, 81, 84, 86, 87, 89-93, 96, 98, 100-102, 104, 107-109, 112-117] (n=77,046) demonstrating that prolonged standing was associated with a 12% increase in the odds of PTD (OR: 1.12, 95% CI: 1.02 to 1.22, I^2=30%; see Figure 4). The certainty was downgraded from 'low' to 'very low' due to inconsistency. However, there was no evidence of a significant association between prolonged walking and PTD [43, 100, 107, 108, 113, 115, 116] (seven studies, n=14,236; OR: 1.03, 95% CI: 0.87 to 1.21, I^2=0%; 'low' certainty).

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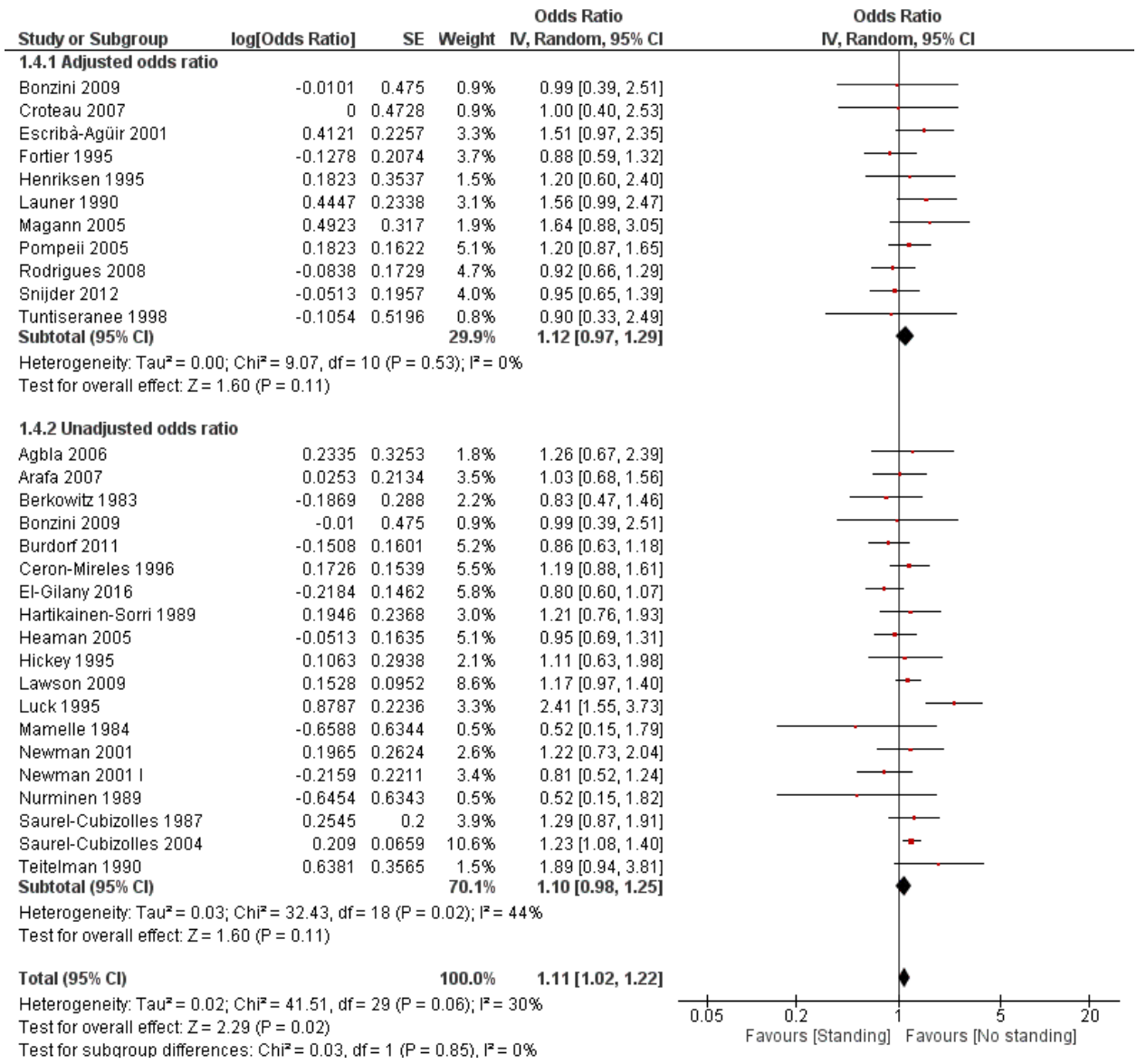

Figure 4. Effect of prolonged standing on the odds of preterm delivery. Sensitivity analyses were conducted with studies reporting adjusted odds ratio for confounders and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Overall, there was 'very low' certainty evidence from 15 observational studies (n=377,454) regarding the association between total physical workload and PTD [70, 82, 87, 88, 95, 100, 102, 105-107, 110, 118-121]. The certainty was downgraded from 'low' to 'very low' due to inconsistency. The pooled estimate demonstrated that a heavy physical workload was associated with a 23% increase in the odds of PTD compared with a light physical workload (OR: 1.23, 95% CI: 1.07 to 1.41, I^2=32%).

Two studies [86, 98] reported the association between bending and PTD and demonstrating that prolonged bending at work was not associated with PTD (n=7082; OR: 1.07, 95% CI: 0.75 to 1.51; 'very low' certainty, downgraded from "low" to "very low" due to imprecision).

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Miscarriage

Overall, there was 'very low' certainty evidence from 12 studies (n = 118,376) [49, 51, 53, 56, 57, 72, 73, 80, 122-125] that showed no association between rotating shifts and miscarriage (OR=1.05, 95% CI: 0.85 to 1.29, I^2=64). The certainty of evidence was downgraded from 'low' to 'very low' because of serious risk of bias, inconsistency and imprecision. However, pregnant women who worked fixed night shifts had higher rates of miscarriage than women who worked regular day shifts (10 studies, n=62,877; OR=1.23, 95% CI: 1.03 to 1.47, I^2=33%; 'very low' certainty, downgraded because of serious risk of bias; see Figure 5)[49, 53, 56, 57, 73, 122-126]. Meanwhile, women who worked >40h per week had a 38% increase in the odds of miscarriage compared to women who did not (eight studies, n=73,855; OR=1.38, 95% CI: 1.08 to 1.77, I^2=73%; 'very low' certainty, downgraded due to serious risk of bias and inconsistency)[53, 61, 63, 64, 73, 80, 122, 123].

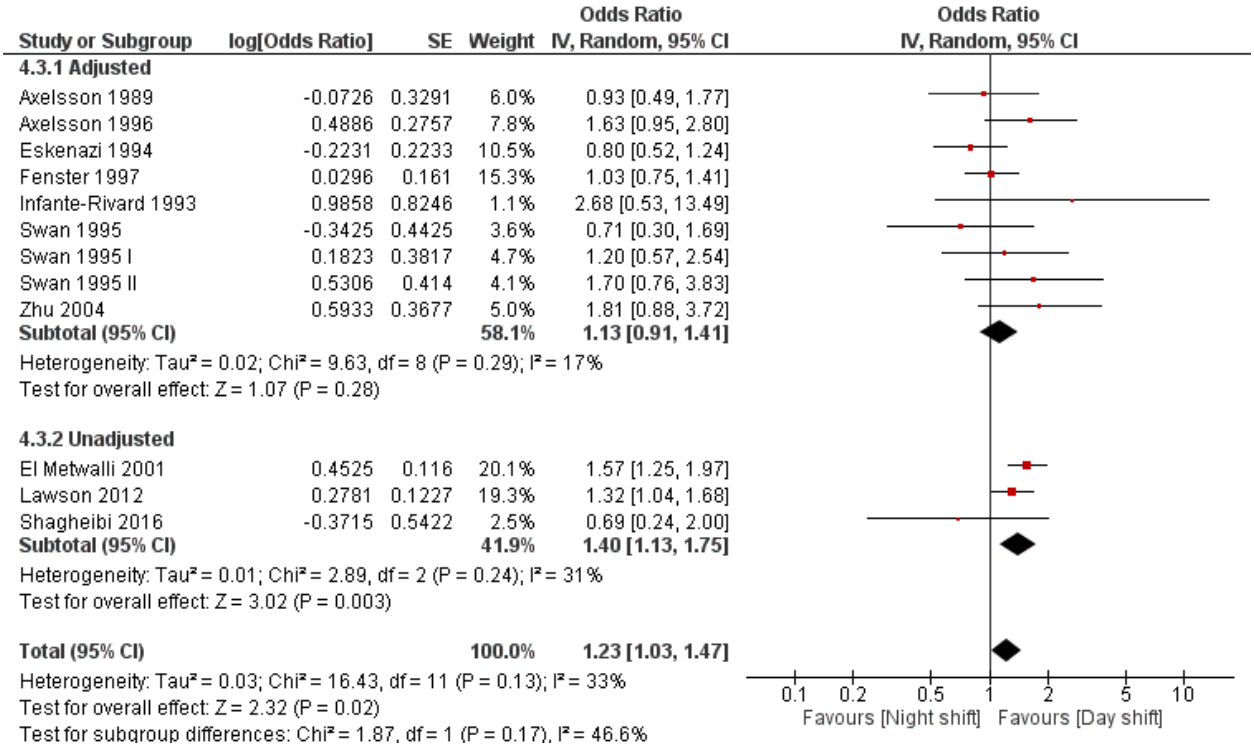

Figure 5. Effects of fixed night shift compared with day shift on odds of miscarriage. Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounders and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

There was 'low' certainty evidence from 13 studies [12, 57, 58, 68, 73, 75, 77, 80, 83, 122, 123, 126, 127](n=94,484) demonstrating that lifting more than 11 kg per time was associated with a 31% increase in the odds of miscarriage (OR:1.31, 95% CI: 1.08 to 1.58, I^2=79%; see Figure 6). Lifting more than 100 kg per day at work did not have an increase in miscarriage compared to those lifting less weight or no weight (six studies, n=81,451; 95% CI: 0.82 to 1.73, I^2=81%; 'low' certainty) [12, 49, 68, 122, 123, 128].

There was 'very low' certainty evidence from nine studies [56, 61, 73, 75, 80, 83, 122, 123, 129] (n=15,231) demonstrating that prolonged standing was not significantly associated with miscarriage (OR: 1.06, 95% CI: 0.92 to 1.22, I^2=0%). The certainty was downgraded from 'low' to 'very low' due to imprecision.

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Overall, there was 'very low' certainty evidence from six observational studies (n=9,311) regarding the association between total physical workload and miscarriage [59, 76, 80, 123, 125, 126]. The certainty was downgraded from 'low' to 'very low' due to inconsistency and imprecision. There was no significant association between a heavy physical workload and the risk of miscarriage (OR: 1.49, 95% CI: 0.91 to 2.45, I^2=90%).

There was 'very low' certainty evidence from five studies [58, 76, 122, 123, 126] (n=10,812) demonstrating that prolonged bending at work was not significantly associated with miscarriage (OR: 1.32, 95% CI: 0.82 to 2.12). The certainty was downgraded from 'low' to 'very low' due to serious risk of bias, inconsistency and imprecision.

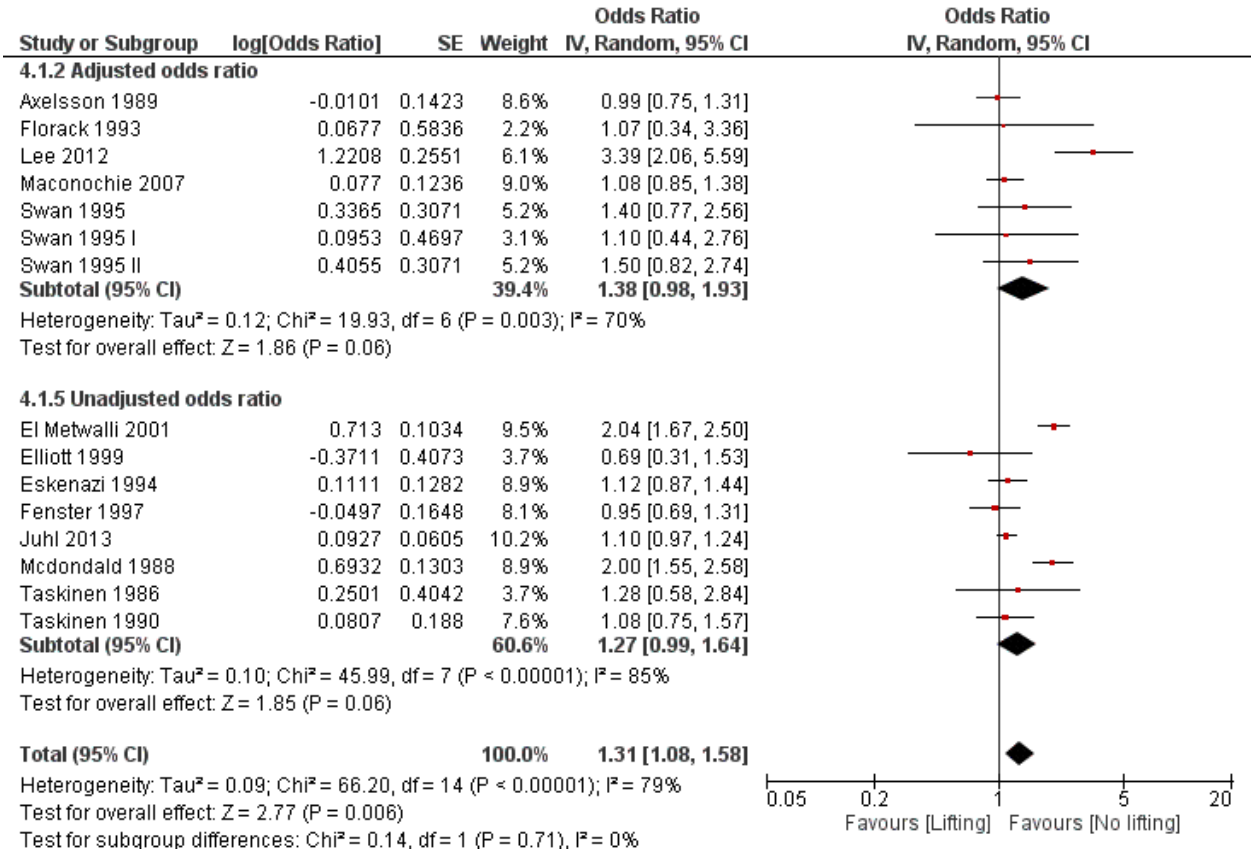

Figure 6. Effects of lifting more than 11 kilograms per time on the odds of miscarriage. Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounders and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Stillbirth

Only one study (n=41,769) reported the association between shift work and stillbirth indicated that rotating shifts or fixed night shift was not associated with stillbirth (rotating shifts, hazard ratios (HRs)=0.81, 95% CI: 0.38 to 1.70; fixed night shift, HRs=1.92, 95% CI: 0.82 to 4.5)[125]. Only one study [12] reported the association between heavy lifting and stillbirth and demonstrated that lifting ≥100 kg per day was not significantly associated with stillbirth (n=71,500; OR: 1.02, 95% CI: 0.74 to 1.40; 'very low' certainty, downgraded from 'low' to 'very low' due to serious risk of bias and inconsistency).

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Maternal outcomes

Preeclampsia

There was 'very low' certainty evidence from two studies (n=29,588) which found that rotating shifts was associated with a 75% increase in the odds of preeclampsia compared with those who worked a day shift (OR=1.75, 95% CI: 1.01 to 3.01, I^2=75%)[130, 131]. The certainty of evidence was downgraded from 'low' to 'very low' because of serious risk of bias, and inconsistency. However, there was no association between working a night shift and preeclampsia (three studies, n=33,247; OR=1.05, 95% CI: 0.63 to 1.75, I^2=0%, 'very low' certainty, downgraded due to imprecision)[44, 79, 131]. Long working hours was also not associated with preeclampsia (five studies, n=34,650; OR=1.27, 95% CI: 0.74 to 2.19, I^2=84%; 'very low' certainty, downgraded due to inconsistency and imprecision)[44, 79, 131-133].

There was 'very low' certainty evidence from five studies [44, 71, 79, 130, 133] (n=20,716) showing that lifting more than 11 kg per time was associated with a 35% increase in the odds of preeclampsia compared with lifting less weight or no weight (OR:1.35, 95% CI: 1.07 to 1.71, I^2=0%). The certainty was downgraded from 'low' to 'very low' due to serious risk of bias. Only one study [130] reported on women who lifted more than 100 kg per day at work and found a 65% increase in the odds of preeclampsia compared to those who lifted less weight or no weight (n=5,388; OR:1.65, 95% CI: 1.31 to 2.09; 'very low' certainty, downgraded from 'low' to 'very low' due to serious risk of bias and inconsistency).

There was 'very low' certainty evidence from six studies [44, 71, 79, 130, 132, 133] (n=26831) demonstrating that prolonged standing was not significantly associated with preeclampsia (OR: 0.95, 95% CI: 0.58 to 1.55, I^2=78%). The certainty was downgraded from 'low' to 'very low' due to inconsistency and imprecision. Evidence from three studies [44, 79, 132] (n=9,777) demonstrated that prolonged walking was not significantly associated with preeclampsia (OR: 0.70, 95% CI: 0.46 to 1.08, I^2=41%; 'very low' certainty, downgraded from 'low' to 'very low' due to imprecision).

There was 'very low' certainty evidence from two studies [71, 134] (n=6085) demonstrating that heavy physical workload at work was not significantly associated with preeclampsia (OR:1.30, 95% CI: 0.69 to 2.43). The certainty was downgraded from 'low' to 'very low' due to impression.

There was 'very low' certainty evidence from two studies [79, 130](n=9,970) demonstrating that prolonged bending at work was associated with a 51% increase in the odds of preeclampsia (OR:1.51, 95% CI: 1.09 to 2.08, I^2=12%). The certainty was downgraded from 'low' to 'very low' due to serious risk of bias.

Gestational hypertension

Evidence from two studies (n=25,675) demonstrated that rotating shifts was associated with a 19% increase in the odds of gestational hypertension compared with those who worked a day shift (OR=1.19, 95% CI: 1.10 to 1.29, I^2=0%; 'low' certainty)[97, 131]. There was 'very low' certainty evidence from four studies (n=51,971) that found that working night shift was not associated with gestational hypertension (OR=1.19, 95% CI: 0.97 to 1.45, I^2=2%; 'very low' certainty, downgraded due to imprecision)[44, 66, 79, 131]. Working long hours was also not associated with gestational hypertension (five studies, n=34,650; OR=0.99, 95% CI: 0.72 to 1.37, I^2=62%; 'very low' certainty, downgraded due to inconsistency and imprecision)[44, 79, 131-133]. The one study that was not included in the pooled estimated because the data could not be converted into a usable form demonstrated that working 16-32 h/week was not associated with gestational hypertension compared with working >32 h/week (n=2264, OR=0.83, 95% CI: 0.62 to 1.12)[41].

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Evidence from five studies [44, 67, 71, 79, 133] (n=15,946) demonstrated that lifting more than 11 kg per time was not significantly associated with gestational hypertension (OR: 1.35, 95% CI: 0.97 to 1.89, I^2=37%; 'very low' certainty, downgraded from 'low" to 'very low' due to imprecision).

There was 'very low' certainty evidence from five studies [44, 67, 71, 79, 132, 133] (n=16,676) demonstrating that prolonged standing was not significantly associated with gestational hypertension (OR: 1.29, 95% CI: 0.93 to 1.77, I^2=55%). The certainty was downgraded from 'low" to 'very low' due to inconsistency and imprecision. Evidence from three studies [44, 79, 132] (n=9,777) demonstrated that prolonged walking was not significantly associated with gestational hypertension (OR: 1.14, 95% CI: 0.72 to 1.81, I^2=50%; 'very low' certainty; downgraded from 'low" to 'very low' due to imprecision).

Two study [67] reported the association between a heavy physical workload and the risk of gestational hypertension and demonstrated that heavy physical workload was not significantly associated with gestational hypertension (n=6,226, OR: 2.01, 95% CI: 0.75 to 5.43; 'very low' certainly; downgraded from 'low" to 'very low' due to serious risk of bias, inconsistency and imprecision).

Only one study [79] reported the association between prolonged bending and gestational hypertension and demonstrated that prolonged bending at work was not significantly associated with gestational hypertension (n=4,582; OR: 1.10, 95% CI: 0.71 to 1.71; 'low' certainty, downgraded from 'low' to 'very low' due to serious risk of bias and inconsistency).

Gestational diabetes mellitus

Only one study reported the association between working hours and GDM demonstrated that working 16-32 h/week was not associated with GDM compared with working >32 h/week (n=2264, OR=0.81, 95% CI: 0.43 to 1.54)[41].

Fetal outcomes

Small for gestational age

There was 'low' certainty evidence from seven studies (n=18,230) that found working rotating shifts was associated with a 18% increase in the odds of SGA compared with working a day shift (OR=1.18, 95% CI: 1.01 to 1.38, I^2=0%)[50, 87, 95, 97, 135, 136]. However, there was no association between night shift and the risk of having an SGA neonate (six studies, n=20,861; OR=1.08, 95% CI: 0.86 to 1.35, I^2=0%; 'very low' certainty, downgraded due to imprecision)[43, 50, 81, 87, 98, 135]. Meanwhile, working long hours was associated with a 16% increase in the odds of SGA compared with women who did not (12 studies, n=38,246; OR=1.16, 95% CI: 1.00 to 1.36, I^2=57%; 'very low' certainty, downgraded due to inconsistency)[43, 50, 78, 81, 87, 95, 98, 101, 103, 105, 107, 135]. Two studies were not included in the pooled estimate because data that could not be converted into a usable form. One study found that working ≥32h per week was not associated with SGA compared with working 8-23h/week (OR=1.1, 95% CI: 0.8 to 1.5)[137]. The other study indicated that working 16-32 h/week was not associated with SGA compared with working >32 h/week (n=2264, OR= 0.86, 95% CI: 0.6 to 1.25)[41].

There was 'very low' certainty evidence from eight studies [43, 81, 87, 98, 103, 107, 135, 138] (n=91,346) demonstrating that there was no significant association between lifting ≥11 kg per time and SGA (OR:1.10, 95% CI: 0.99 to 1.23, I^2=0%). The certainty was downgraded from 'low" to 'very low' due to imprecision. There was also no significant association between lifting more than 100 kg per day and SGA (three studies, n=73,175; OR: 1.10, 95% CI: 0.96 to 1.26, I^2=0%; 'very low' certainty, downgraded from 'low" to 'very low' due to imprecision)[81, 103, 138] .

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There was 'low' certainty evidence from 13 studies [43, 81, 87, 89, 98, 101, 103, 107, 115, 116, 135-137] (n=39,096) demonstrating that prolonged standing was associated with a 17% increase in the odds of SGA (95% CI: 1.01 to 1.35, I^2=41%). Prolonged walking was associated with a 21% increase in the odds of SGA (five studies, n=17,115; 95% CI: 1.06 to 1.39, I^2=0%; 'low' certainty)[43, 103, 107, 115, 116, 137].

Overall, there was 'low' certainty evidence from eight observational studies [87, 95, 103, 105, 107, 116, 136, 137] (n=25,967) demonstrating that heavy physical workload was associated with a 34% increase in the odds of SGA (OR: 1.34, 95% CI: 1.03 to 1.73, I^2=42).

Only one study [98] reported the association between bending and SGA and demonstrated that prolonged bending was not significantly associated with SGA (n=1,327; OR: 1.16, 95% CI: 0.67 to 2.01; 'very low' certainty, downgraded from 'low" to 'very low' due to inconsistency).

Low birth weight

There was 'very low' certainty evidence from three studies (n=3,750) that demonstrated no association between rotating shifts and LBW (OR=1.41, 95% CI: 0.82 to 2.41, I^2=20%)[50, 74, 95]. The certainty of evidence was downgraded from 'low' to 'very low' because of serious risk of bias, and imprecision. There was 'very low' certainty evidence from three studies (n=8,442) indicating no association between fixed night shift and LBW (OR=1.44, 95% CI: 0.76 to 2.75, I^2=0%)[43, 50, 84]. The certainty of evidence was downgraded from 'low' to 'very low' because of imprecision. However, women who working more than 40 h/week was associated with 43% increase in the odds of LBW compared with women who did not (six studies, n=14,074; OR=1.43, 95% CI: 1.11 to 1.84, I^2=0%; 'low' certainty)[43, 50, 84, 95, 106, 107]. The one study that was not included in the pooled estimate because data could not be converted demonstrated that working >30 h/week was not associated with LBW compared with working ≤30 h/week (n=283, OR= 1.43,95% CI: 0.82 to 2.49)[139].

There was 'very low' certainty evidence from five studies [13, 43, 84, 85, 107](n=18,158) showing that lifting more than 11 kg per time was no significantly associated with the odds of LBW (95% CI: 0.98 to 2.57, I^2=82%; 'very low' certainty). The certainty was downgraded from 'low" to 'very low' due to serious risk of bias, inconsistency and imprecision. There was 'very low' certainty evidence from three studies [13, 85, 107] showing that lifting more than 100 kilograms per day was associated with 108% increase in the odds of PTD (n=11,091; 95% CI: 1.06 to 4.11, I^2=0%). The certainty was downgraded from 'low" to 'very low' due to serious risk of bias and inconsistency.

There was 'very low' certainty evidence from four studies [43, 84, 107, 140](n=8,864) demonstrating that prolonged standing was not associated with LBW (OR:1.16, 95% CI: 0.97 to 1.38, I^2=0%). The certainty was downgraded from 'low" to 'very low' due to imprecision. There was no significant association between prolonged walking and the risk of having a LBW neonate (two studies, n=6,477; OR:0.89, 95% CI: 0.59 to 1.34, I^2=0%; 'very low' certainty, downgraded from 'low" to 'very low' due to imprecision)[43, 107].

Overall, there was 'very low' certainty evidence from seven observational studies (n=160,492) regarding the association between total physical workload and LBW [82, 84, 95, 106, 107, 119, 141]. The certainty was downgraded from 'low' to 'very low' due to inconsistency. The pooled estimate demonstrated that a heavy physical workload was associated with a 79% increase in the odds of LBW compared with a light physical workload (OR: 1.79, 95% CI: 1.11 to 2.87, I^2=87%).

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Intrauterine growth restriction

One study reported the association between working hours and IUGR and demonstrated that long working hours was not associated with IUGR (n=1,047; OR= 1.62, 95% CI: 0.93 to 2.85; 'very low' certainty, downgraded because of inconsistency)[142].

Two studies [11, 142] reported the association between standing and IUGR and demonstrated that prolonged standing was not significantly associated with IUGR (n=1,294; OR: 1.14, 95% CI: 0.57 to 2.29, I^2=65%, P=0.70; 'very low' certainty, downgraded from 'low" to 'very low' due to inconsistency and imprecision).

See Table 1 for the summary of finding from meta-analyses.

Table 1. Summary of finding from meta-analyses.

Occupational activities / **Clinical outcomes**	Rotating shift work	Fixed night shift	Long working hours	Lifting ≥11kg/time	Lifting ≥100kg/day	Standing≥ 4h/day	Walking ≥4h/day	Bending ≥1h/day	Heavy physical workload
Preterm delivery	+	+	+	NS	+	+	NS	NS	+
Low birth weight	NS	NS	+	NS	+	NS	NS	__	+
Small-for-gestational-age	+	NS	+	NS	NS	+	+	NS	+
Miscarriage	NS	+	+	+	NS	NS	__	NS	NS
Preeclampsia	+	NS	NS	+	+	NS	NS	+	NS
Gestational Hypertension	+	NS	NS	NS	__	NS	NS	NS	NS
Intrauterine growth restriction	__	__	NS	__	__	NS	__	__	__
Gestational Diabetes mellitus	__	__	NS	__	__	__	__	__	__
Still birth	NS	NS	__	__	NS	__	__	__	__

Notes:

+ Statistically significant with more than one study included in the analysis (P<0.05)
+ Statistically significant based on a single study (P<0.05)
NS Non-significant with more than one study included in the analysis
NS Non-significant based on a single study
__ Outcome not reported in study

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Meta-regressions

Meta-regression analyses using linear and spline regression were conducted when there were at least 10 studies with sufficient data available [143]. Thus, the dose-response analysis was conducted for working hours, standing hours and the risk of PTD. Linear models were presented unless the fit of the spline was significantly better ($p<0.05$). Thirteen observation studies (n=38,849) were included in the working hours and PTD dose-response analysis using a linear model. Compared to a 40 hour workweek, working at least 55.5 hours per week was associated with a 10% increase in the odds of having a preterm delivery.

Ten observational studies (n=28,428) were included in the standing hours and PTD dose-response analysis using a linear model [52, 55, 81, 86, 87, 90, 94, 96, 102, 112, 113]. Compared to no standing at work, standing 2.5 hours per day was associated with a 10% increase in the odds of having a preterm delivery.

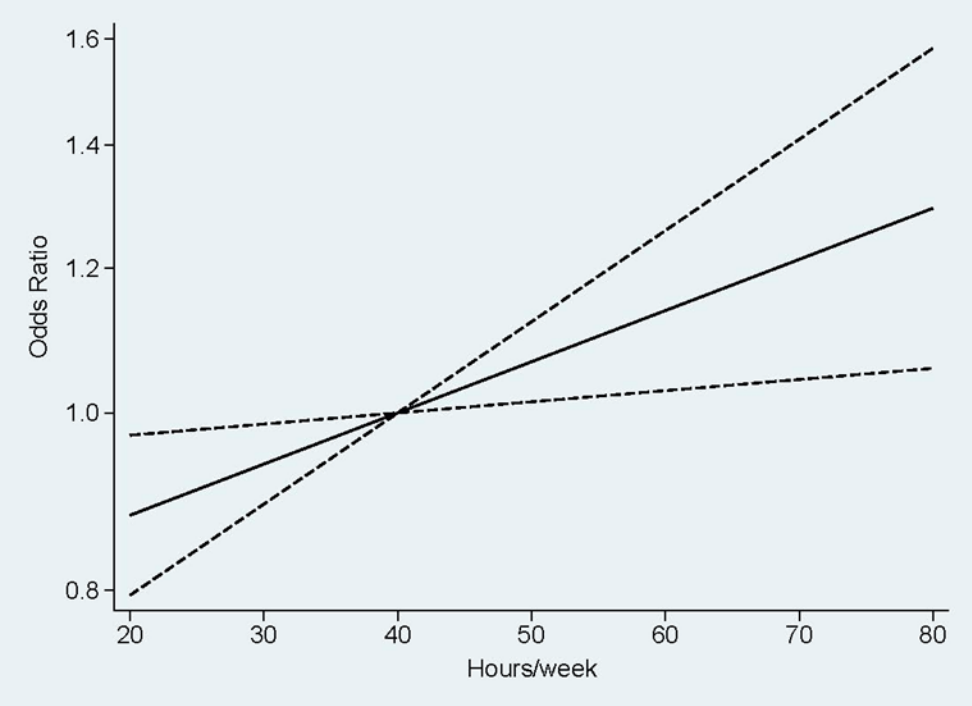

Figure 7. Linear regression of 13 observational studies examining the hours of employment per week and odds of preterm delivery. Black line, line of best fit; Grey dash line, 95% confidence.

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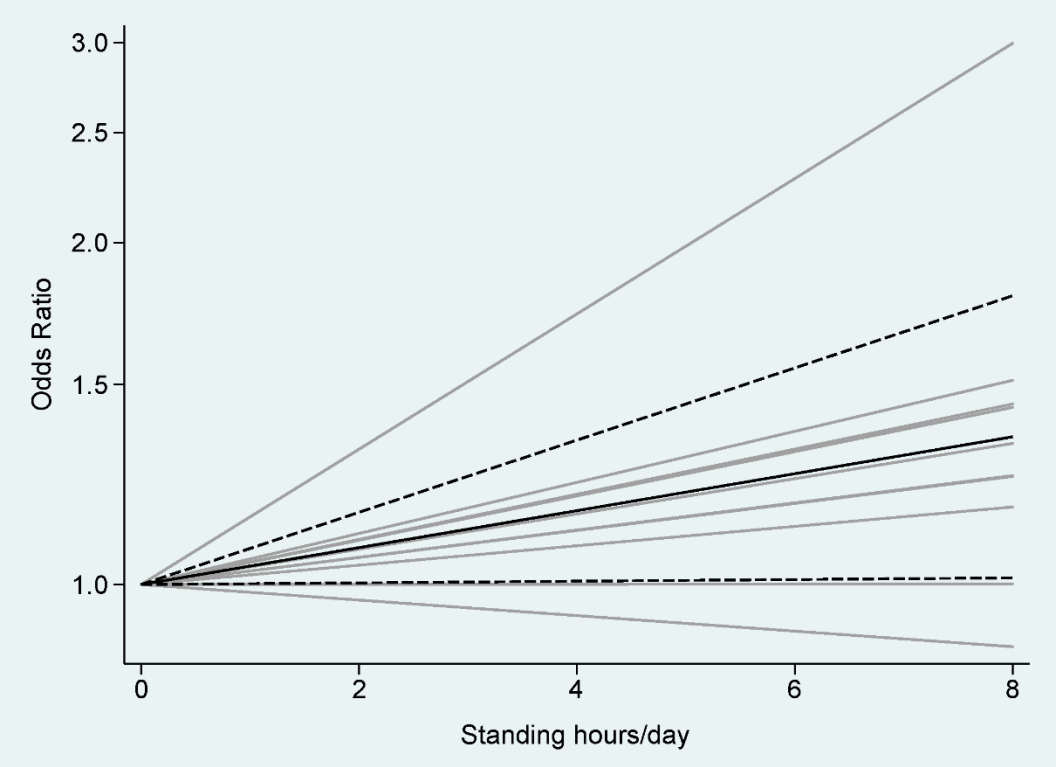

Figure 8. Linear regression of 10 observational studies examining the hours of occupational standing per day and odds of preterm delivery. Black line, line of best fit; Black dash line, 95% confidence.

Sensitivity Analyses

The pooled estimates of PTD, miscarriage, preeclampsia, SGA, or LBW for the adjusted odds ratio were not significantly different from the pooled estimate for the unadjusted odds ratio for worked with rotating shifts, fixed night shifts, or longer hours. However, the pooled estimate examining the impact of long working hours on risk of gestational hypertension was significantly different between the adjusted OR (one study, n=4465; OR= 1.57, 95% CI: 0.20 to 0.91; 'very low' certainty evidence, downgraded due to inconsistency)[44] and unadjusted OR subgroups (four studies, n=30,185; OR=1.11, 95% CI: 0.86 to 1.43; 'very low' certainty evidence, downgraded due to imprecision)[79, 131-133].

The pooled estimate of all outcomes for the adjusted odds ratios were not significantly different from the pooled estimate for the unadjusted odds ratios for all exposures except heavy physical workloads. The pooled estimate for the adjusted odds ratio showed that a heavy physical workload increased the odds of SGA by 26% (seven studies, n=25,909; OR: 1.26, 95% CI: 1.01 to 1.56; 'low' certainty evidence, downgraded from 'low' to 'very low' due to serious risk of bias and imprecision, see online supplement Figure 22) [87, 95, 103, 105, 107, 116, 137] while the pooled estimate for the unadjusted odds ratio showed that working a heavy physical workload increased the odds of SGA by 251% (one study, n=1,064; OR=3.51, 95% CI 1.33 to 9.24; 'very low' certainty evidence, downgraded from 'low' to 'very low' due to inconsistency)[136]. The pooled estimate for the adjusted odds ratio showed that a heavy physical workload was not associated with miscarriage (four studies, n=49,456; OR: 1.10, 95% CI: 0.71 to 1.70; 'very low' certainty evidence, downgraded from 'low' to 'very low' due to inconsistency and imprecision, see online supplement Figure 7) while the pooled estimate for the unadjusted odds ratio showed that working a heavy physical workload increased the odds of miscarriage by 151% (two studies, n=158,695;

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OR=2.51, 95% CI 1.42 to 4.45; 'very low' certainty evidence, downgraded from 'low' to 'very low' due to serious risk of bias and inconsistency).

Subgroup Analyses

The association between long working hours, rotating shifts, or fixed night shifts and gestational hypertension, SGA, or LBW were not dependent on the cut-off value for long working hours, study design, or study population.

The association between long working hours, rotating shift work or fixed night shift and PTD were not dependent on study design or study population. The test for subgroup differences of cut-off values for long working hours was statistically significant ($p<0.05$). Results showed that compared to women who worked ≤35 h/week, working >35 h/week increased the odds of PTD by 59%; compared to women who worked ≤40 h/week[50, 55, 65, 103], worked >40 h/week increased the odds of PTD by 13%[52, 60, 78, 86, 87, 90, 93, 95, 96, 98-102, 104-107].

The association between rotating shift or fixed night shift work and miscarriage were not dependent on study design or study population. The test for subgroup differences of long working hours by study types and study population were both statistically significant ($p<0.05$). Results from retrospective studies showed that long working hours increased the odds of miscarriage by 46%[53, 61, 63, 64, 73, 80, 122]. Results from one prospective study showed that long working hours was not associated with miscarriage[123]. Results from general population studies showed that long working hours was not associated with miscarriage [122, 123, 144]. Results from specific occupations studies showed that long working hours increased the odds of miscarriage by 64%[53, 61, 63, 64, 73].

The association between long working hours or fixed night shift and preeclampsia was not dependent on the specific cut-off value for long working hours, or study design. The test for subgroup differences of rotating shift work by study types was statistically significant. Results from one retrospective study showed rotating shift work was not associated with preeclampsia [97]while the other prospective study showed rotating shift work increased the odds of preeclampsia by 127%[131].

A series of subgroup analyses were performed for subsets of rotating shift work (i.e., studies that included night shift as part of rotating shift work and studies that did not provide the information). No significant difference was detected between groups in across all outcomes.

The association between lifting ≥11 kg per time, prolonged standing, prolonged bending, heavy total physical workload and preeclampsia, or LBW were not dependent on study design, or study population.

The test for subgroup differences of prolonged standing with PTD by study population was statistically significant. Results from general population studies showed prolonged standing was not significantly associated with PTD [43, 52, 81, 84, 86, 87, 89-94, 96, 98, 100-102, 104, 107-109, 112-117, 145]. Results from specific occupation studies (nurses and military women) showed that prolonged standing increased the odds of PTD by 112% [11, 55].

The test for subgroup differences of prolonged standing with gestational hypertension by study population was statistically significant. Results from studies in the general population showed that prolonged standing was not significantly associated with gestational hypertension [44, 79, 132, 133]. Results

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from one specific occupational study of hospital employees showed that prolonged standing doubled the odds of gestational hypertension [67].

The test for subgroup differences of a heavy workload with SGA by study design was statistically significant. Results from prospective cohort studies showed that a heavy workload was not significantly associated with SGA [87, 95, 103, 107, 137]. However, results from retrospective cohort studies showed that a heavy workload increased the odds of SGA by 98% [105, 116, 136].

All other subgroup analyses were not significantly different.

Discussion

Strengths and limitations

This study provided in-depth analyses of up-to-date evidence including meta-regression to identify dose response between the amount and type of occupational activity with adverse pregnancy outcomes. Rigorous methodological standards (following GRADE guidelines) were used to assess the certainty of the evidence, and to further decrease bias we examined the grey literature and did not limit our search to a single language.

Nevertheless, several limitations should be noted. This study used observational data and, as such, cannot eliminate potential unmeasured confounders, including socio-economic status of the participants which may related to both type of work hours as well as clinical outcomes. Only a few studies have considered socio-economic status as an independent factor and included it as a confounder in their adjusted models. The majority of the included studies did not consider the independent effect of socio-economic status on clinical outcomes. As a result, we cannot identify the independent link of socio-economic status to poor pregnancy outcomes. Despite the lack of randomized studies, our study adjusted for a variety of clinical risk factors and subgroup analysis and did not find significant differences between unadjusted and adjusted models. In addition, the majority of the studies assessed occupational activities through self-reported measures, which increases the risk of recall bias. Furthermore, some studies were limited to a single ethnic group, and the majority of the included studies did not detail the type of work performed, limiting the generalizability of the study findings. Finally, few studies were also available on the specific outcomes of gestational hypertension, preeclampsia, IUGR, GDM, and stillbirth thus limiting the ability to draw firm conclusions on work patterns and these outcomes.

Audiences for potential knowledge translation

Our Knowledge Translation plan is to generate awareness and interest in the proposed research, impart knowledge to relevant stakeholders, and inform future research. Our target audience is pregnant women (especially who worked with physically demanding jobs), employers, clinicians, and policy makers at OHS. Policy makers at the Government of Alberta OHS are our primary government authority end-users. The finalized research reported will be submitted to the Government of Alberta OHS for review and endorsement.

Types of knowledge translation products that have been or could be developed

My Knowledge Translation strategy includes dissemination of information gained from the proposed research via academic conference presentations and peer-reviewed publications. Two systematic review with meta-analysis papers generated from this project have been submitted (First paper was published and the other paper is pending on the final decision) in the American Journal of Obstetrics and Gynecology:

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1. Cai, C., Vandermeer, B., Khurana, R., Nerenberg, K., Featherstone, R., Sebastianski, M. and Davenport, M.H., 2019. The impact of occupational shift work and working hours during pregnancy on health outcomes: a systematic review and meta-analysis. American journal of obstetrics and gynecology.

2. Cai, C., Vandermeer, B., Khurana, R., Nerenberg, K., Featherstone, R., Sebastianski, M. and Davenport, M.H. The impact of occupational activities during pregnancy on pregnancy outcomes: a systematic review and meta-analysis

We also presented our findings in the 2019 American College of Sports Medicine annual meeting at Orlando, USA (May 28 - Jun 01, 2019):

1. Cai, C., Featherstone, R., Sebastianski, M. and Davenport, M.H., 2019. Influence Of Shift Work On Pregnancy Outcomes: A Systematic Review And Meta-analysis: 1056: Board# 290 May 29 2: 00 PM-3: 30 PM. Medicine & Science in Sports & Exercise, 51(6), p.281.

2. Davenport, M.H., Featherstone, R., Vandermeer, B., Sebastianski, M. and Cai, C., 2019. Influence Of Working Hours On Pregnancy Outcomes: A Systematic Review And Meta-analysis: 1055: Board# 289 May 29 2: 00 PM-3: 30 PM. Medicine & Science in Sports & Exercise, 51(6), pp.280-281.

I will disseminate our research to pregnant women through updates to our website (exerciseandpregnancy.ca), lab Facebook page, online videos, and media broadcasts. Our research findings have been gained great attention on social media, such as National Post (https://nationalpost.com/pmn/entertainment-pmn/night-shifts-long-hours-linked-to-miscarriages-and-preterm-births), University of Alberta folio (https://www.folio.ca/pregnant-women-who-work-night-shifts-have-higher-risk-of-preterm-delivery-miscarriage-study/), Mayo clinic (https://twitter.com/MayoAnesthesia/status/1154013363724259329?s=20), CTV (https://edmonton.ctvnews.ca/shift-work-while-pregnant-increases-risk-of-preterm-delivery-miscarriage-u-of-a-study-1.4530083) and BMJ news (BMJ 2019;366:l5061). I have developed a website and facebook page for the Program for Pregnancy and Postpartum Health (www.exerciseandpregnancy.ca and https://www.facebook.com/exerciseandpregnancy/?fref=nf) which is designed to be both a resource for pregnant women and a study recruitment tool. This webpage includes information regarding current guidelines for exercise during pregnancy. The findings of this systematic review would provide additional resources.

At the completion of this grant, I aim to work with OHS to develop an evidence-based position paper outlining recommendations for occupational activity for pregnant women. To my knowledge, this would be the first document of its kind in Alberta (and Canada). The development of recommendations and identification of risk thresholds are critically needed by pregnant women, employers and health care providers to ensure the health and safety of pregnant women in the workplace.

Conclusion

This systematic review and meta-analysis demonstrates that certain occupational activities including shift work, long working hours, heavy lifting, prolonged standing, prolonged walking, prolonged bending and heavy physical workload increase the risks of important adverse pregnancy outcomes such as PTD, LBW, SGA, and preeclampsia. Our findings suggest that working 55.5 hours or more per week is associated with a 10% increase in the odds of preterm delivery compared to working less than 40 hours per week; standing 2.5 hours or more per day is associated with a 10% increase in the odds of preterm delivery compared to no standing at work. Adverse health outcomes, such as preterm delivery and SGA, are associated with long-term neurodevelopment impairment and chronic health problems in the

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offspring. Taken together, physically demanding work may have major implications for the short-term and long-term health of both women and their children. These novel findings may help inform decision making on occupational directives or workplace design for the prevention of adverse pregnancy outcomes.

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Classification: Public

Appendices

List and examples of activities undertaken for knowledge transfer/dissemination

Publication

1. Cai, C., Vandermeer, B., Khurana, R., Nerenberg, K., Featherstone, R., Sebastianski, M. and Davenport, M.H., 2019. The impact of occupational shift work and working hours during pregnancy on health outcomes: a systematic review and meta-analysis. American journal of obstetrics and gynecology.

2. Cai, C., Vandermeer, B., Khurana, R., Nerenberg, K., Featherstone, R., Sebastianski, M. and Davenport, M.H. The impact of occupational activities during pregnancy on pregnancy outcomes: a systematic review and meta-analysis. (pending on final decision).

Conference

2019 American College of Sports Medicine annual meeting at Orlando, USA (May 28 - Jun 01, 2019):

1. Cai, C., Featherstone, R., Sebastianski, M. and Davenport, M.H., 2019. Influence Of Shift Work On Pregnancy Outcomes: A Systematic Review And Meta-analysis: 1056: Board# 290 May 29 2: 00 PM-3: 30 PM. Medicine & Science in Sports & Exercise, 51(6), p.281.

2. Davenport, M.H., Featherstone, R., Vandermeer, B., Sebastianski, M. and Cai, C., 2019. Influence Of Working Hours On Pregnancy Outcomes: A Systematic Review And Meta-analysis: 1055: Board# 289 May 29 2: 00 PM-3: 30 PM. Medicine & Science in Sports & Exercise, 51(6), pp.280-281.

Social media

National Post (https://nationalpost.com/pmn/entertainment-pmn/night-shifts-long-hours-linked-to-miscarriages-and-preterm-births)

University of Alberta folio (https://www.folio.ca/pregnant-women-who-work-night-shifts-have-higher-risk-of-preterm-delivery-miscarriage-study/)

Mayo clinic (https://twitter.com/MayoAnesthesia/status/1154013363724259329?s=20)

CTV (https://edmonton.ctvnews.ca/shift-work-while-pregnant-increases-risk-of-preterm-delivery-miscarriage-u-of-a-study-1.4530083)

BMJ news (BMJ 2019;366:l5061).

Classification: Public

Preterm delivery

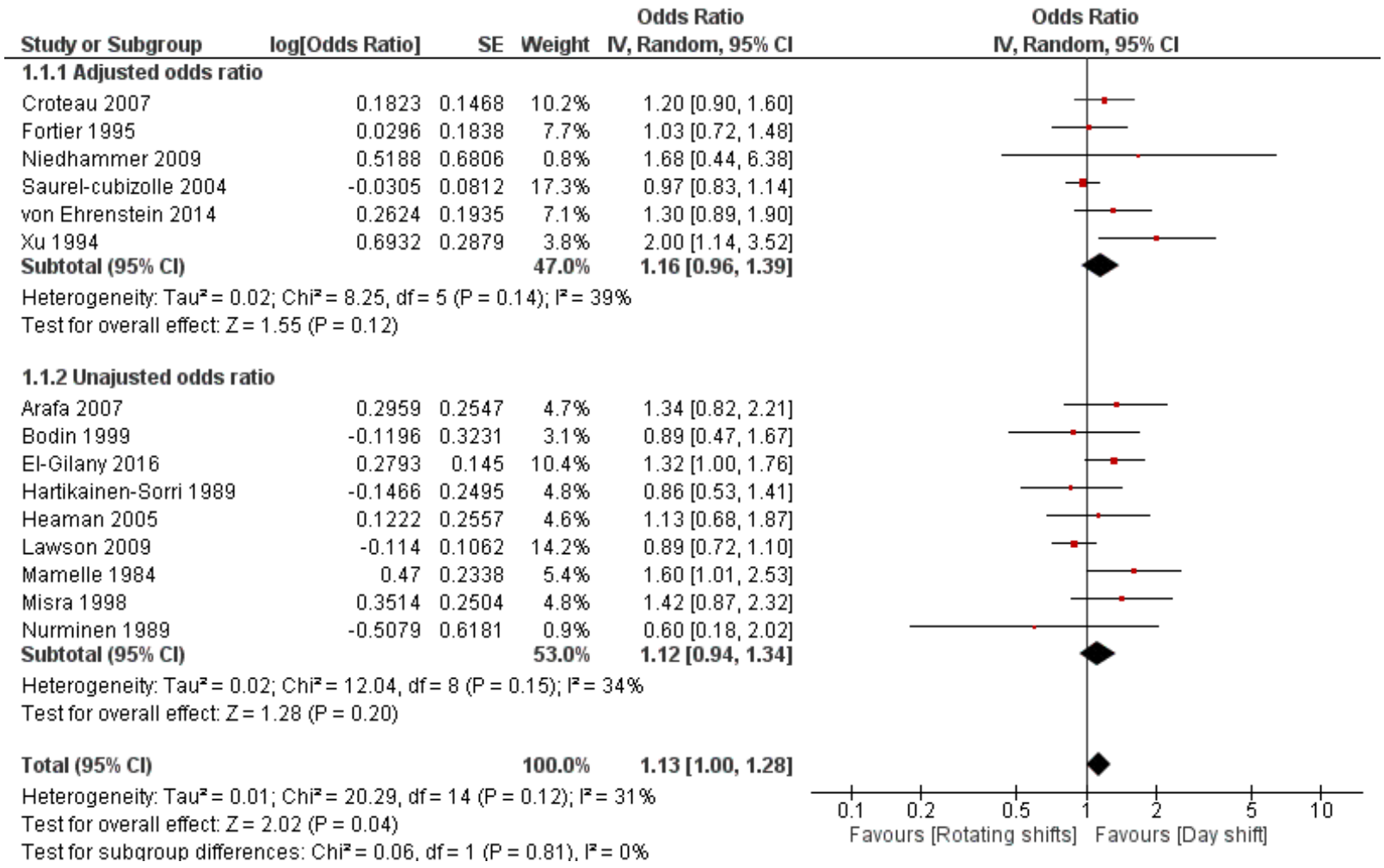

Figure 1: Effects of rotating shift work compared with day shift on odds of preterm delivery. Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounding and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method

Classification: Public

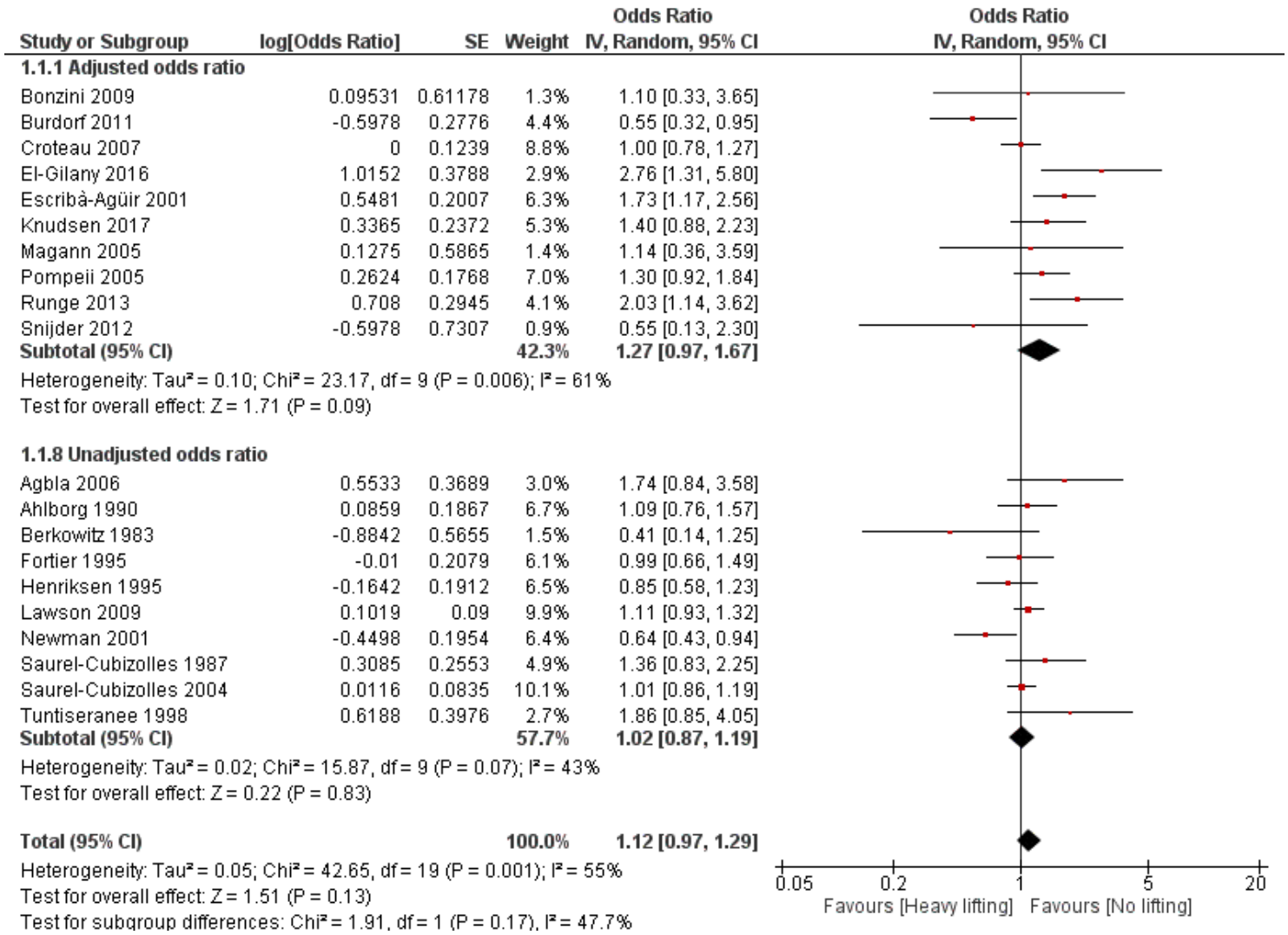

Figure 2: Effects of lifting ≥11 kilograms per day on the odds of preterm delivery. Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounders and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

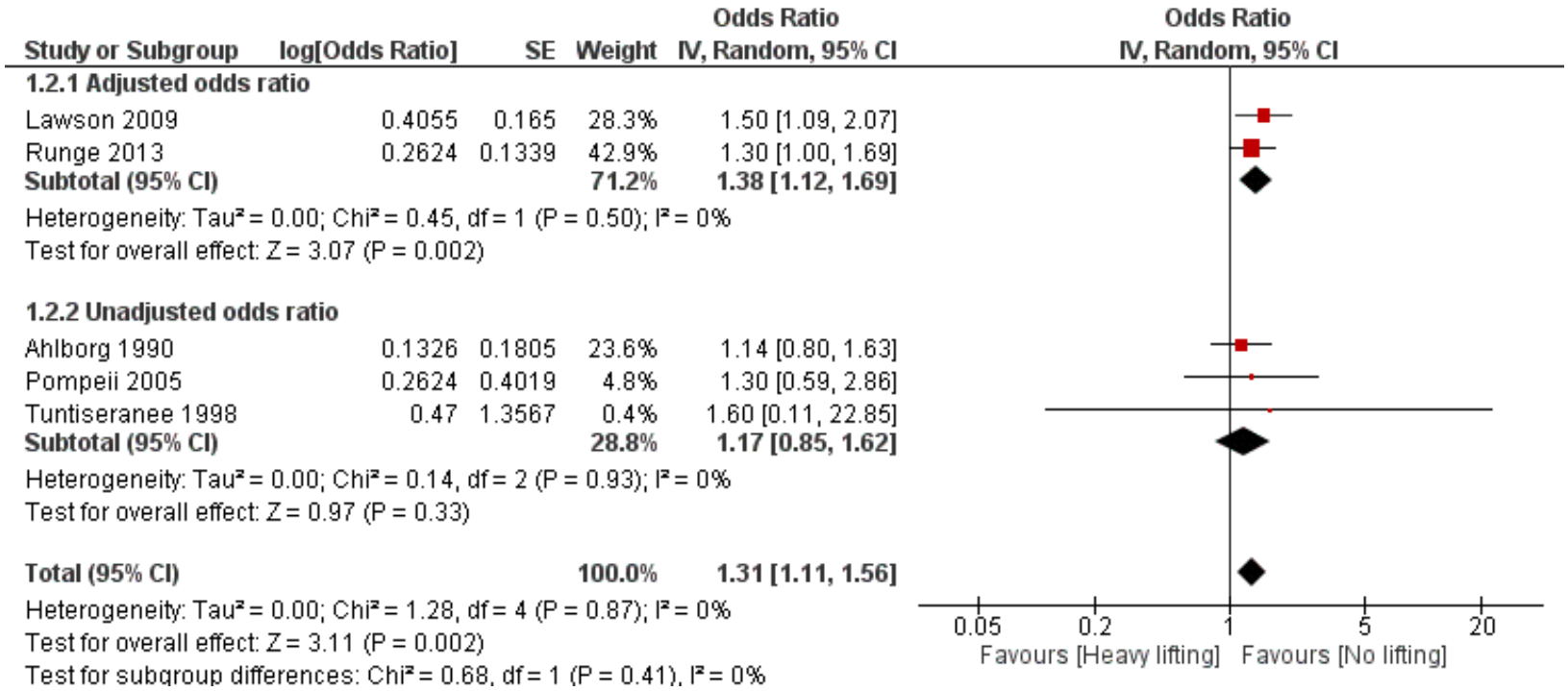

Figure 3: Effects of lifting ≥100 kilograms per day on the odds of preterm delivery. Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounders and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

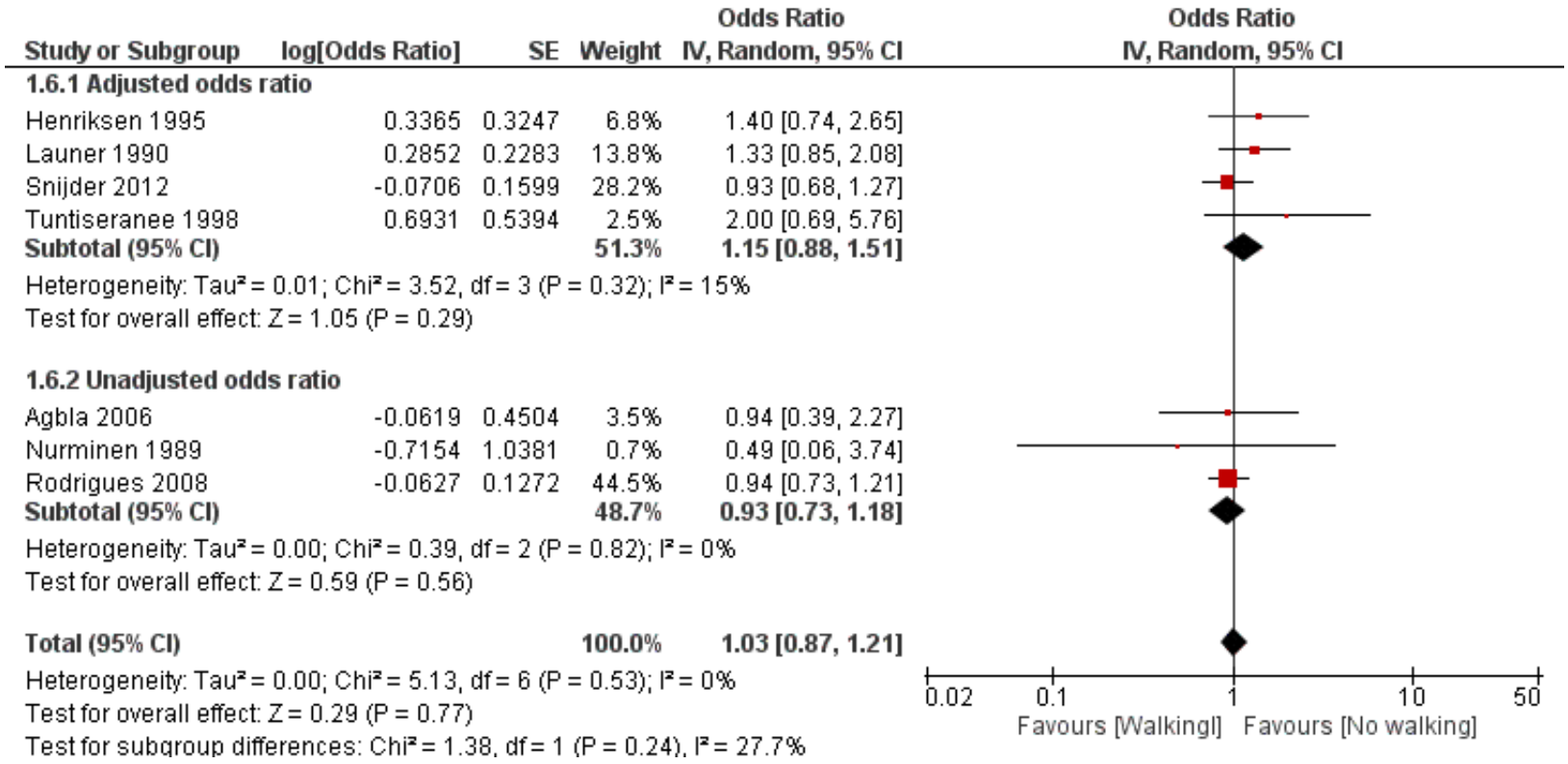

Figure 4: Effects of prolonged walking on the odds of preterm delivery. Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounders and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

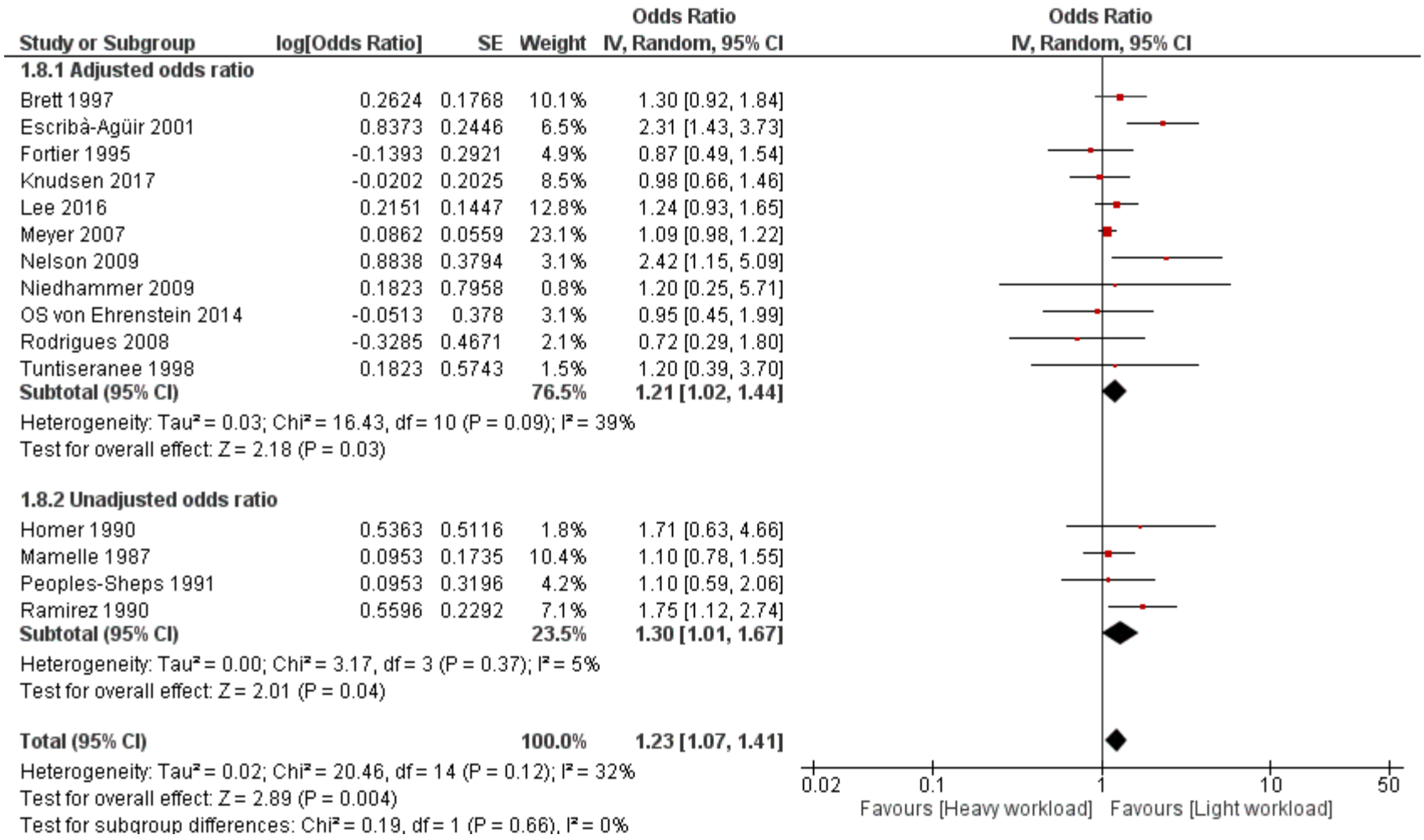

Figure 5: Effects of heavy physical workload on the odds of preterm delivery. Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounders and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

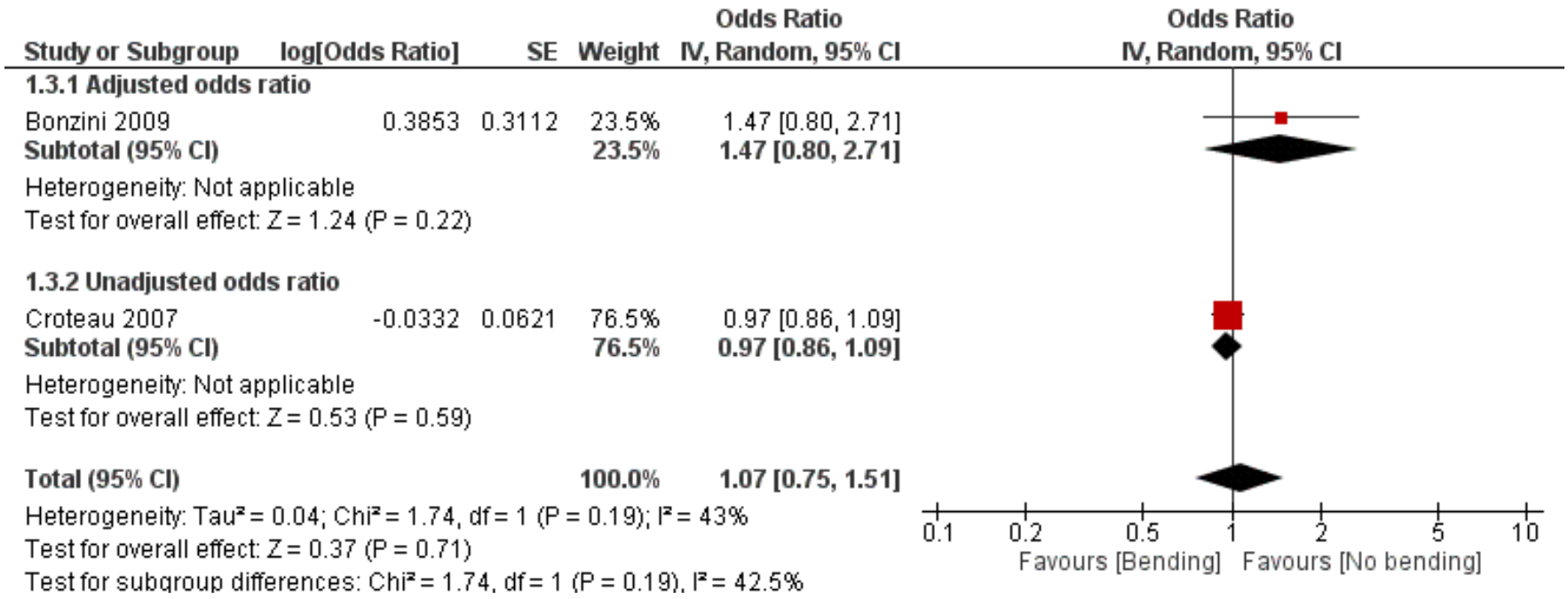

Figure 6: Effects of prolonged bending on the odds of preterm delivery. Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounders and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

Table 1. Summary of findings from meta-analyses describing the association of work activities and preterm delivery.

Subgroup factor	Subgroups	OR (with 95% CI)	Test for subgroup difference χ2
Lifting ≥11 kg per time			
Study design	Retrospective	1.22 (0.97 to 1.55)	
	Prospective	1.08 (0.89 to 1.30)	
	Overall	1.12 (0.97 to 1.29)	0.68
Study population	General population	1.12 (0.96 to 1.30)	
	Specific occupational groups	1.14 (0.36 to 3.59)	
	Overall	1.12 (0.97 to 1.29)	0.00
Lifting ≥100 kg per day			
Study design	Retrospective	1.25 (1.02 to 1.53)	
	Prospective	1.50 (1.09 to 2.07)	
	Overall	1.31 (1.11 to 1.56)	0.90
Study population	General population	1.25 (1.02 to 1.53)	
	Specific occupational groups	1.50 (1.09 to 2.07)	
	Overall	1.31 (1.11 to 1.56)	0.90
Standing			
Study design	Retrospective	1.12 (0.96 to 1.30)	
	Prospective	1.12 (1.01 to 1.25)	
	Overall	1.11 (1.01 to 1.21)	0.00
Study population	General population	1.09 (1.01 to 1.17)	
	Specific occupational groups	2.12 (1.48 to 3.03)	
	Overall	1.11 (1.01 to 1.21)	12.76
Walking			
Study design	Retrospective	0.93 (0.73 to 1.18)	
	Prospective	1.15 (0.88 to 1.51)	

Classification: Public

	Overall	1.03 (0.87 to 1.21)	1.38
Total physical workload			
Study design	Retrospective	1.33 (1.08 to 1.65)	
	Prospective	1.05 (0.79 to 1.39)	
	Overall	1.27 (1.06 to 1.53)	1.79
Study population	General population	1.21 (1.04 to 1.41)	
	Specific occupational groups	1.35 (0.86 to 2.13)	
	Overall	1.23 (1.07 to 1.41)	0.22

Classification: Public

Miscarriage

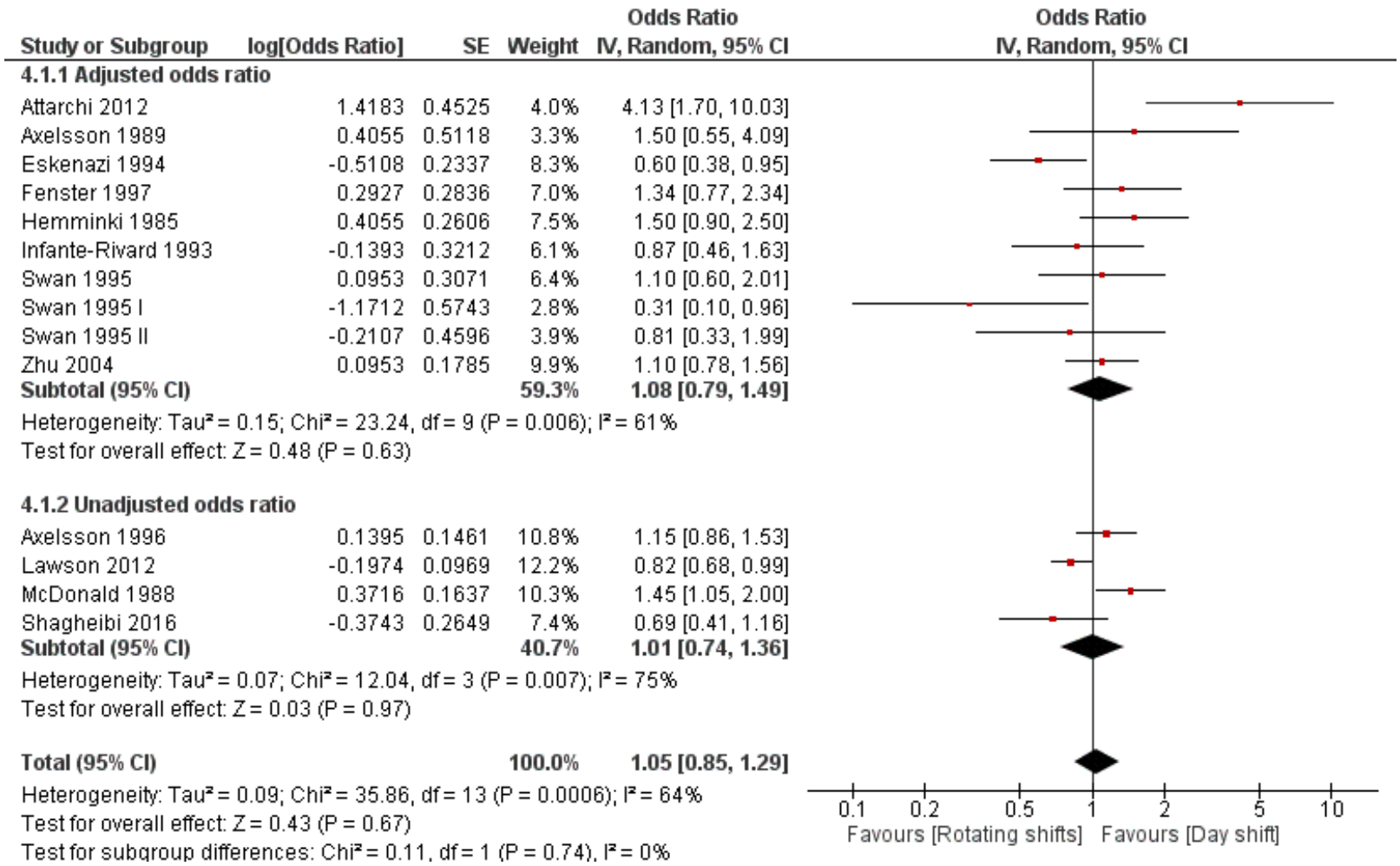

Figure 7: Effects of rotating shift work compared with day shift on odds of miscarriage. Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounding and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

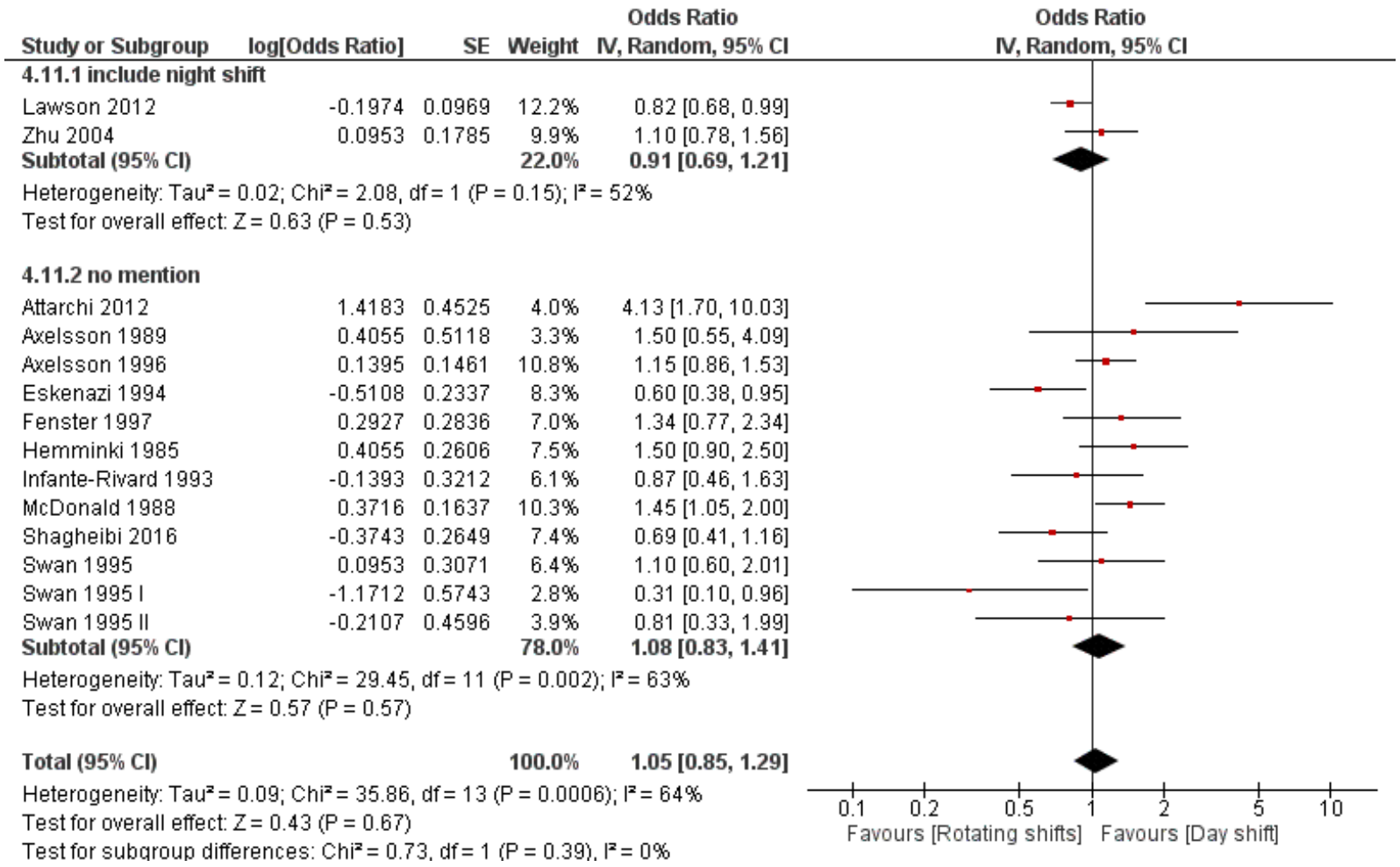

Figure 8: Effects of rotating shift work compared with day shift on odds of miscarriage. Subgroup analyses were conducted with studies included night shift as part of rotating shift work and studies did not provide the information. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

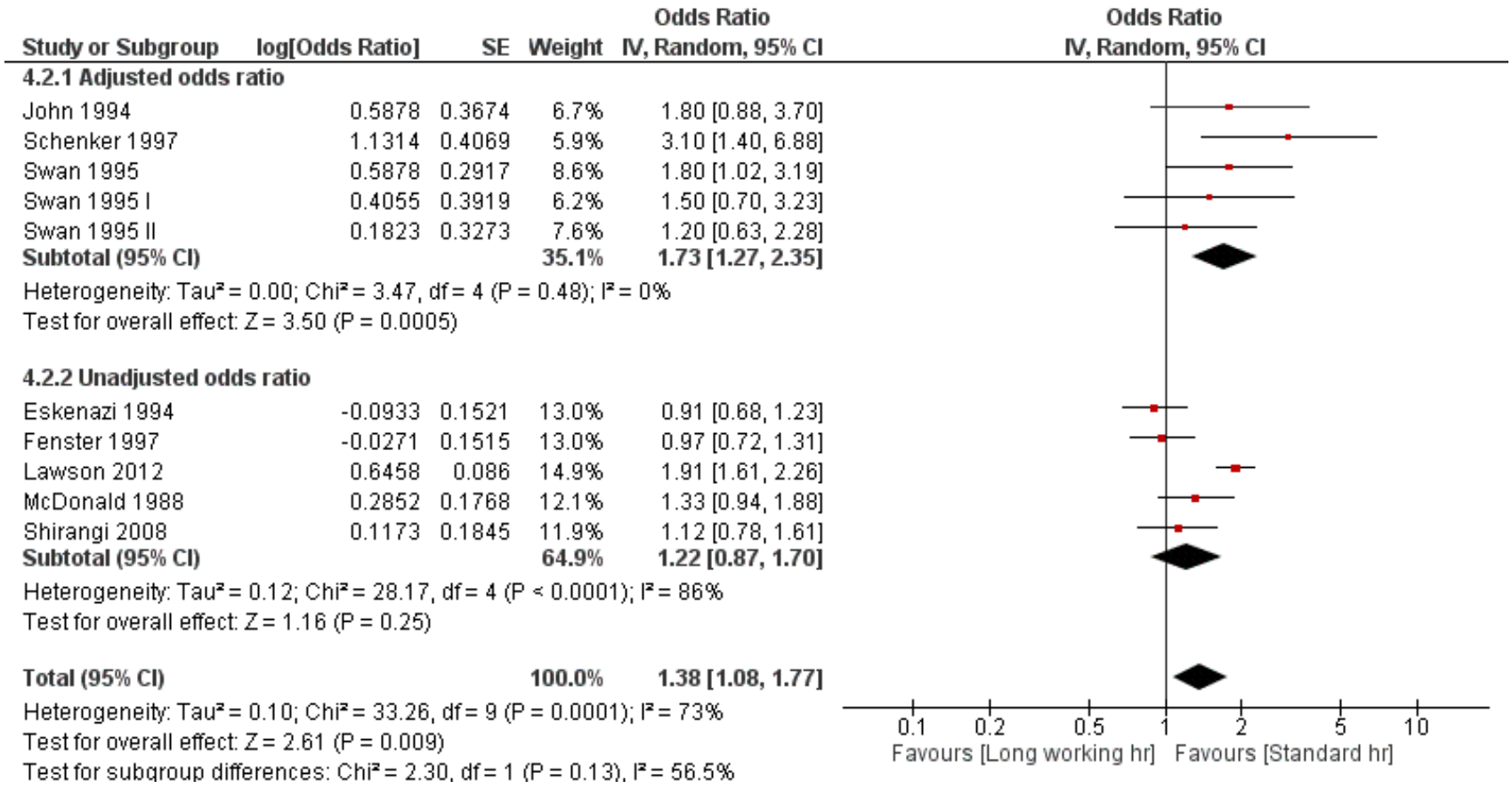

Figure 9: Effects of worked >40 hours/week compared with worked ≤40 hours/week on odds of miscarriage. Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounding and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

Table 2. Summary of findings from meta-analyses describing the association of long working hours, shift work and miscarriage.

			Test for subgroup difference	
Subgroup factor	Subgroups	OR (with 95% CI)	$\chi 2$	p Value
Long working hours				
Study design	Retrospective	1.46 (1.13 to 1.88)		
	Prospective	0.97 (0.72 to 1.31)		
	Overall	1.38 (1.08 to 1.77)	4.09	**0.04**
Study population	General population	1.04 (0.84 to 1.29)		
	Specific occupations	1.64 (1.29 to 2.08)		
	Overall	1.38 (1.08 to 1.77)	7.58	**0.006**
Rotating shift work				
Study design	Retrospective	1.02 (0.80 to 1.31)		
	Prospective	1.16 (0.87 to 1.56)		
	Overall	1.05 (0.85 to 1.29)	0.43	0.51
Study population	General population	1.04 (0.76 to 1.44)		
	Specific occupations	1.06 (0.78 to 1.43)		
	Overall	1.05 (0.85 to 1.29)	0.00	0.96
Fixed night shift				
Study design	Retrospective	1.24 (1.01 to 1.52)		
	Prospective	1.24 (0.74 to 2.08)		
	Overall	1.23 (1.03 to 1.47)	0.00	1.00
Study population	General population	1.19 (0.86 to 1.65)		
	Specific occupations	1.29 (1.06 to 1.55)		
	Overall	1.23 (1.03 to 1.47)	0.15	0.70

Classification: Public

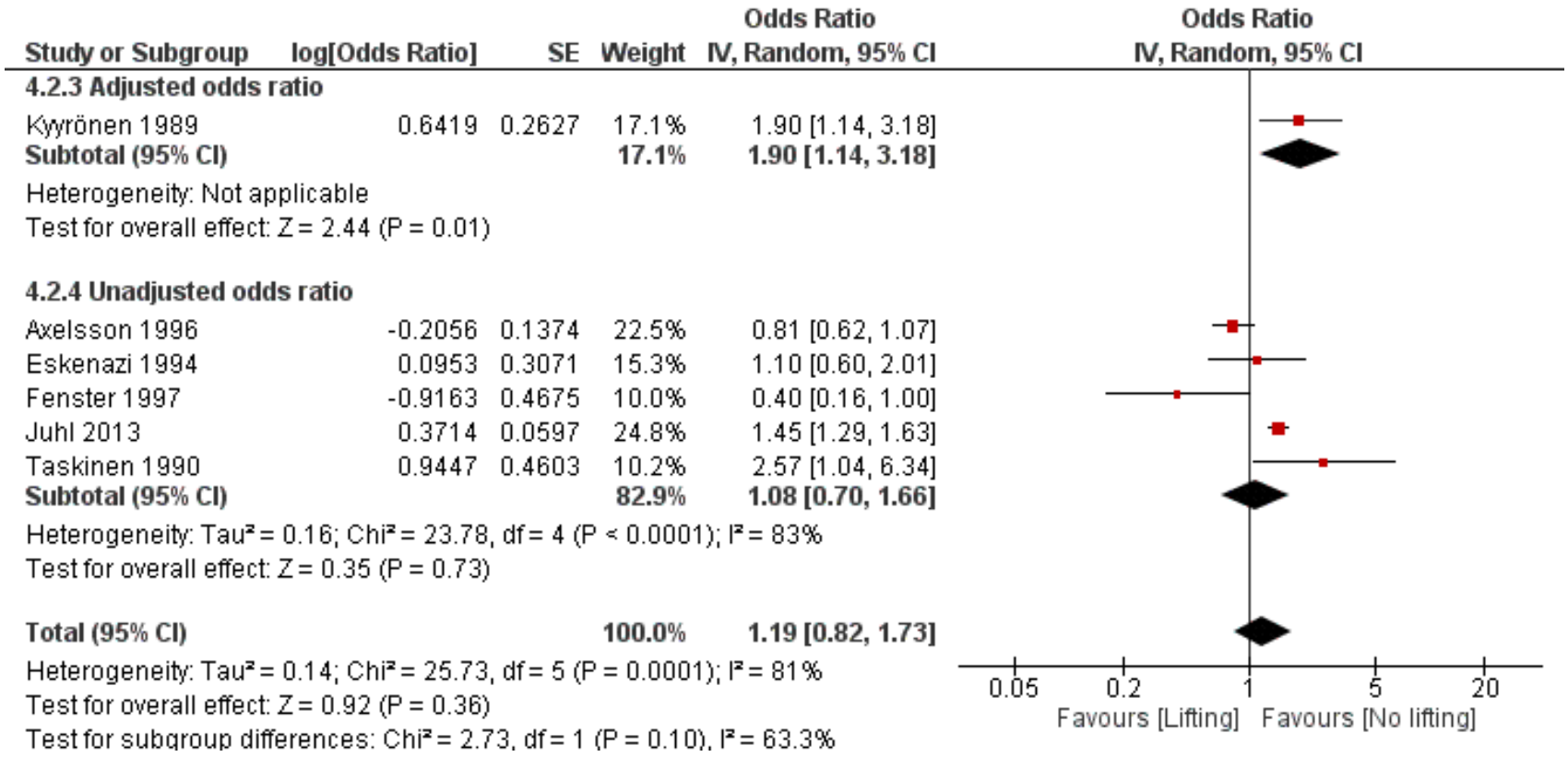

Figure 10: Effects of lifting ≥100 kilograms per day on the odds of miscarriage. Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounders and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

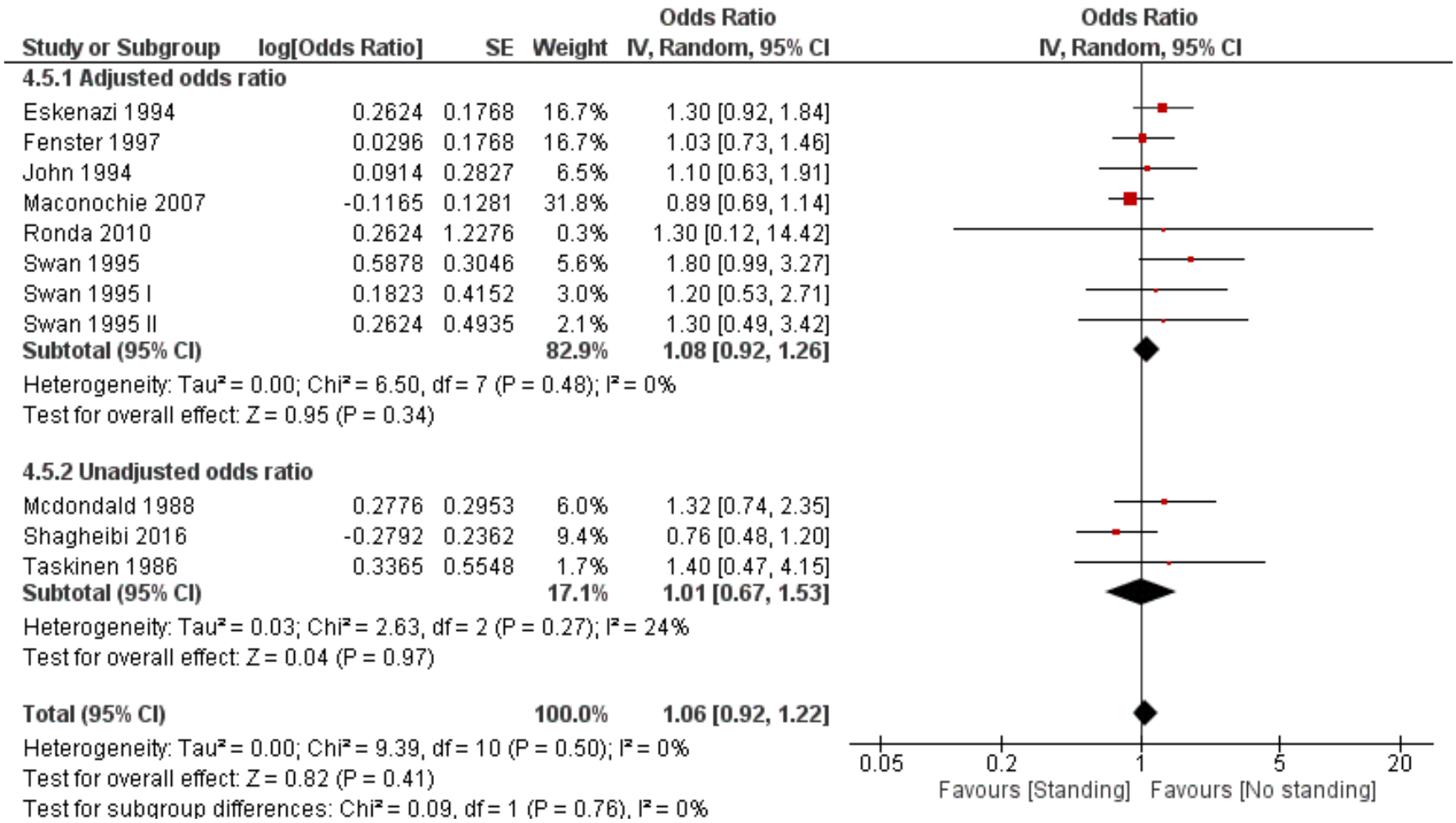

Figure 11: Effects of prolonged standing on the odds of miscarriage. Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounders and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

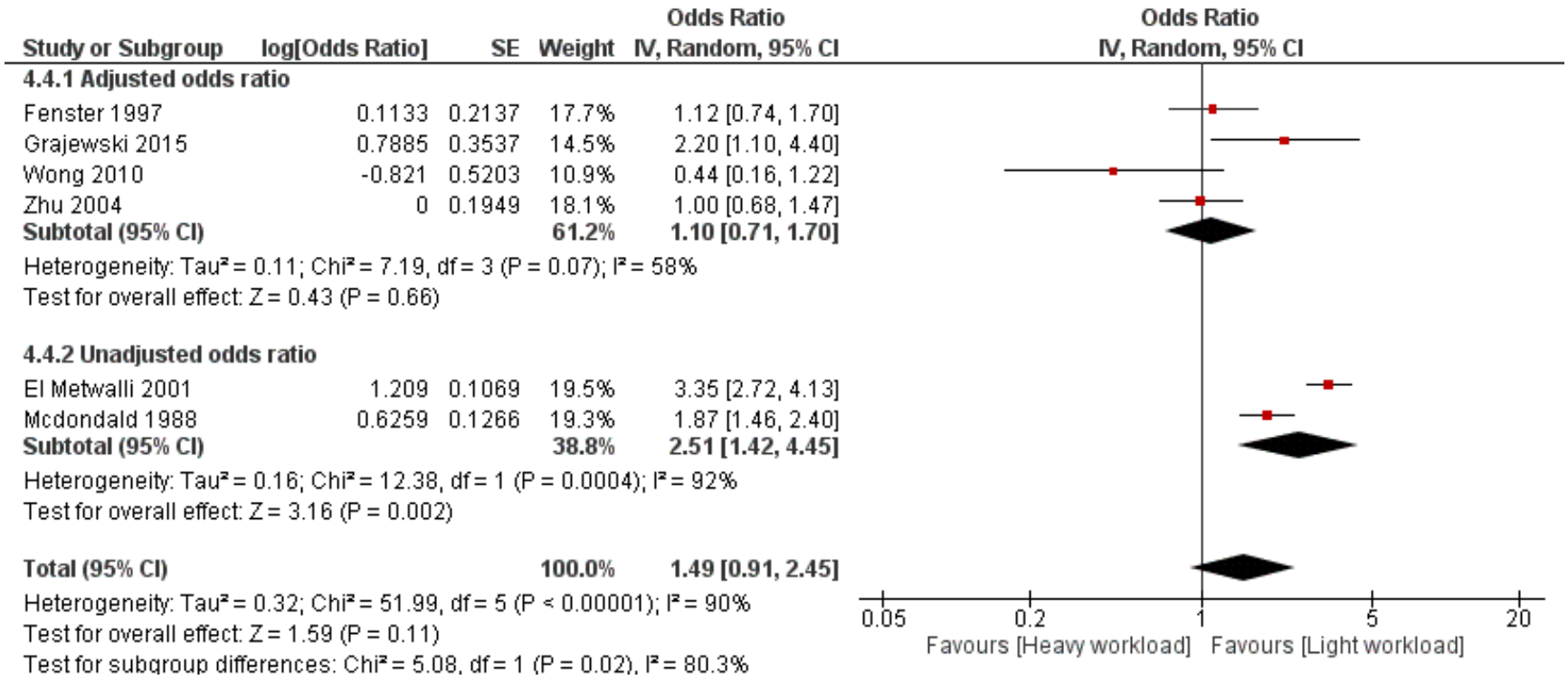

Figure 12: Effects of heavy physical workload on the odds of miscarriage. Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounders and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

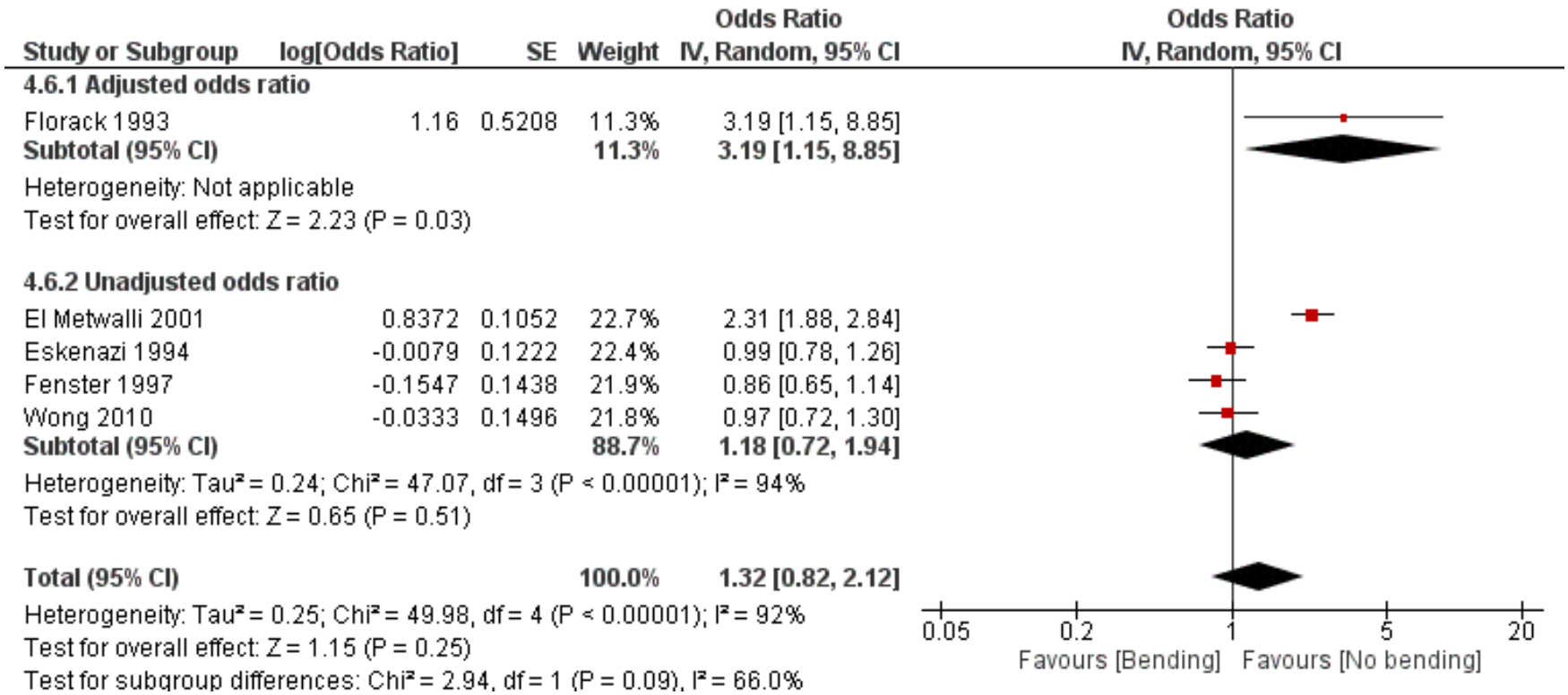

Figure 13: Effects of prolonged bending on the odds of miscarriage. Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounders and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

Table 3. Summary of findings from meta-analyses describing the association of work activities and miscarriage.

			Test for subgroup difference
Subgroup factor	**Subgroups**	**OR (with 95% CI)**	**χ2**
Lifting≥11kg per time			
Study design	Retrospective	1.36 (1.06 to 1.75)	
	Prospective	1.08 (0.97 to 1.21)	
	Overall	1.27 (1.04 to 1.55)	2.81
Study population	General population	1.34 (1.06 to 1.69)	
	Specific occupations	1.11 (0.88 to 1.39)	
	Overall	1.31 (1.08 to 1.58)	1.32
Lifting≥100kg per day			
Study design	Retrospective	1.34 (0.79 to 2.27)	
	Prospective	0.83 (0.24 to 2.89)	
	Overall	1.19 (0.82 to 1.73)	0.48
Study population	General population	1.34 (0.91 to 1.98)	
	Specific occupations	0.81 (0.62 to 1.07)	
	Overall	1.19 (0.82 to 1.73)	4.29
Standing			
Study design	Retrospective	1.08 (0.91 to 1.27)	
	Prospective	1.03 (0.73 to 1.46)	
	Overall	1.06 (0.92 to 1.22)	0.05
Study population	General population	1.01 (0.85 to 1.19)	
	Specific occupations	1.34 (0.97 to 1.86)	
	Overall	1.06 (0.92 to 1.22)	2.36
Total physical workload			
Study design	Retrospective	1.49 (0.55 to 1.02)	
	Prospective	1.05 (0.77 to 1.42)	
	Overall	1.28 (0.75 to 2.18)	0.45
Study population	General population	1.54 (0.96 to 2.47)	
	Specific occupations	0.81 (0.18 to 3.73)	
	Overall	1.28 (0.75 to 2.18)	0.63
Bending			

Classification: Public

Study design	Retrospective	1.50 (0.42 to 5.38)	
	Prospective	1.31 (0.72 to 2.39)	
	Overall	1.32 (0.82 to 2.12)	0.04
Study population	General population	1.45 (0.71 to 2.62)	
	Specific occupations	0.97 (0.72 to 1.30)	
	Overall	1.32 (0.82 to 2.12)	1.49

Classification: Public

Preeclampsia

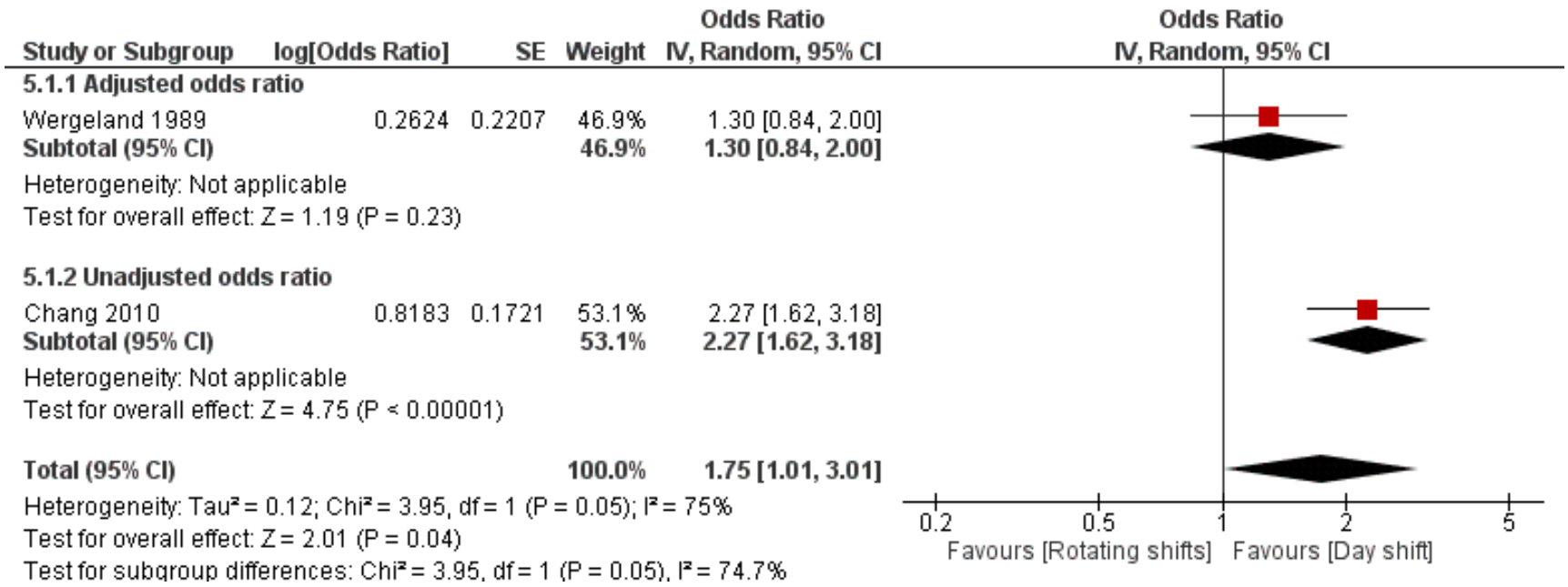

Figure 14: Effects of rotating shift work compared with day shift on odds of preeclampsia. Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounding and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

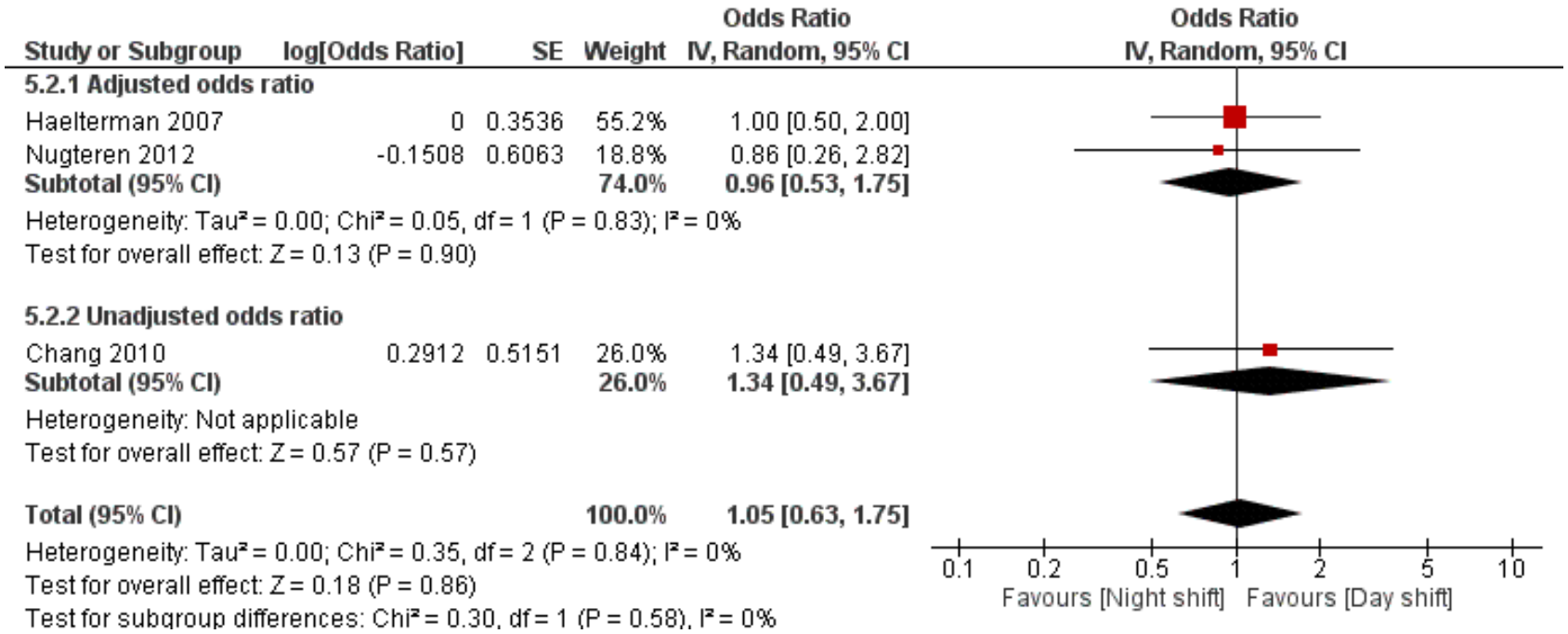

Figure 15: Effects of fixed night shift compared with day shift on odds of preeclampsia. Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounding and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

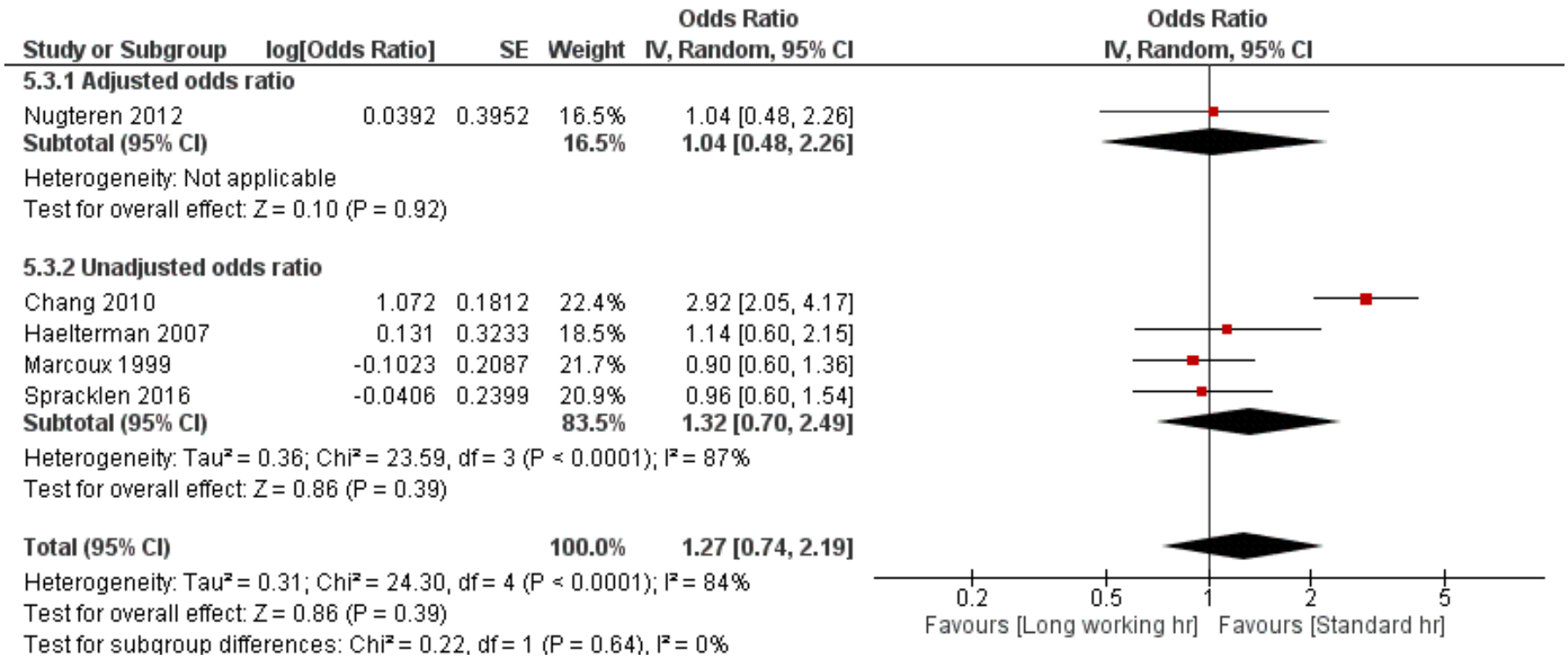

Figure 16: Effects of worked >40h per week compared with worked ≤40h per week on odds of pre-eclampsia. Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounding and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

Table 4. Summary of findings from meta-analyses describing the association of long working hours, shift work and preeclampsia.

			Test for subgroup difference	
Subgroup factor	Subgroups	OR (with 95% CI)	χ2	p Value
Long working hours				
Cut-off value for long working hours	35 hours	0.90 (0.60 to 1.36)		
	40 hours	1.39 (0.73 to 2.65)		
	Overall	1.27 (0.74 to 2.19)	1.25	0.26
Study design	Retrospective	0.96 (0.73 to 1.27)		
	Prospective	1.85 (1.68 to 5.06)		
	Overall	1.27 (0.74 to 2.19)	1.50	0.22
Rotating shift work				
Study design	Retrospective	1.30 (0.84 to 2.00)		
	Prospective	2.27 (1.62 to 3.18)		
	Overall	1.75 (1.01 to 3.01)	3.95	**0.05**
Fixed night shift				
Study design	Retrospective	1.00 (0.50 to 2.00)		
	Prospective	1.11 (0.52 to 2.40)		
	Overall	1.05 (0.63 to 1.75)	0.04	0.84

Classification: Public

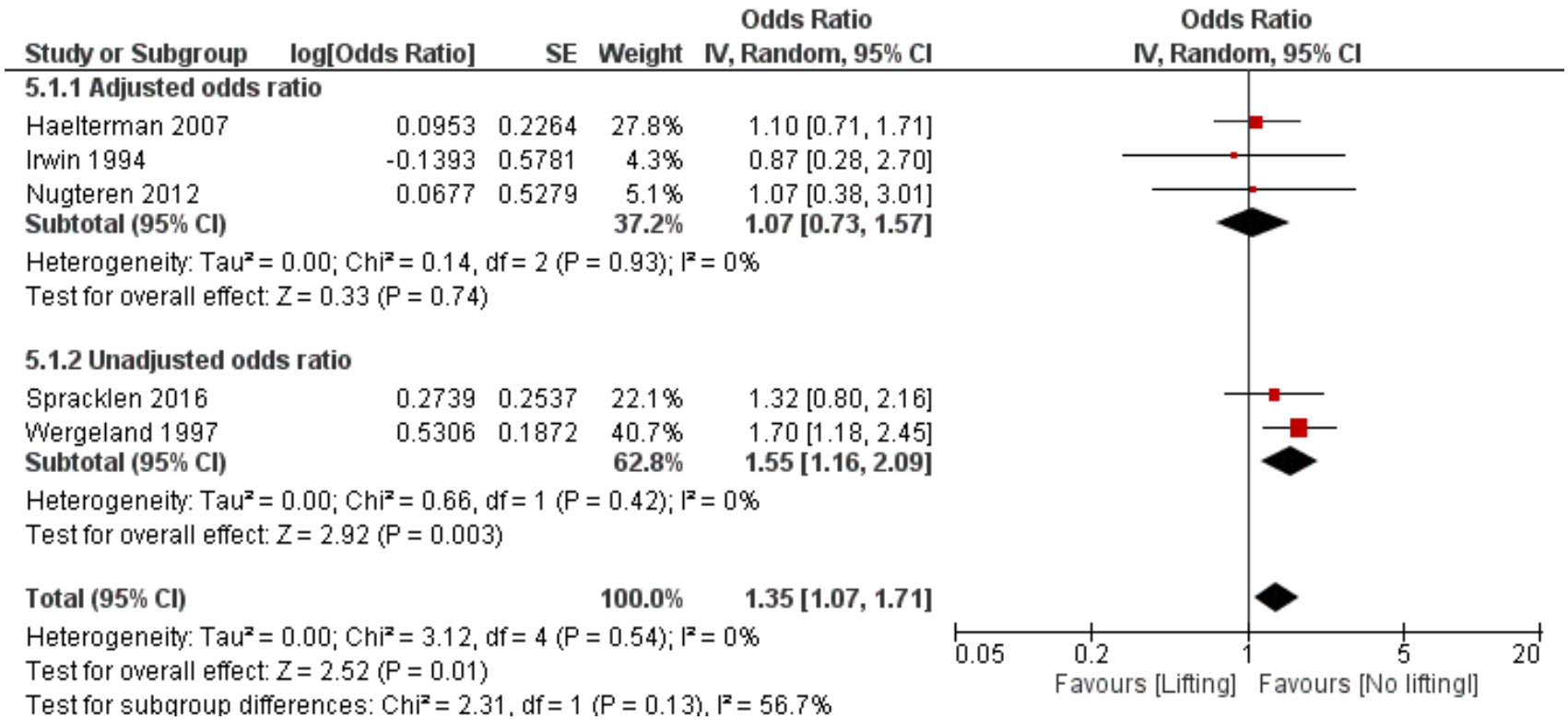

Figure 17: Effects of lifting ≥11 kilograms per time on the odds of pre-eclampsia. Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounders and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

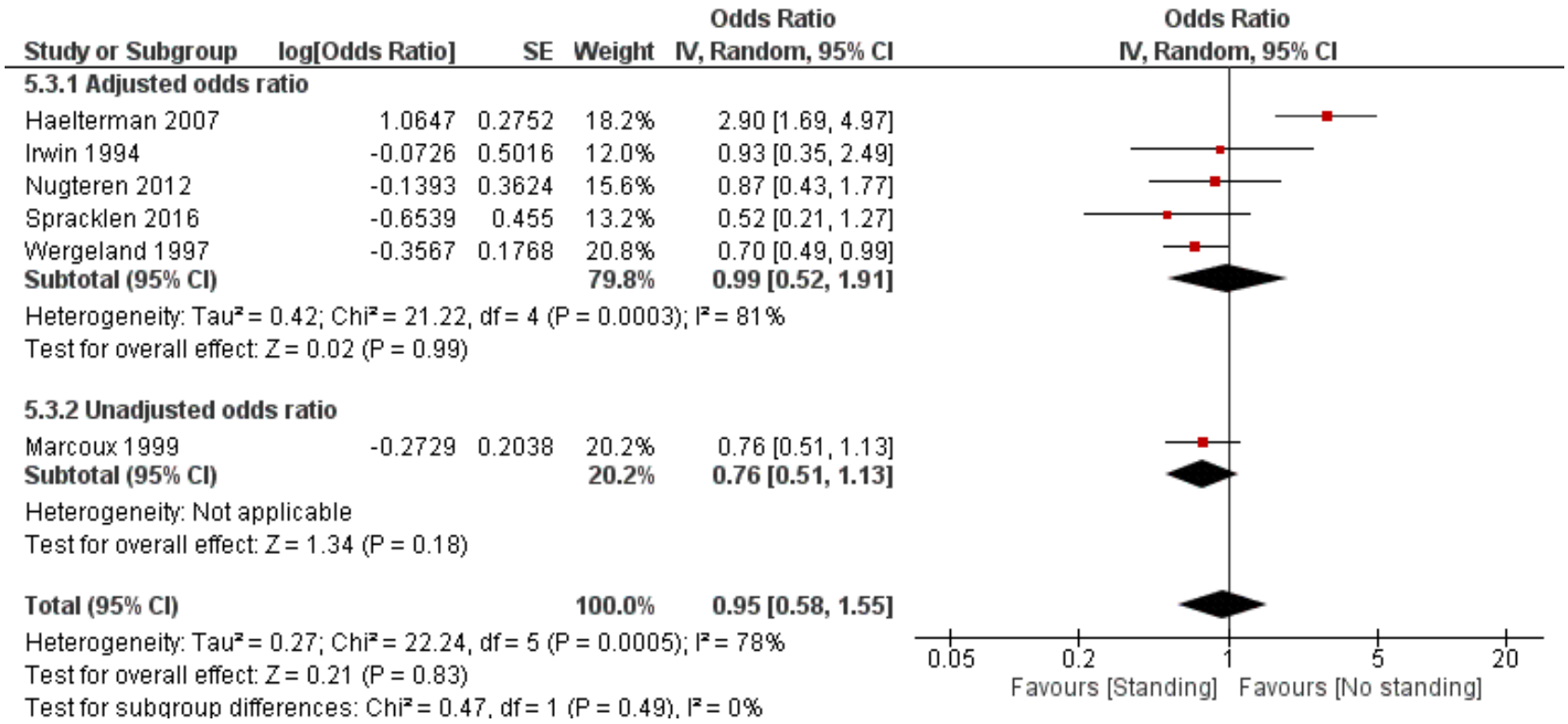

Figure 18: Effects of prolonged standing on the odds of pre-eclampsia. Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounders and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

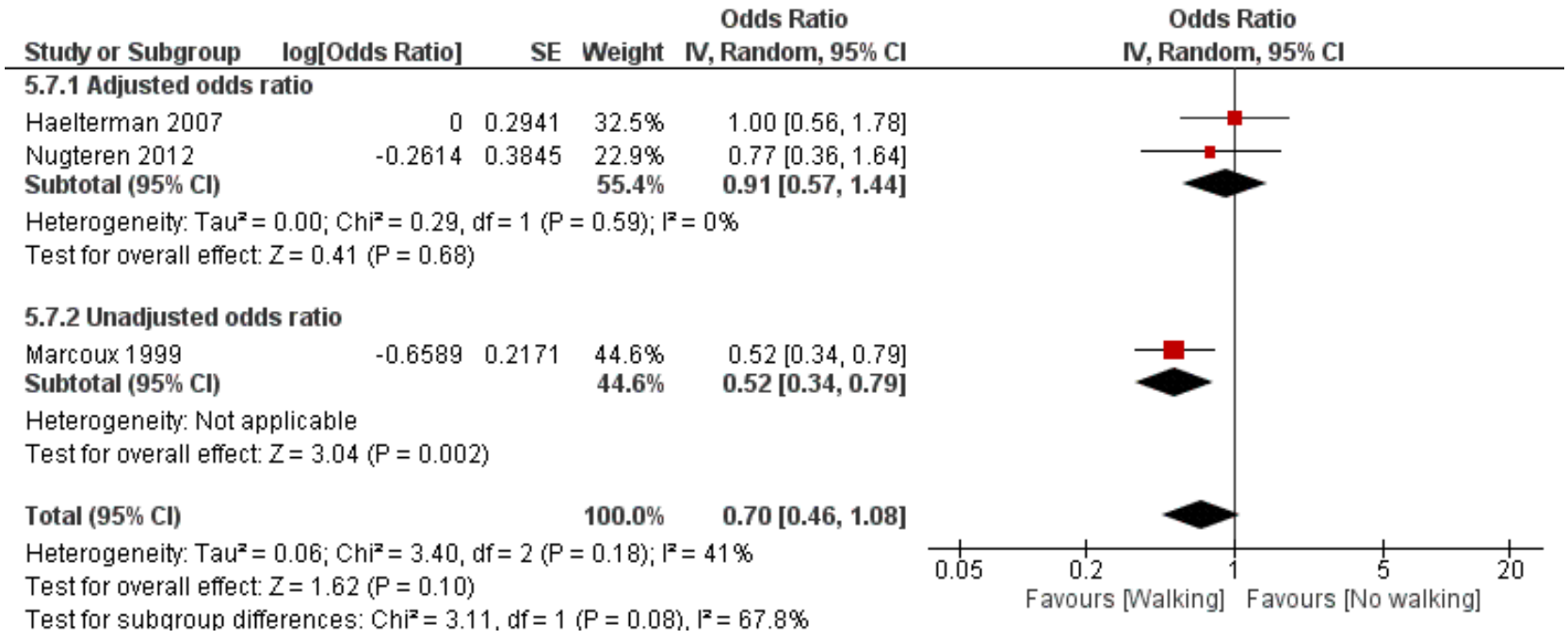

Figure 19: Effects of prolonged walking on the odds of pre-eclampsia. Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounders and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

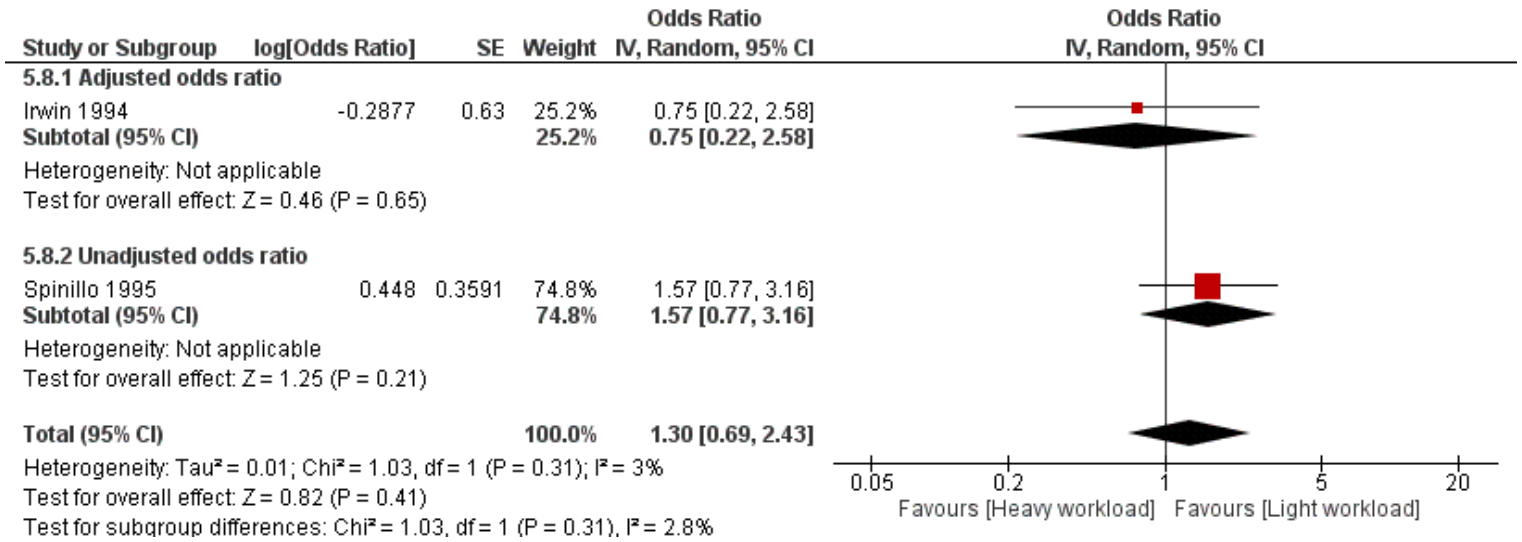

Figure 20: Effects of heavy physically workload on the odds of pre-eclampsia. Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounders and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

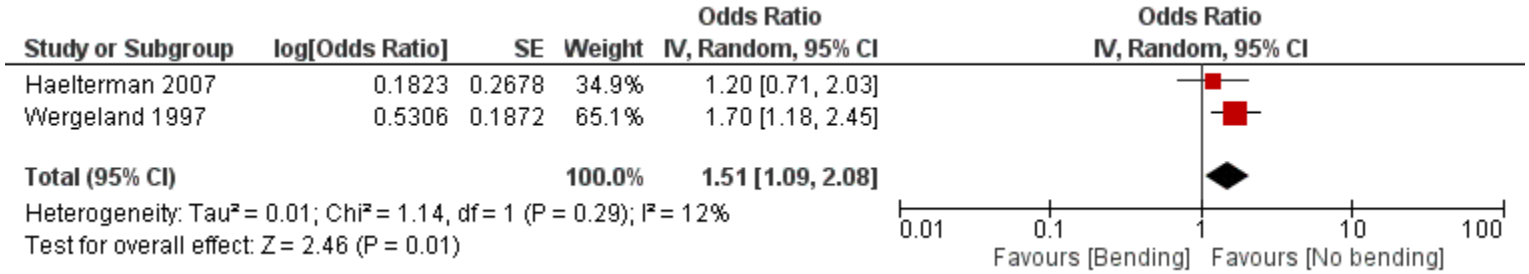

Figure 21: Effects of prolonged bending on the odds of pre-eclampsia. Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounders and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

Table 5. Summary of findings from meta-analyses describing the association of work activities and pre-eclampsia.

			Test for subgroup difference
Subgroup factor	**Subgroups**	**OR (with 95% CI)**	**χ2**
Lifting≥11kg per time			
Study design	Retrospective	1.37 (1.08 to 1.74)	
	Prospective	1.07 (0.38 to 3.01)	
	Overall	1.35 (1.07 to 1.71)	0.20
Standing			
Study design	Retrospective	0.96 (0.54 to 1.72)	
	Prospective	0.87 (0.43 to 1.77)	
	Overall	0.95 (0.58 to 1.55)	0.05

Classification: Public

Gestational hypertension

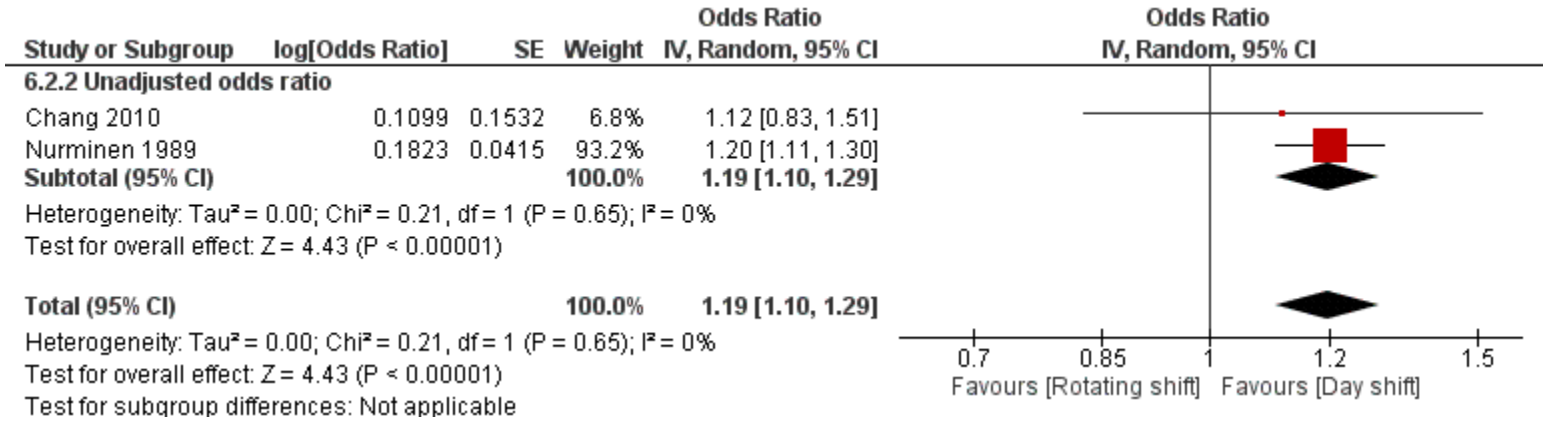

Figure 22: Effects of rotating shift work compared with day shift on odds of gestational hypertension. Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounding and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

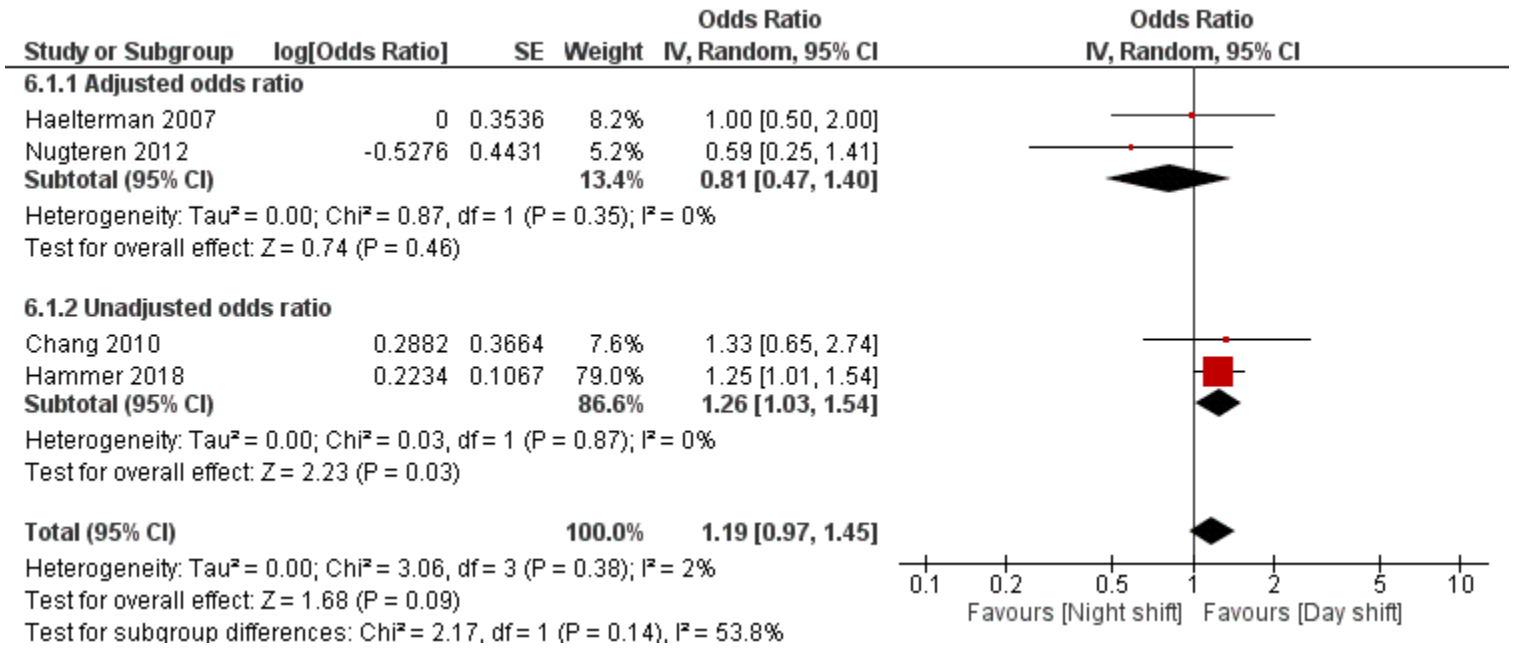

Figure 23: Effects of fixed night shift compared with day shift on odds of gestational hypertension. Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounding and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

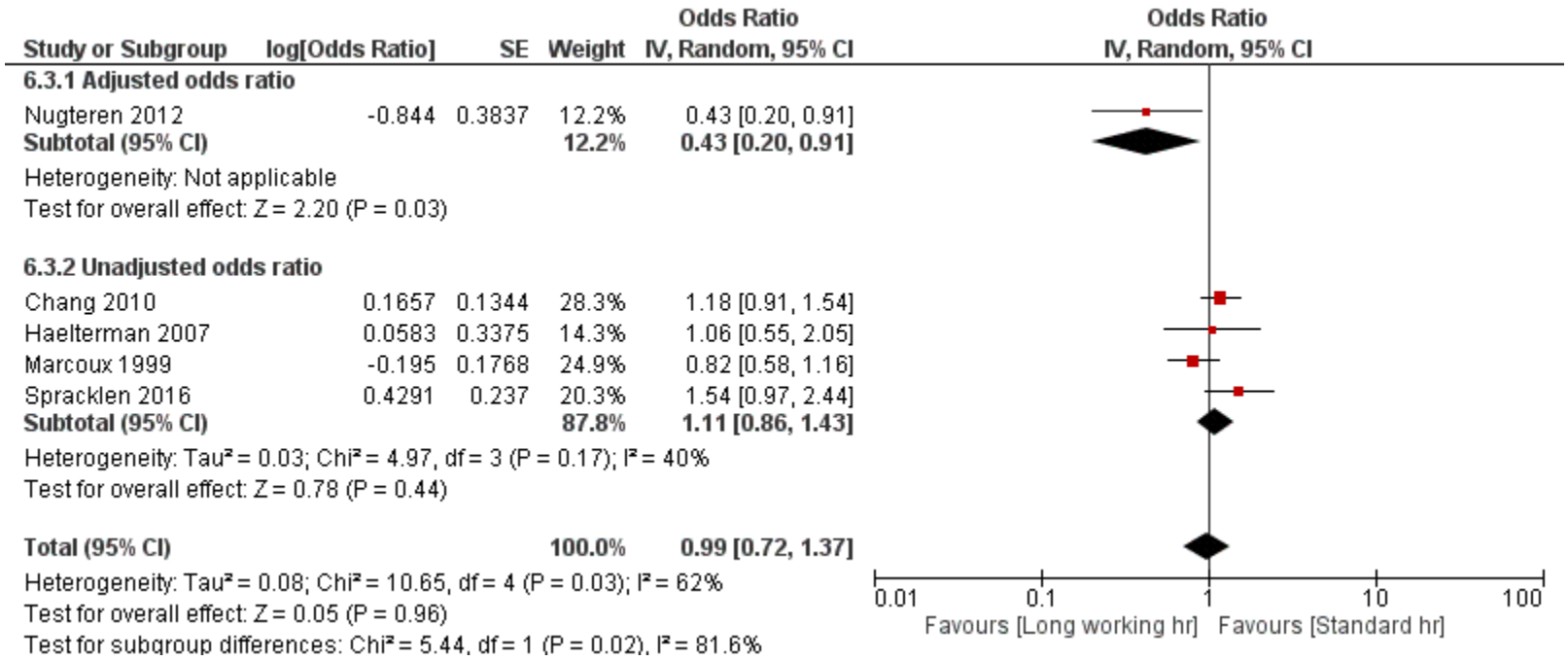

Figure 24: Effects of worked >40h per week compared with worked ≤40h per week on odds of gestational hypertension. Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounding and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

Table 6. Summary of findings from meta-analyses describing the association of long working hours, shift work and gestational hypertension.

Subgroup factor	Subgroups	OR (with 95% CI)	Test for subgroup difference	
			χ^2	p Value
Long working hours				
Cut-off value for long working hours	35 hours	0.82 (0.58 to 1.16)		
	40 hours	1.04 (0.69 to 1.57)		
	Overall	0.99 (0.742 to 1.37)	0.74	0.39
Study design	Retrospective	1.08 (0.72 to 1.63)		
	Prospective	0.76 (0.28 to 2.03)		
	Overall	0.99 (0.72 to 1.37)	0.42	0.52
Rotating shift work				
Study design	Retrospective	1.20 (1.11 to 1.30)		
	Prospective	1.12 (0.83 to 1.51)		
	Overall	1.19 (1.10 to 1.29)	0.21	0.65
Fixed night shift				
Study design	Retrospective	1.23 (1.00 to 1.50)		
	Prospective	0.92 (0.42 to 2.04)		
	Overall	1.19 (0.97 to 1.45)	0.47	0.49
Study population	General population	0.97 (0.63 to 1.50)		
	Specific occupations	1.25 (1.01 to 1.54)		
	Overall	1.19 (0.97 to 1.45)	1.03	0.31

Classification: Public

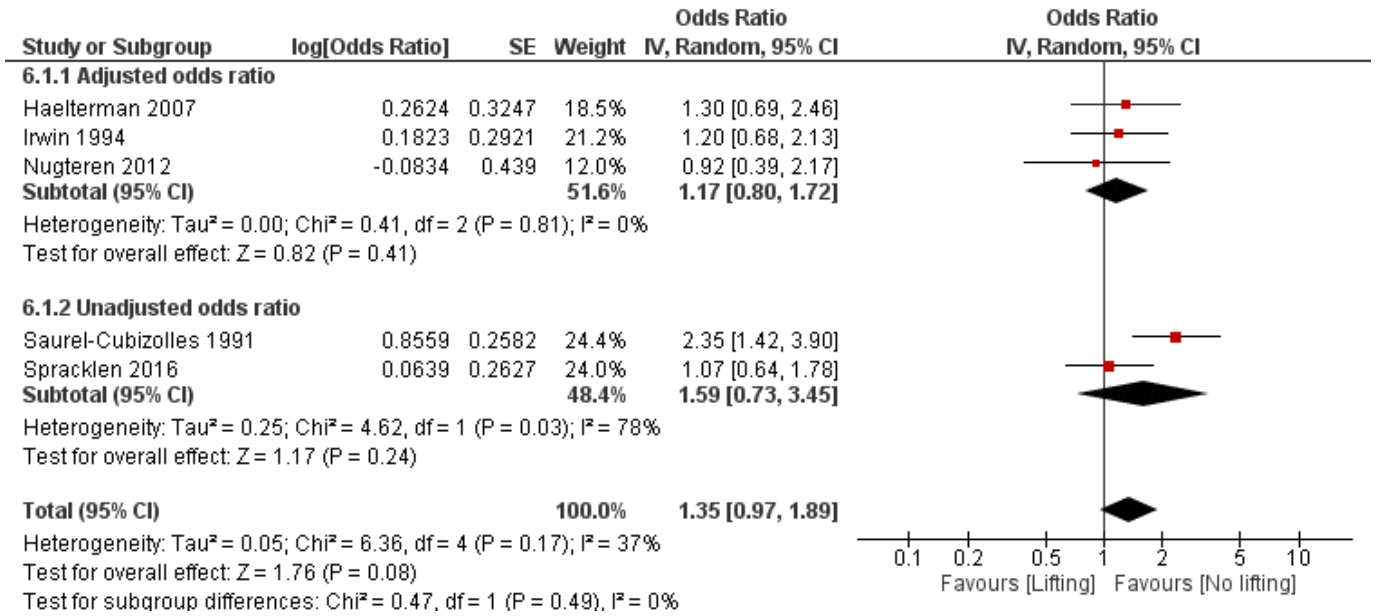

Figure 25: Effects of lifting ≥11 kilograms per time on the odds of gestational hypertension. Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounders and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

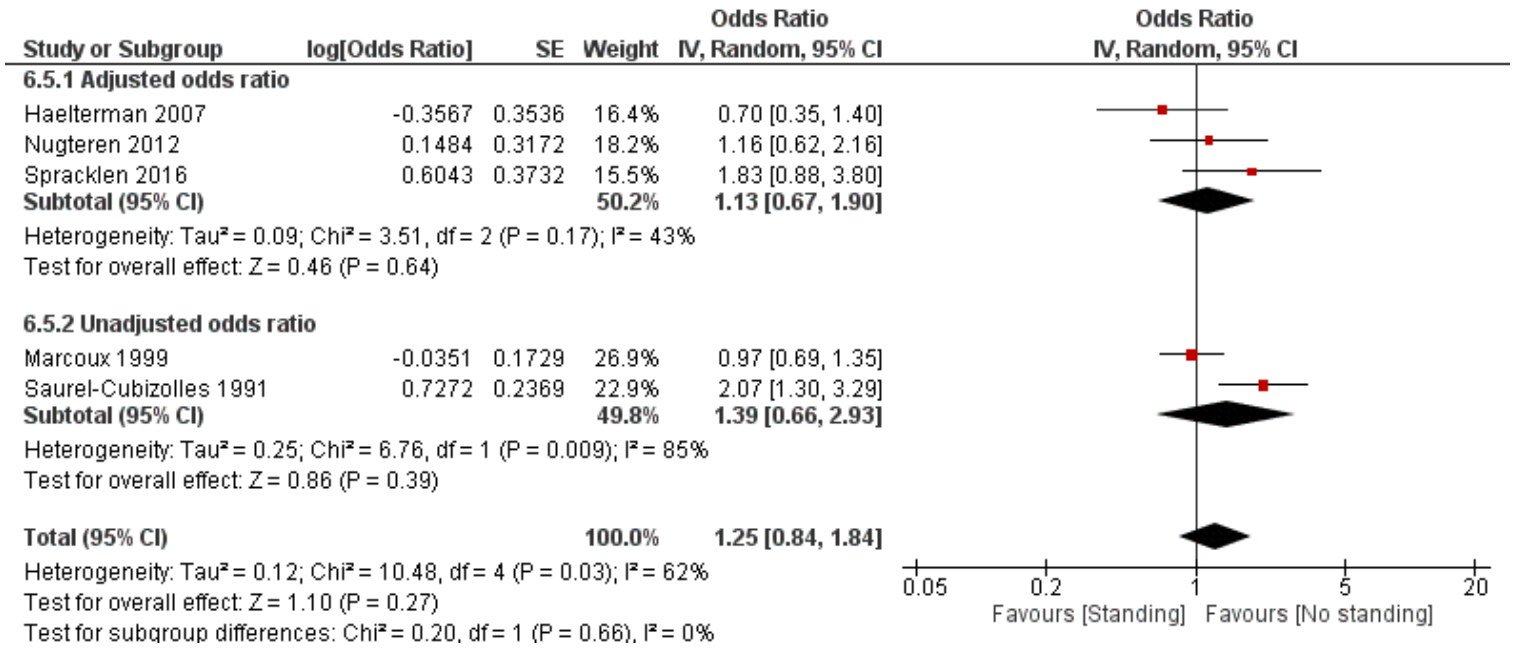

Figure 26: Effects of prolonged standing on the odds of gestational hypertension. Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounders and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

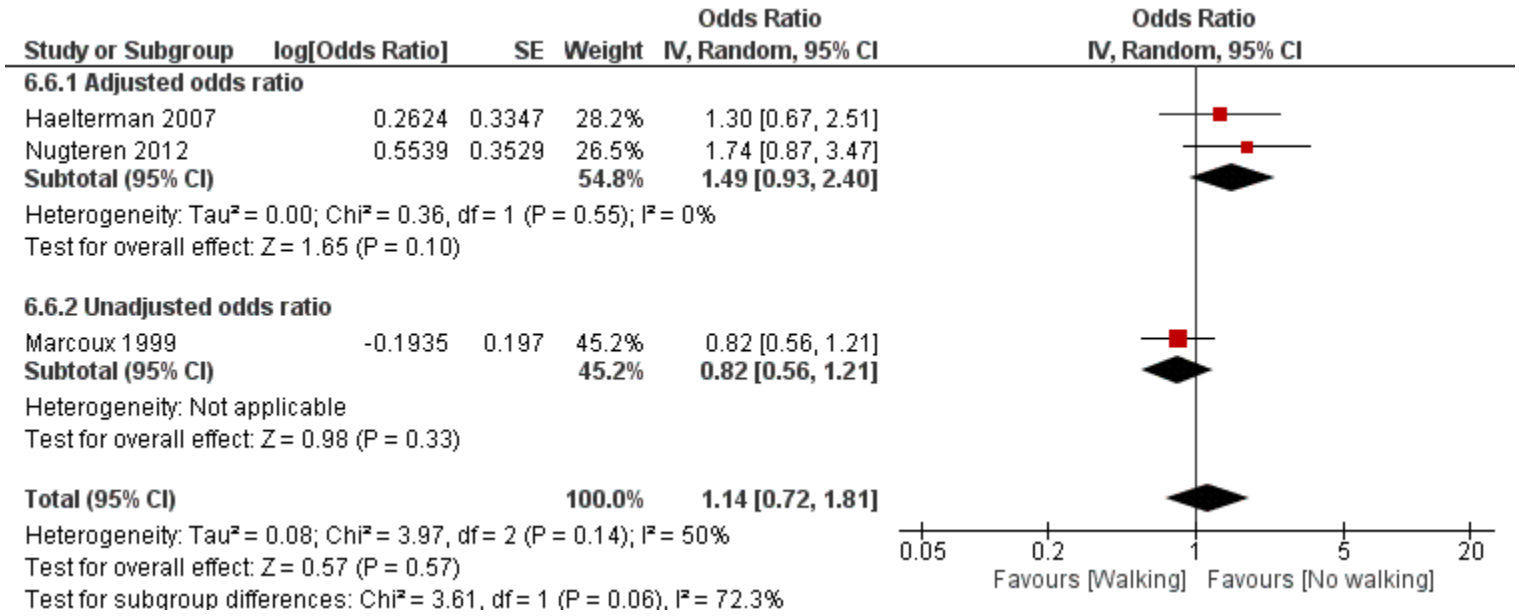

Figure 27: Effects of prolonged walking on the odds of gestational hypertension. Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounders and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

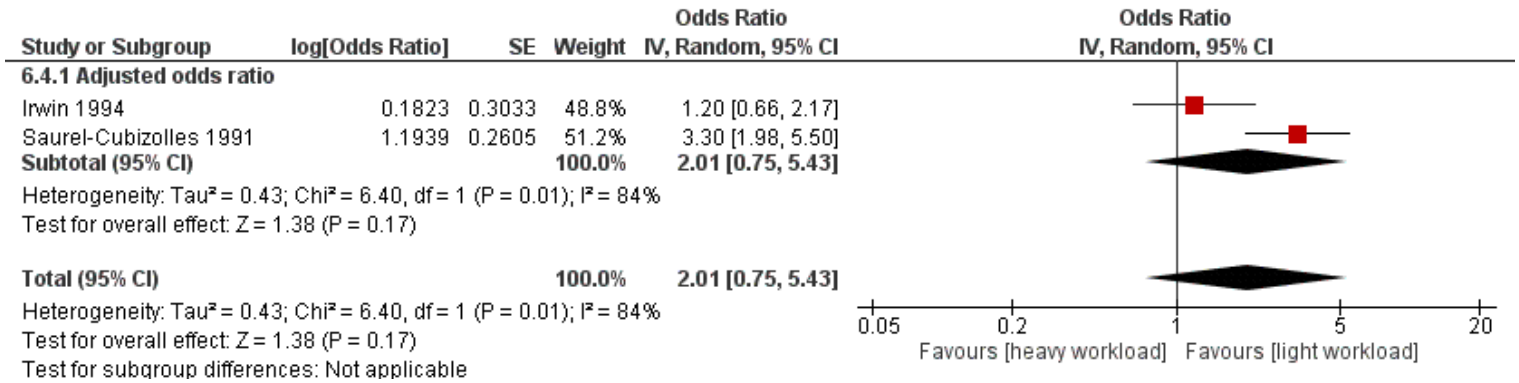

Figure 28: Effects of heavy physically workload on the odds of gestational hypertension. Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounders and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

Table 7. Summary of findings from meta-analyses describing the association of work activities and gestational hypertension.

			Test for subgroup difference
Subgroup factor	**Subgroups**	**OR (with 95% CI)**	**χ2**
Lifting≥11kg per time			
Study design	Retrospective	1.42 (0.98 to 2.07)	
	Prospective	0.92 (0.39 to 2.17)	
	Overall	1.35 (0.97 to 1.89)	0.83
Study population	General population	1.11 (0.77 to 1.59)	
	Specific occupations	1.70 (0.88 to 3.30)	
	Overall	1.35 (0.97 to 1.89)	1.26
Standing			
Study design	Retrospective	1.31 (0.90 to 1.92)	
	Prospective	1.16 (0.62 to 2.16)	
	Overall	1.29 (0.93 to 1.77)	0.11
Study population	General population	1.05 (0.77 to 1.43)	
	Specific occupations	1.77 (1.27 to 2.48)	
	Overall	1.29 (0.93 to 1.77)	5.69
Walking			
Study design	Retrospective	0.96 (0.63 to 1.45)	
	Prospective	1.74 (0.87 to 3.47)	
	Overall	1.14 (0.72 to 1.81)	2.12

Classification: Public

Small-for-gestational-age

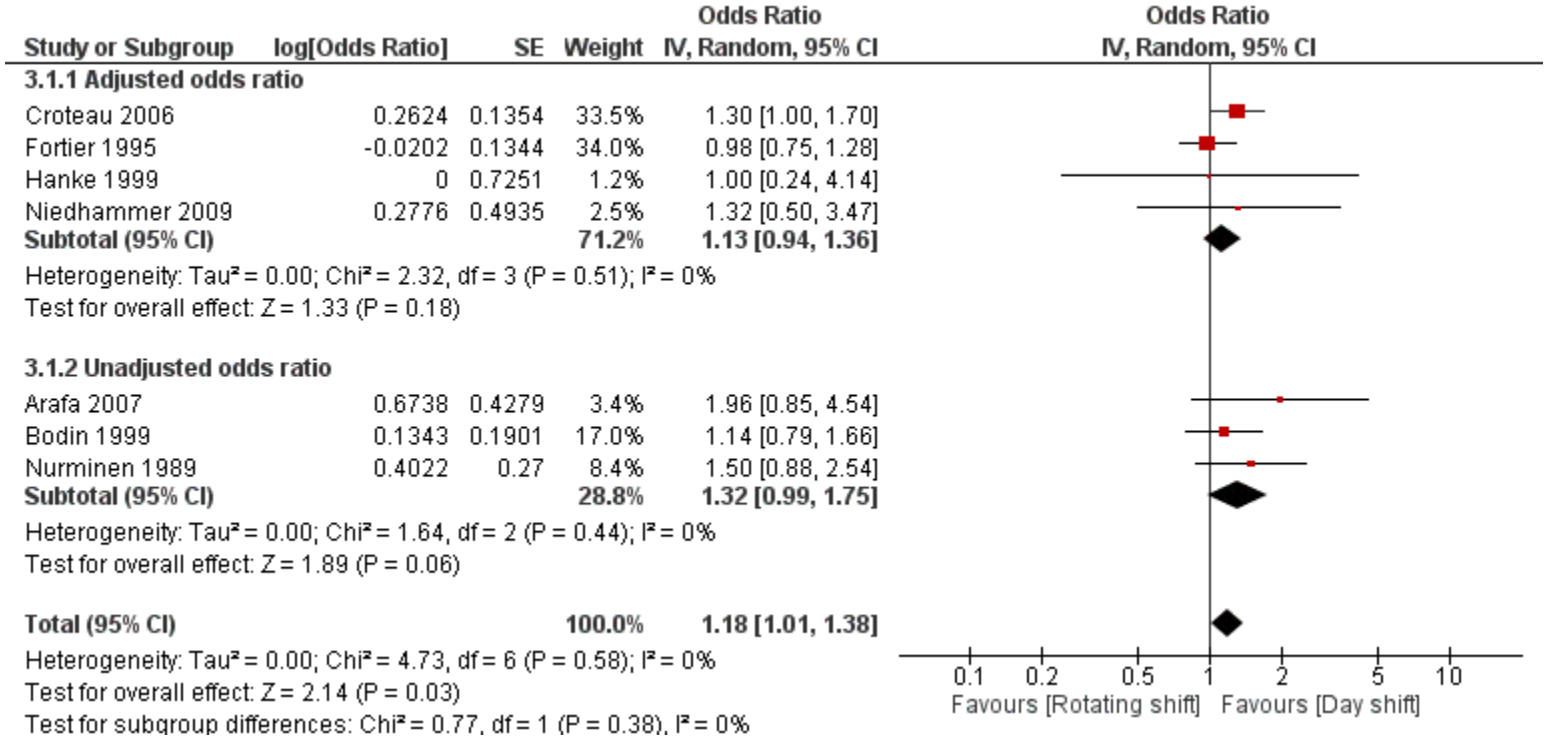

Figure 29: Effects of rotating shift work compared with day shift on odds of having a small-for-gestational-age baby. Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounding and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

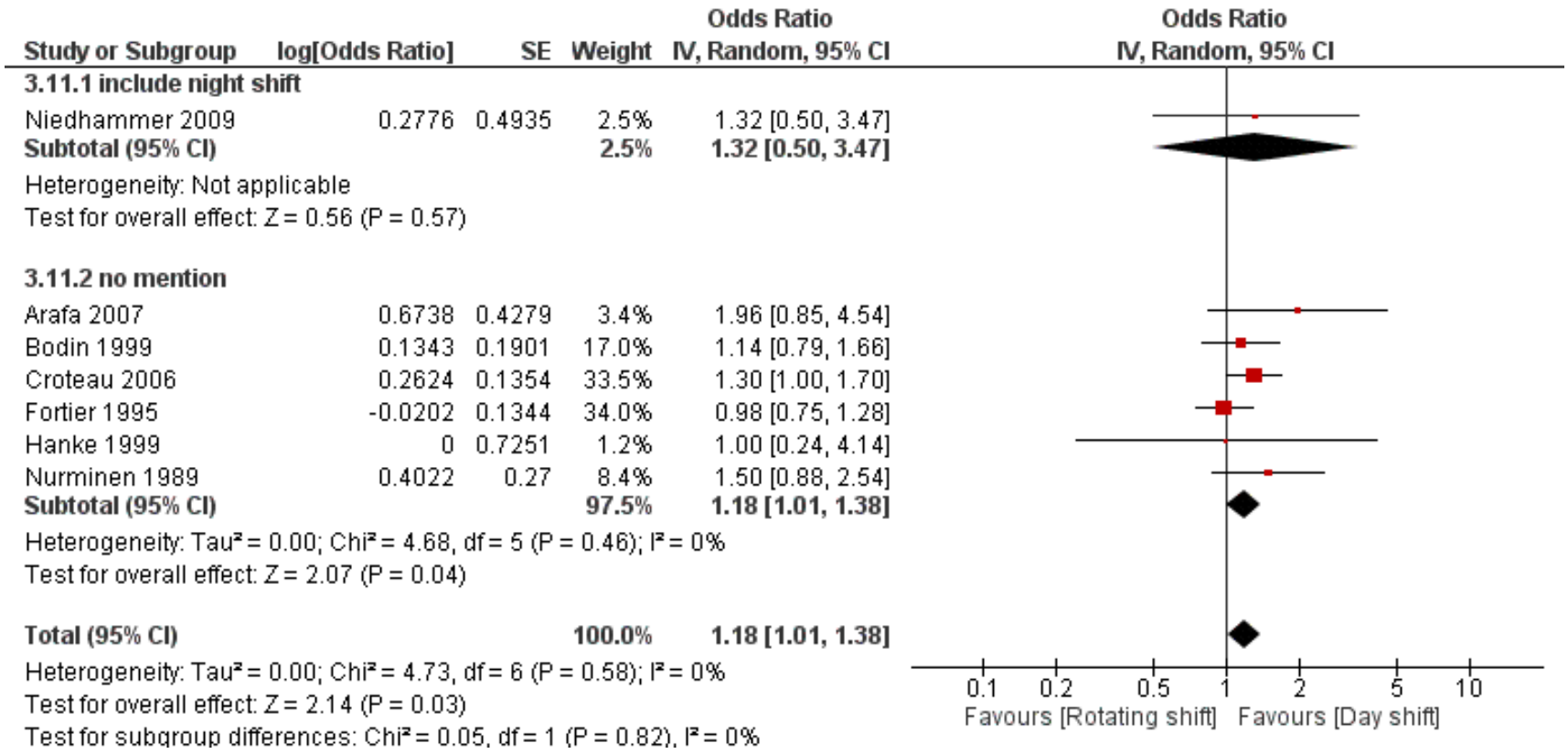

Figure 30: Effects of rotating shift work compared with day shift on odds of having a small-for-gestational-age baby. Subgroup analyses were conducted with studies included night shift as part of rotating shift work and studies did not provide the information. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

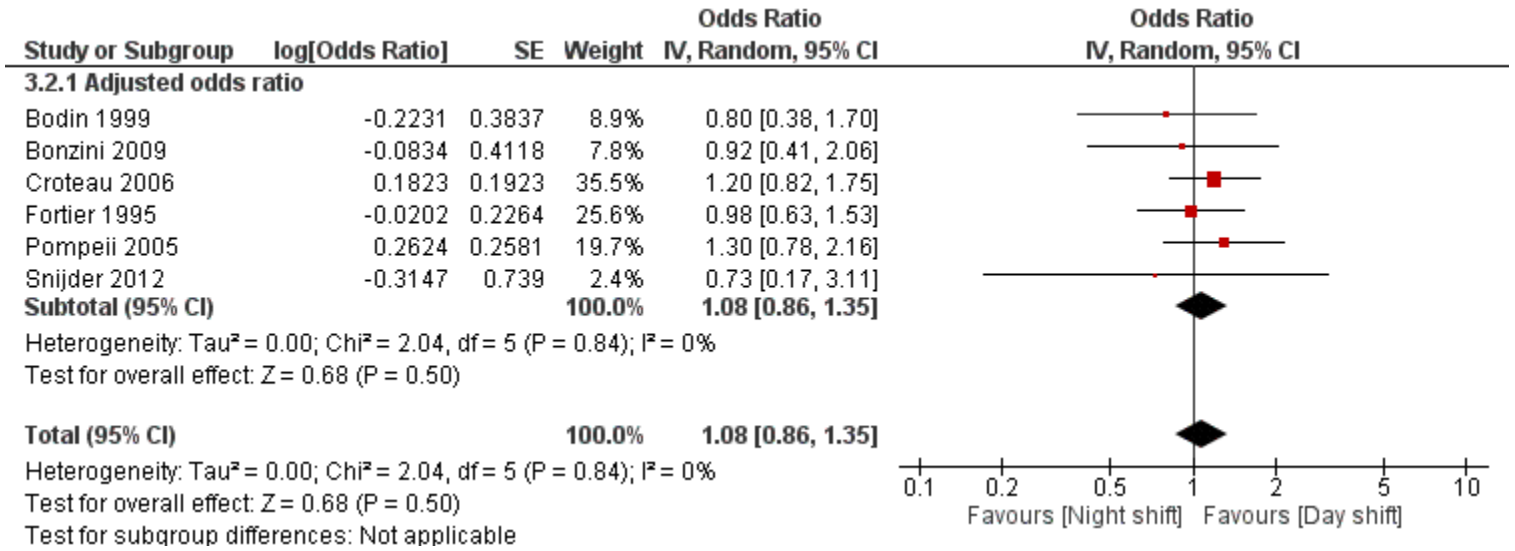

Figure 31: Effects of fixed night shift compared with day shift on odds of having a small-for-gestational-age baby. Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounding and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

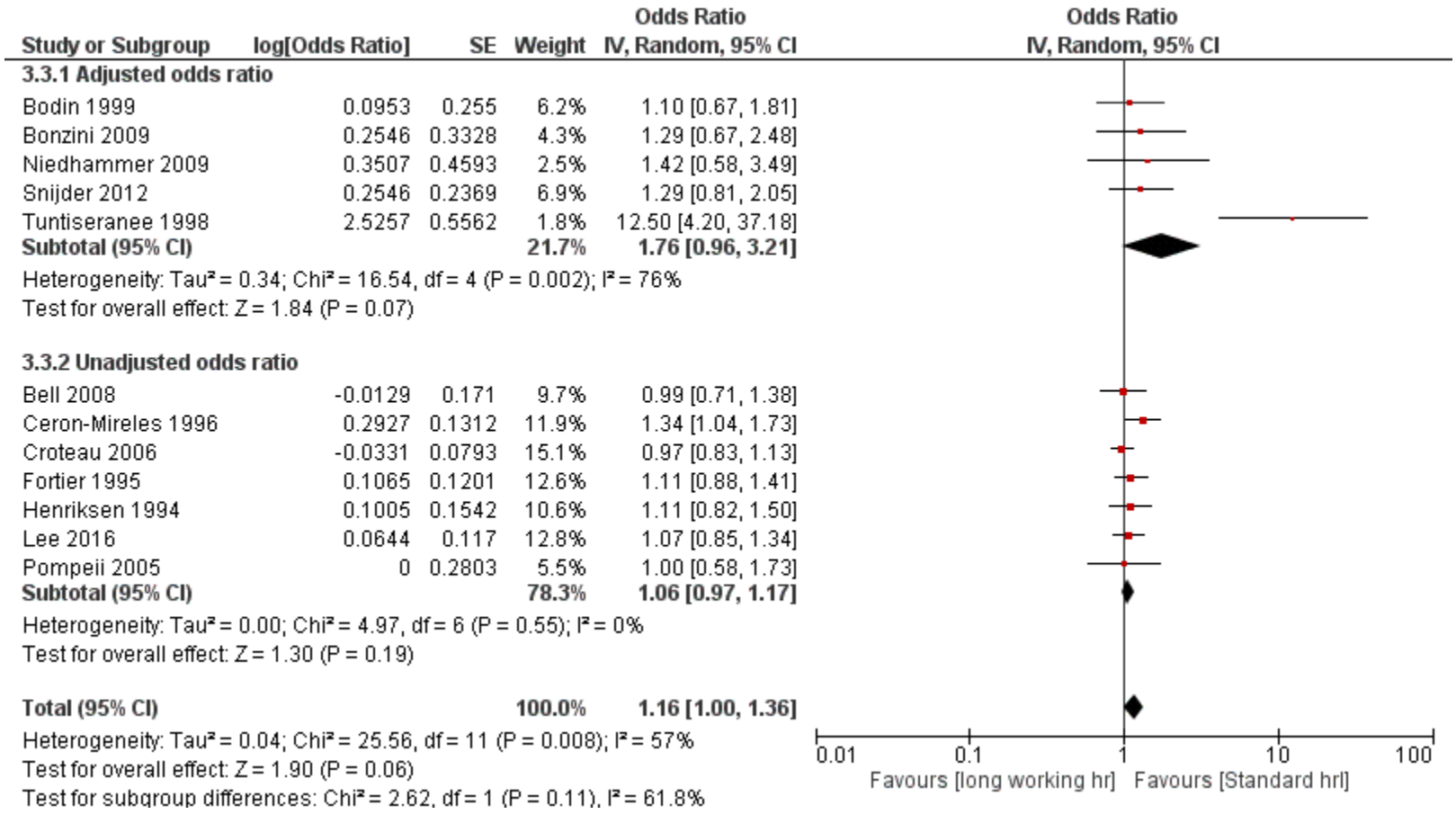

Figure 32: Effects of worked >40 h per week compared with worked ≤40h per week on odds of having a small-for-gestational-age baby. Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounding and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

Table 8. Summary of findings from meta-analyses describing the association of long working hours, shift work and SGA.

			Test for Sensitivity difference	
Subgroup factor	Subgroups	OR (with 95% CI)	χ2	p Value
Long working hours				
Cut-off value for long working hours	35 hours	1.10 (0.85 to 1.43)		
	40 hours	1.27 (1.00 to 1.60)		
	Overall	1.21 (1.01 to 1.46)	0.60	0.44
Study design	Retrospective	1.21 (1.06 to 1.39)		
	Prospective	1.42 (0.96 to 2.10)		
	Overall	1.25 (1.06 to 1.48)	0.53	0.47
Study population	General study population	1.24 (1.03 to 1.49)		
	Specific study population	1.10 (0.67 to 1.81)		
	Overall	1.22 (1.03 to 1.45)	0.19	0.66
Rotating shift work				
Study design	Retrospective	1.30 (1.07 to 1.58)		
	Prospective	1.00 (0.78 to 1.29)		
	Overall	1.18 (1.01 to 1.38)	2.61	0.11
Study population	General study population	1.19 (1.01 to 1.41)		
	Specific occupations	1.14 (0.79 to 1.66)		
	Overall	1.18 (1.01 to 1.38)	0.04	0.85
Fixed night shift				
Study design	Retrospective	1.11 (0.79 to 1.55)		
	Prospective	1.06 (0.78 to 1.43)		
	Overall	1.08 (0.86 to 1.35)	0.03	0.85
Study population	General study population	1.11 (0.88 to 1.41)		
	Specific occupations	0.80 (0.38 to 1.70)		
	Overall	1.08 (0.86 to 1.35)	0.67	0.41

Classification: Public

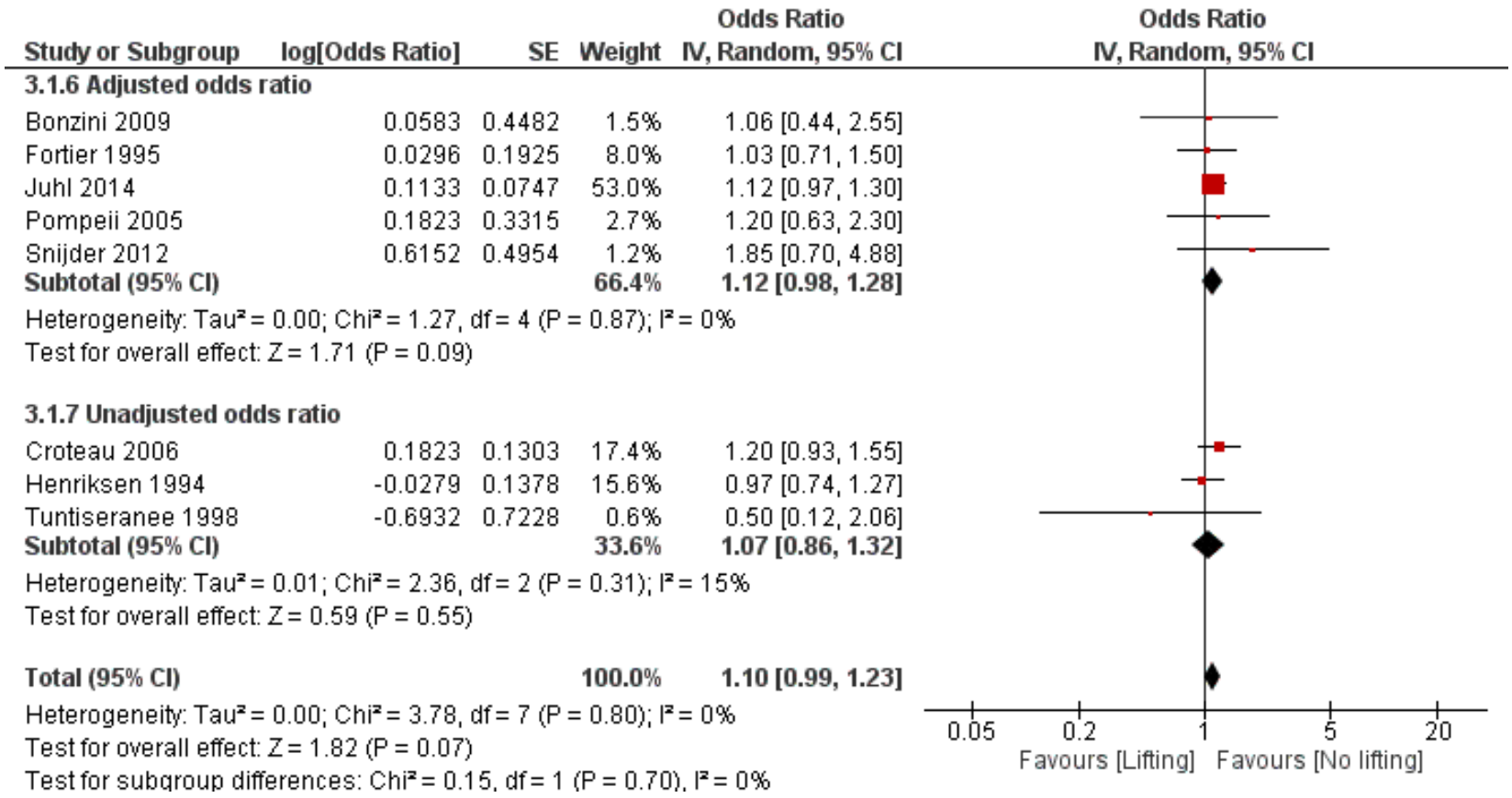

Figure 33: Effects of lifting ≥11 kilograms per time on the odds of small for gestational age (SGA). Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounders and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

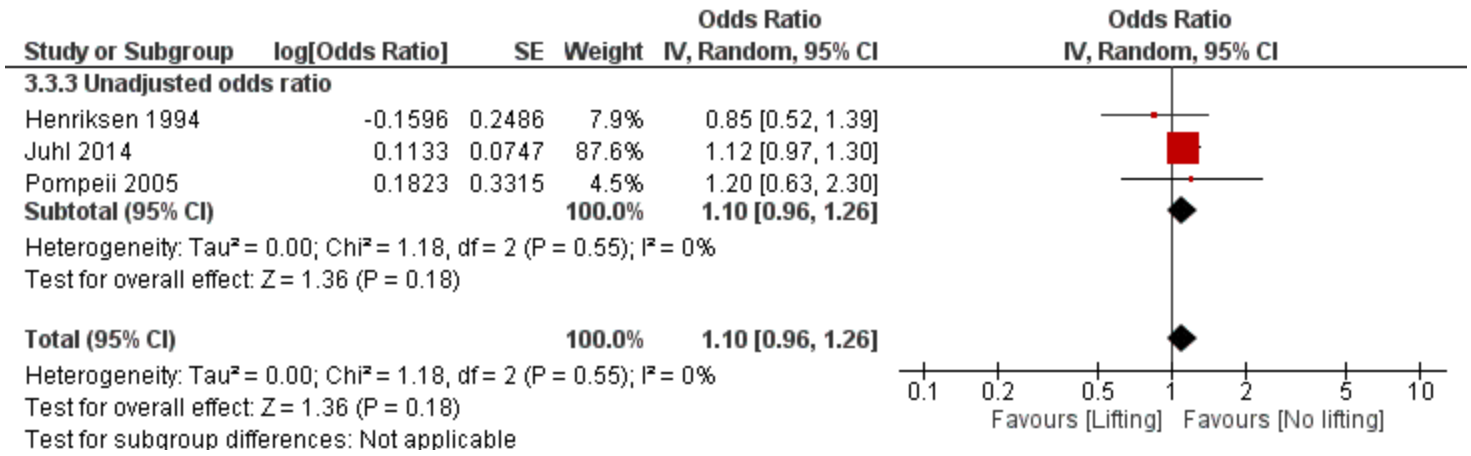

Figure 34: Effects of lifting ≥100 kilograms per day on the odds of small for gestational age (SGA). Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounders and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

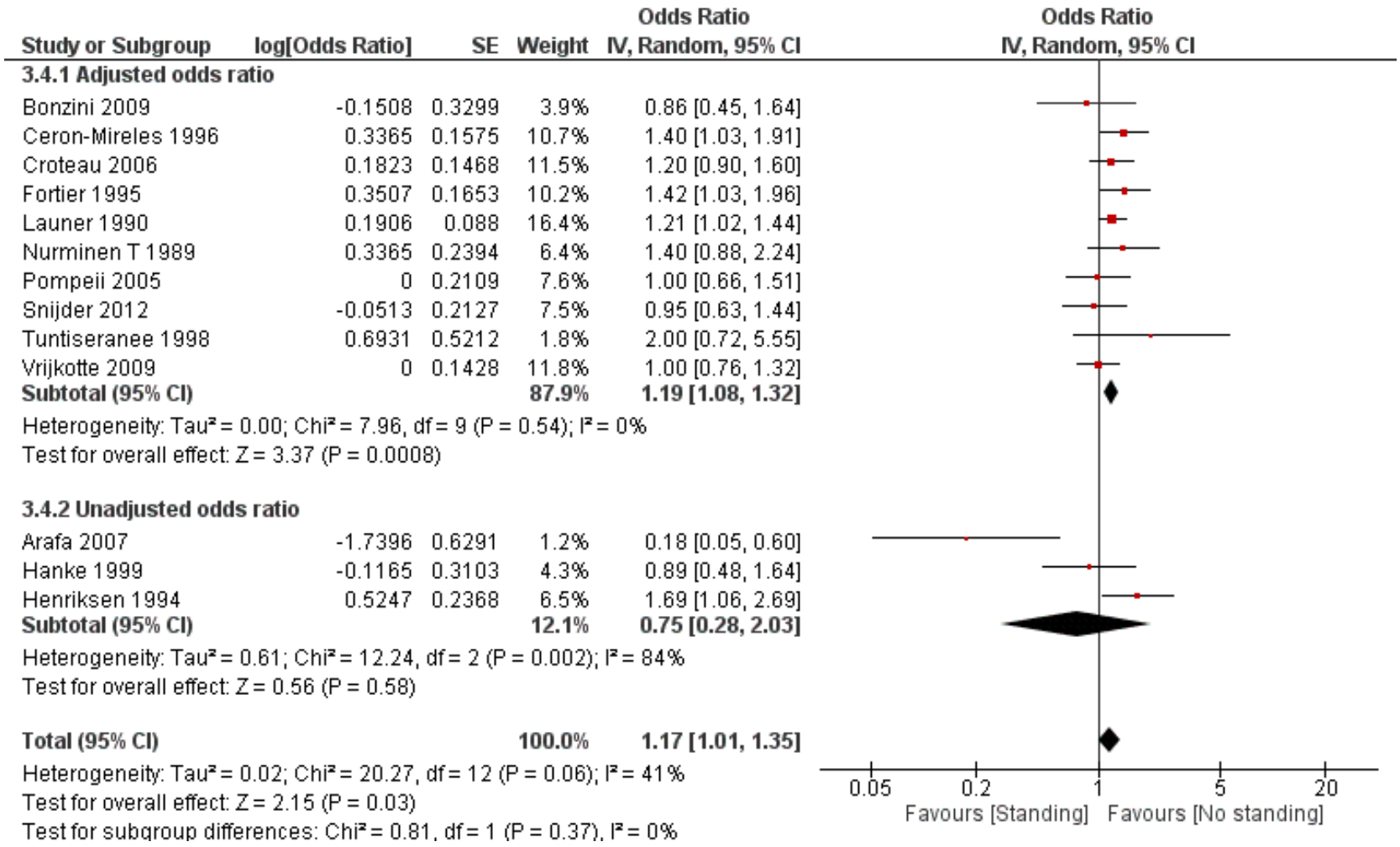

Figure 35: Effects of prolonged standing on the odds of small for gestational age (SGA). Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounders and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

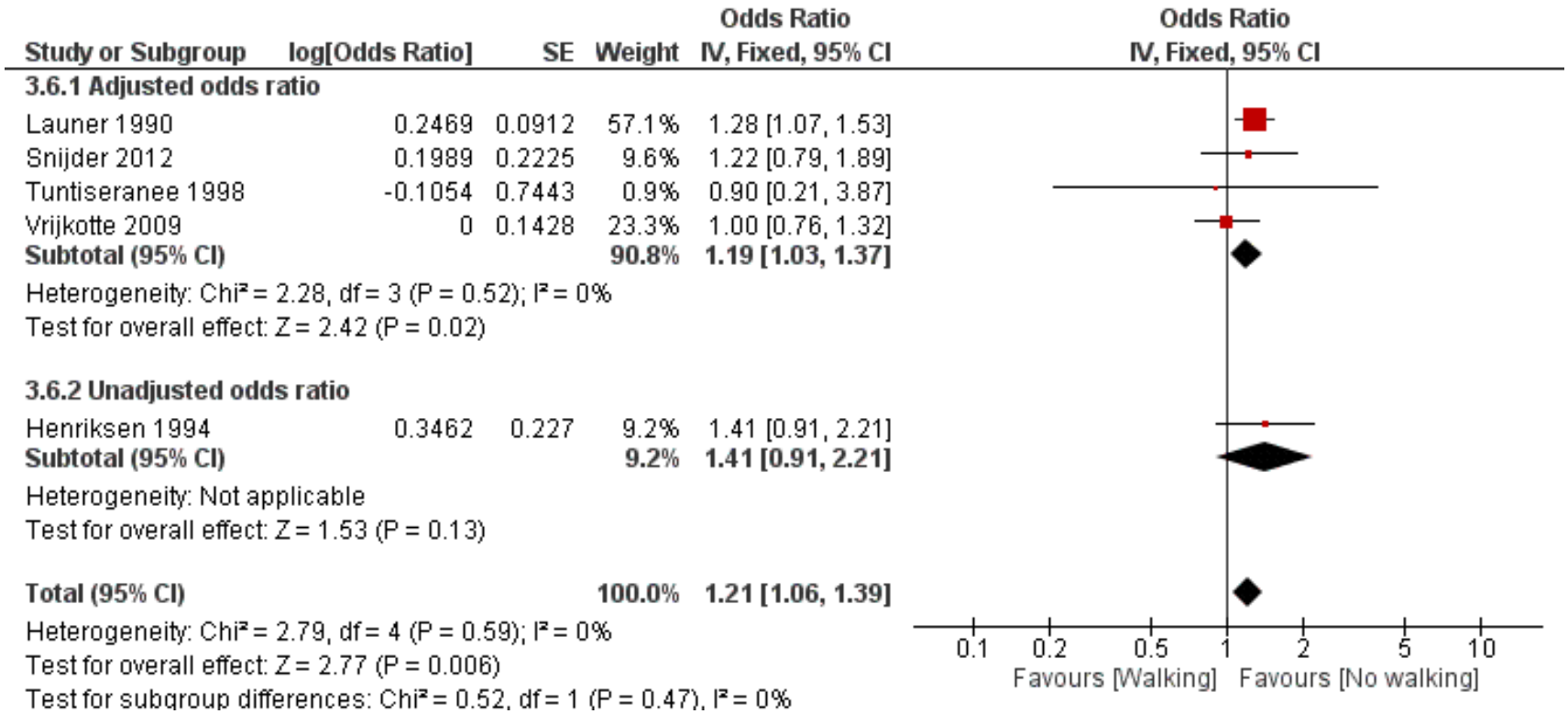

Figure 36: Effects of prolonged walking on the odds of small for gestational age (SGA). Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounders and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

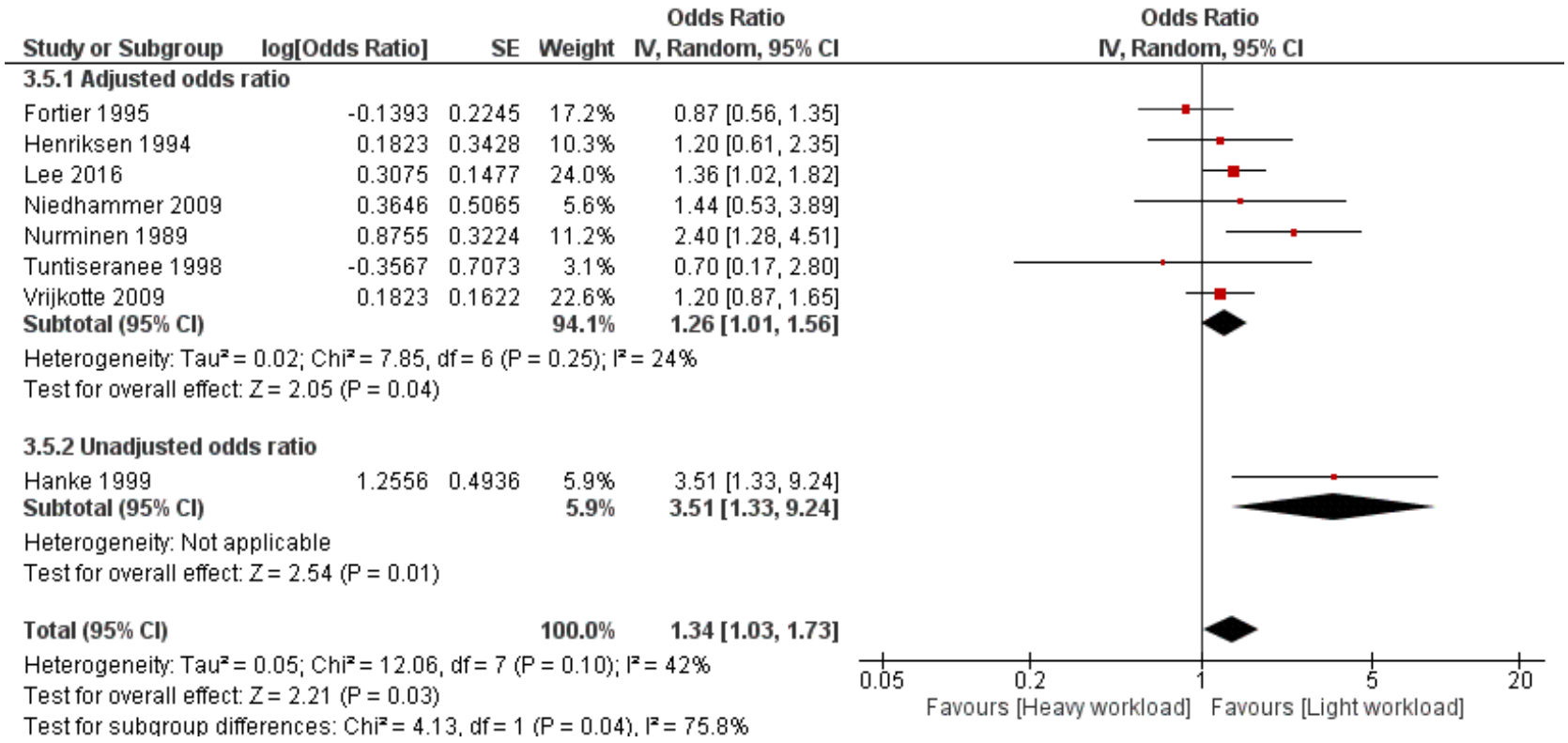

Figure 37: Effects of a heavy physical workload on the odds of small for gestational age (SGA). Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounders and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

Table 9. Summary of findings from meta-analyses describing the association of work activities and small-for-gestational age.

			Test for subgroup difference
Subgroup factor	**Subgroups**	**OR (with 95% CI)**	**χ2**
Lifting≥11kg per time			
Study design	Retrospective	1.20 (0.93 to 1.55)	
	Prospective	1.09 (0.96 to 1.22)	
	Overall	1.10 (0.99 to 1.23)	0.49
Standing			
Study design	Retrospective	0.96 (0.56 to 1.65)	
	Prospective	1.18 (1.05 to 1.35)	
	Overall	1.17 (1.01 to 1.35)	0.52
Total physical workload			
Study design	Retrospective	1.98 (1.14 to 3.46)	
	Prospective	1.09 (0.87 to 1.38)	
	Overall	1.34 (1.03 to 1.73)	3.75

Classification: Public

Low-birth-weight

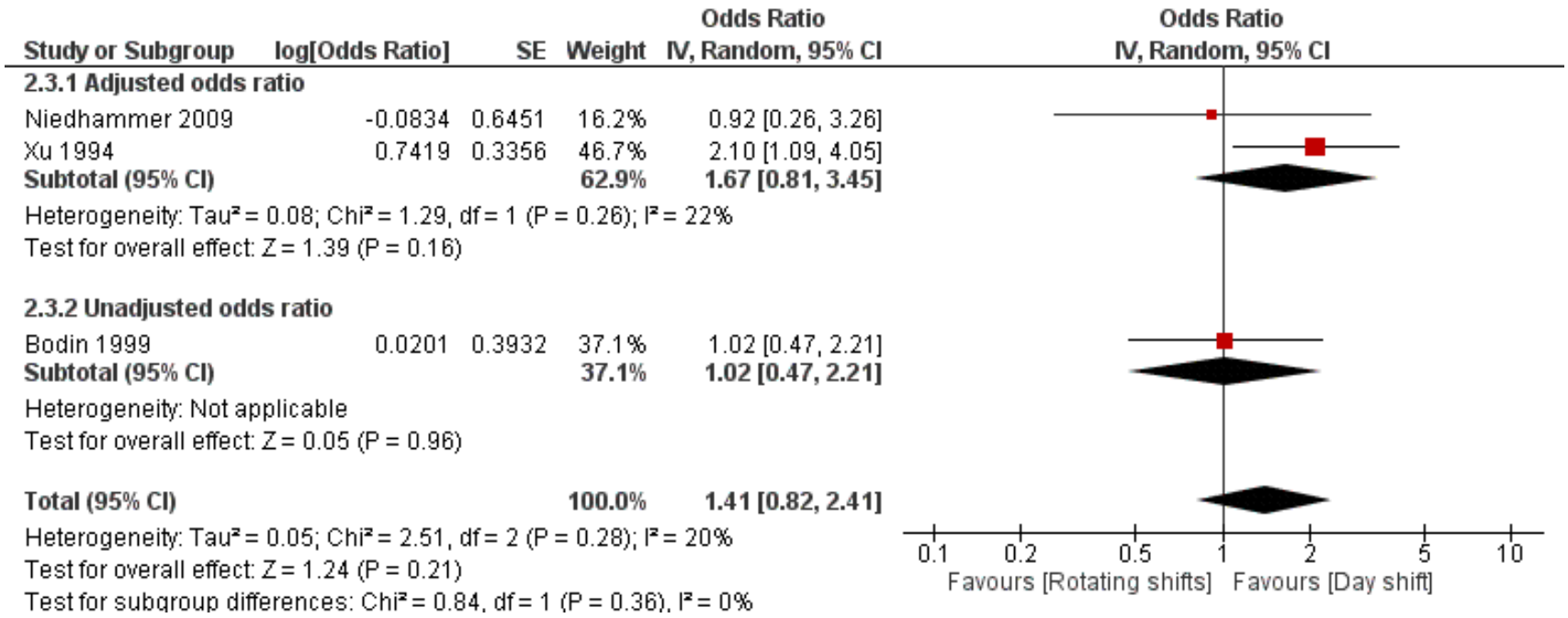

Figure 38: Effects of rotating shift work compared with day shift on odds of having a low-birth-weight baby. Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounding and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

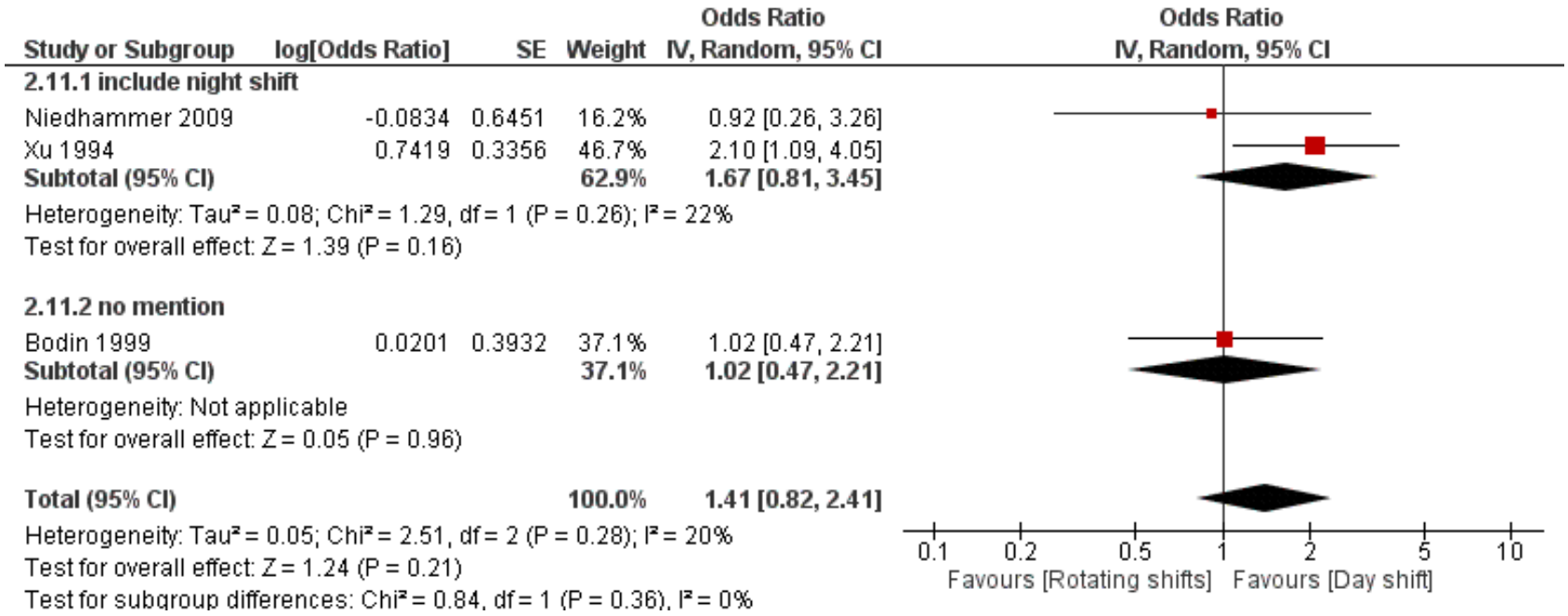

Figure 39: Effects of rotating shift work compared with day shift on odds of having a low-birth-weight baby. Subgroup analyses were conducted with studies included night shift as part of rotating shift work and studies did not provide the information. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

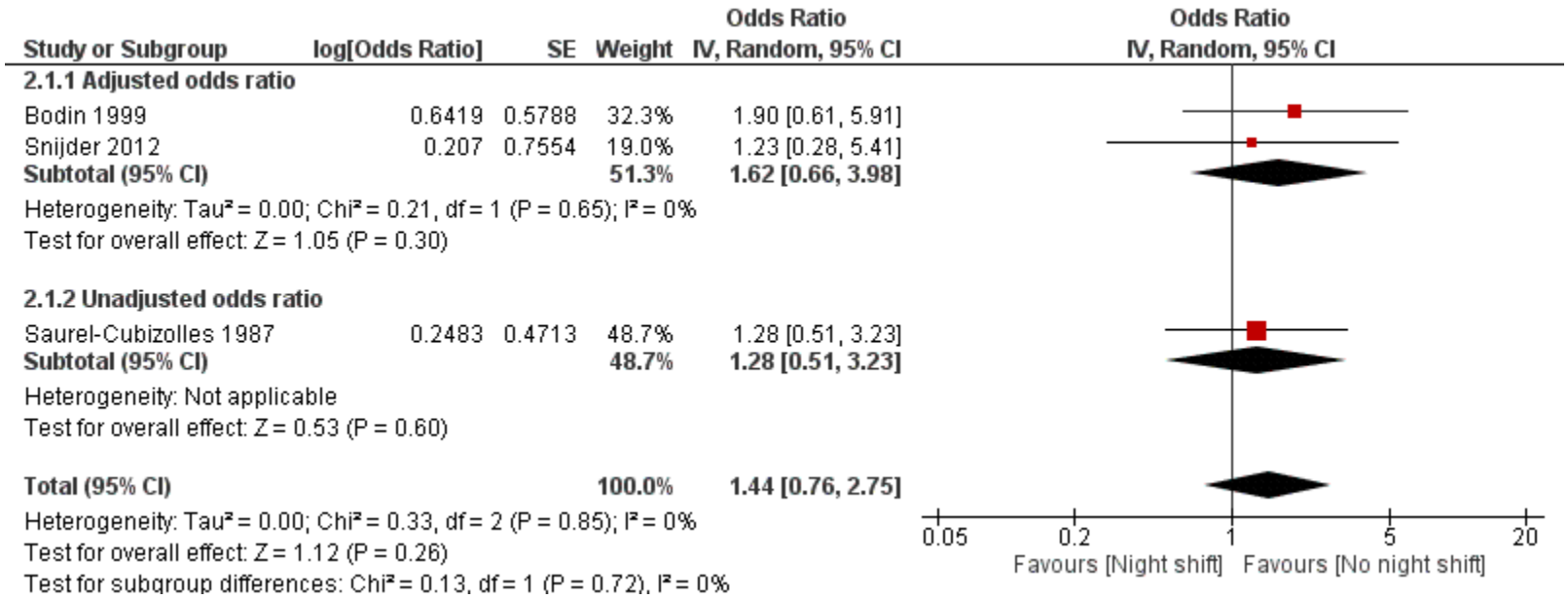

Figure 40: Effects of fixed night shift compared with day shift on odds of having a low-birth-weight baby. Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounding and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

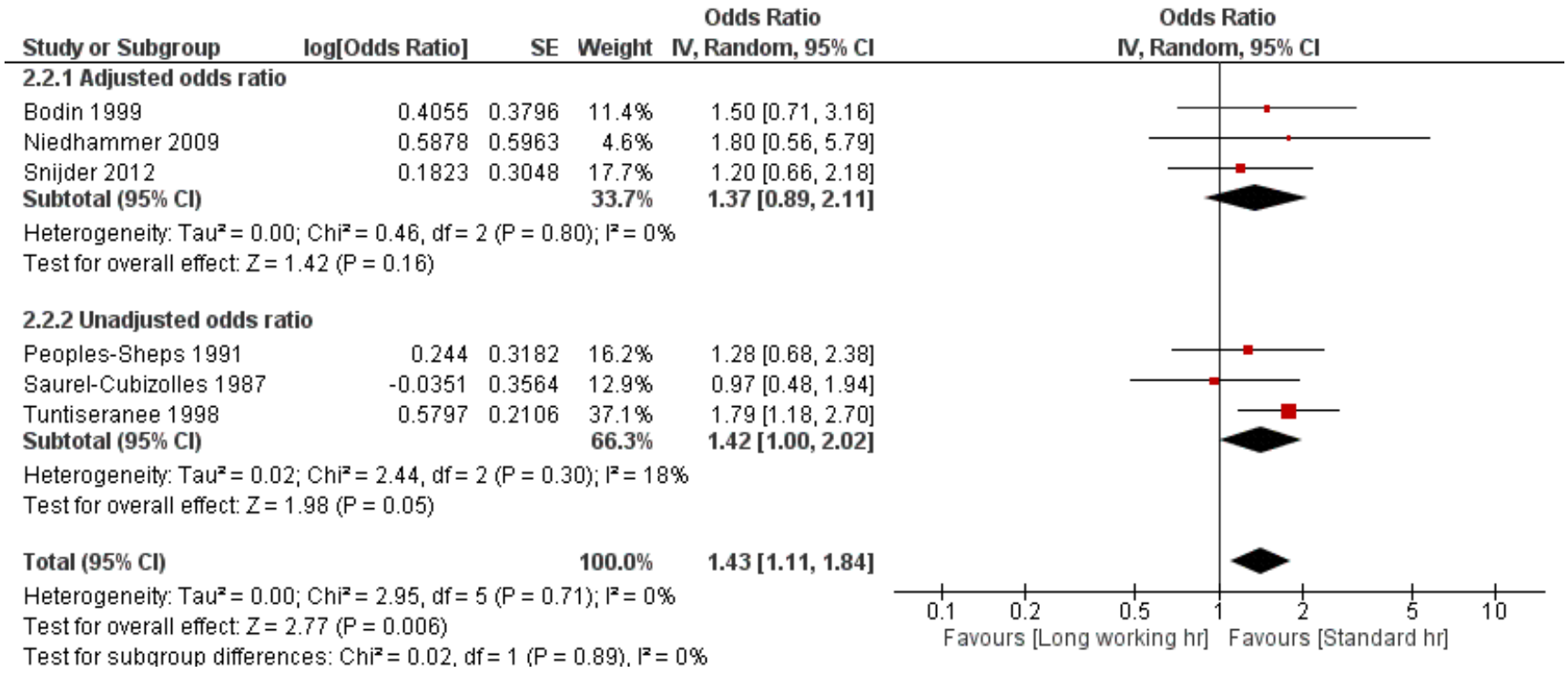

Figure 41: Effects of worked >40 h per week compared with worked ≤40h per week on odds of having a low-birth-weight baby. Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounding and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

Table 10. Summary of findings from meta-analyses describing the association of long working hours, shift work and LBW.

			Test for subgroup difference	
Subgroup factor	Subgroups	OR (with 95% CI)	χ2	p Value
Long working hours				
Cut-off value for long working hours	35 hours	1.50 (0.71 to 3.16)		
	40 hours	1.29 (0.86 to 1.94)		
	Overall	1.34 (0.94 to 1.91)	0.12	0.73
Study design	Retrospective	1.27 (0.87 to 1.85)		
	Prospective	1.56 (1.07 to 2.25)		
	Overall	1.43 (1.11 to 1.84)	0.57	0.45
Study population	General population	1.42 (1.09 to 1.85)		
	Specific occupations	1.50 (0.71 to 3.16)		
	Overall	1.43 (1.11 to 1.84)	0.02	0.89
Rotating shift work				
Study design	Retrospective	1.51 (0.74 to 3.05)		
	Prospective	0.92 (0.26 to 3.26)		
	Overall	1.41 (0.82 to 2.41)	0.45	0.50
Study population	General population	0.92 (0.26 to 3.26)		
	Specific occupations	1.51 (0.74 to 3.05)		
	Overall	1.41 (0.82 to 2.41)	0.45	0.50
Fixed night shift				
Study design	Retrospective	1.50 (0.73 to 3.07)		
	Prospective	1.23 (0.28 to 5.41)		
	Overall	1.44 (0.76 to 2.75)	0.06	0.81
Study population	General population	1.27 (0.58 to 2.77)		
	Specific occupations	1.90 (0.61 to 5.91)		
	Overall	1.44 (0.76 to 2.75)	0.33	0.56

Classification: Public

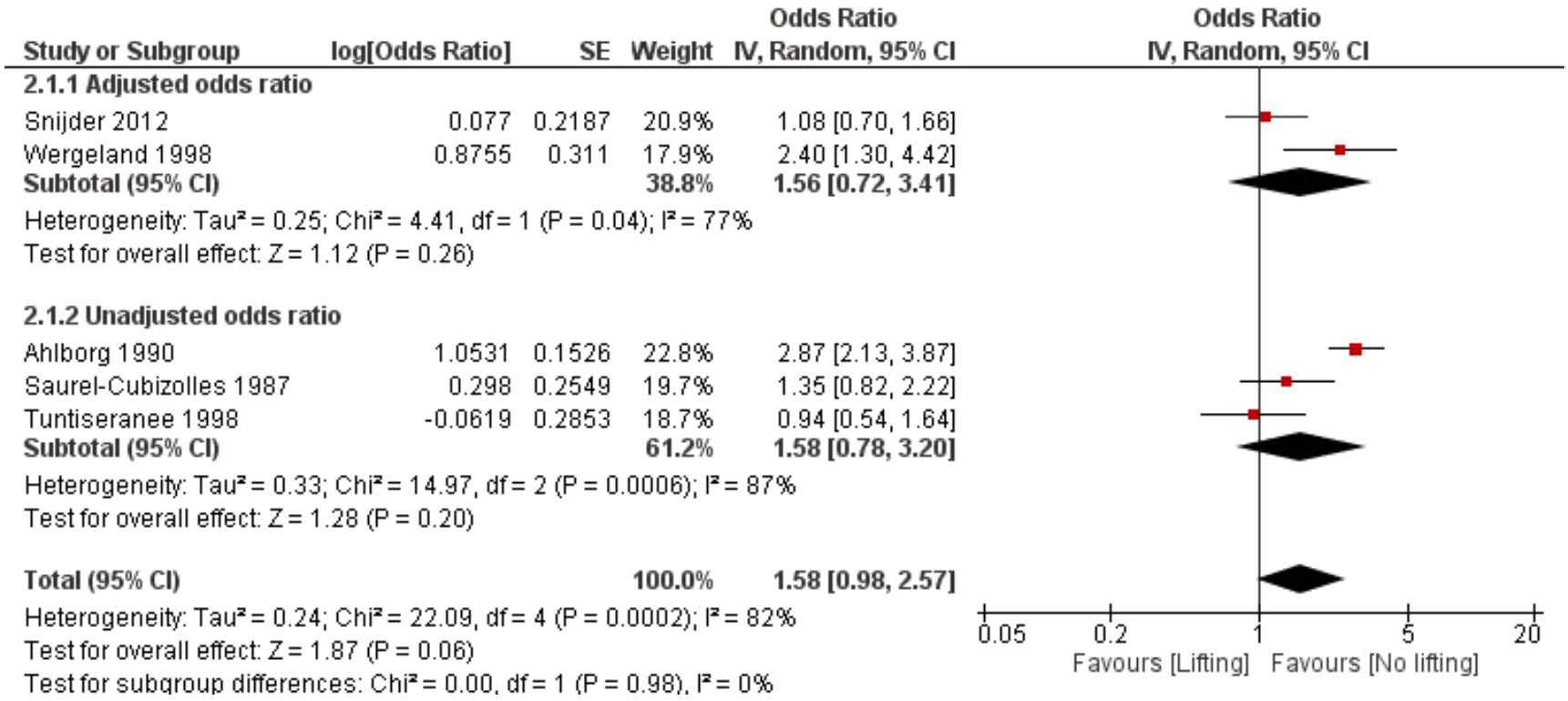

Figure 42: Effects of lifting ≥11 kilograms per time on the odds of low birth weight (LBW). Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounders and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

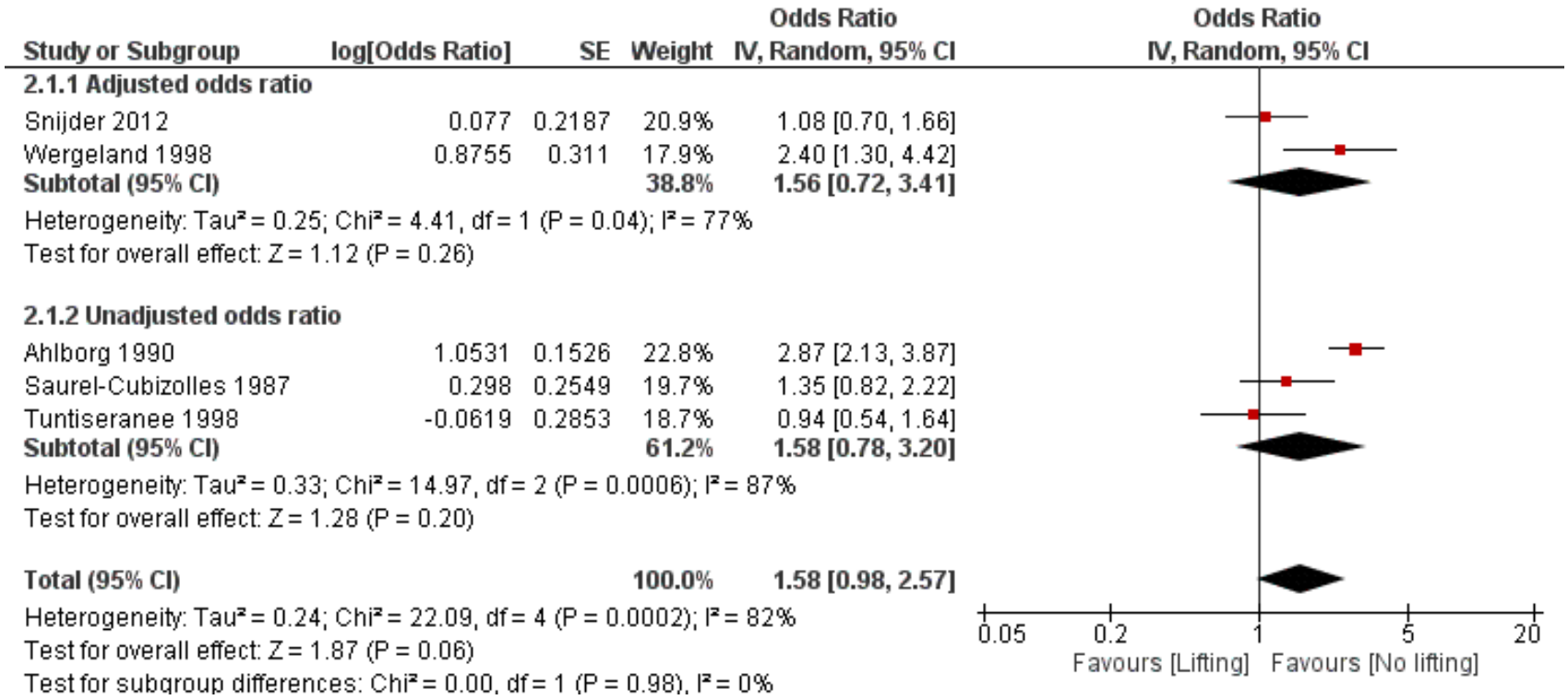

Figure 43: Effects of lifting ≥100 kilograms per day on the odds of low birth weight (LBW). Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounders and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

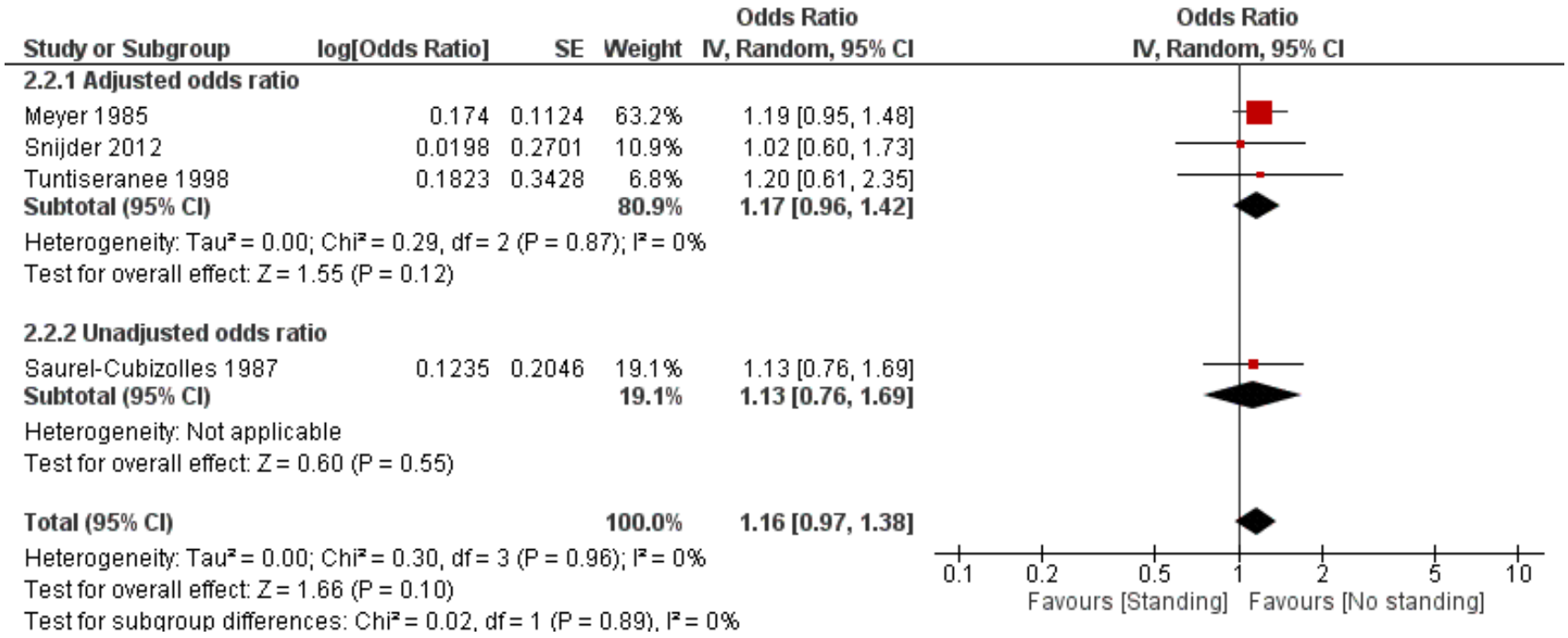

Figure 44: Effects of prolonged standing on the odds of low birth weight (LBW). Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounders and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

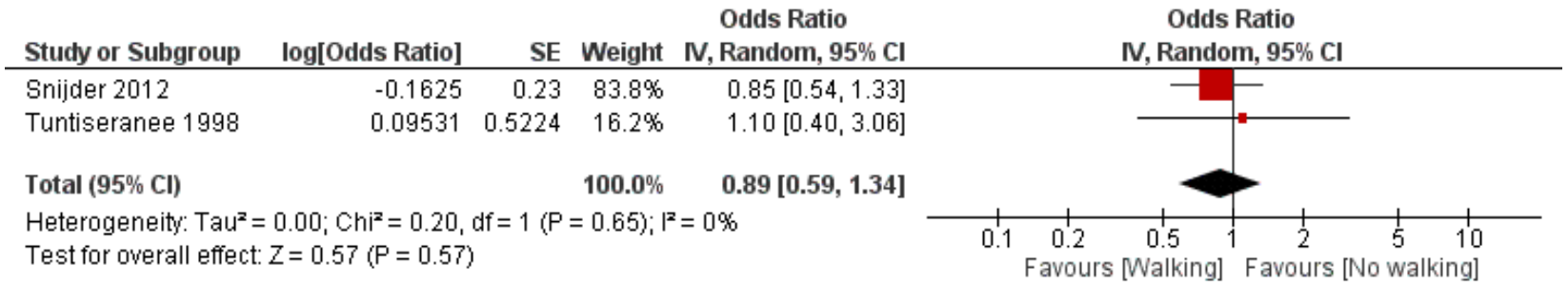

Figure 45: Effects of prolonged walking on the odds of low birth weight (LBW). Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounders and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

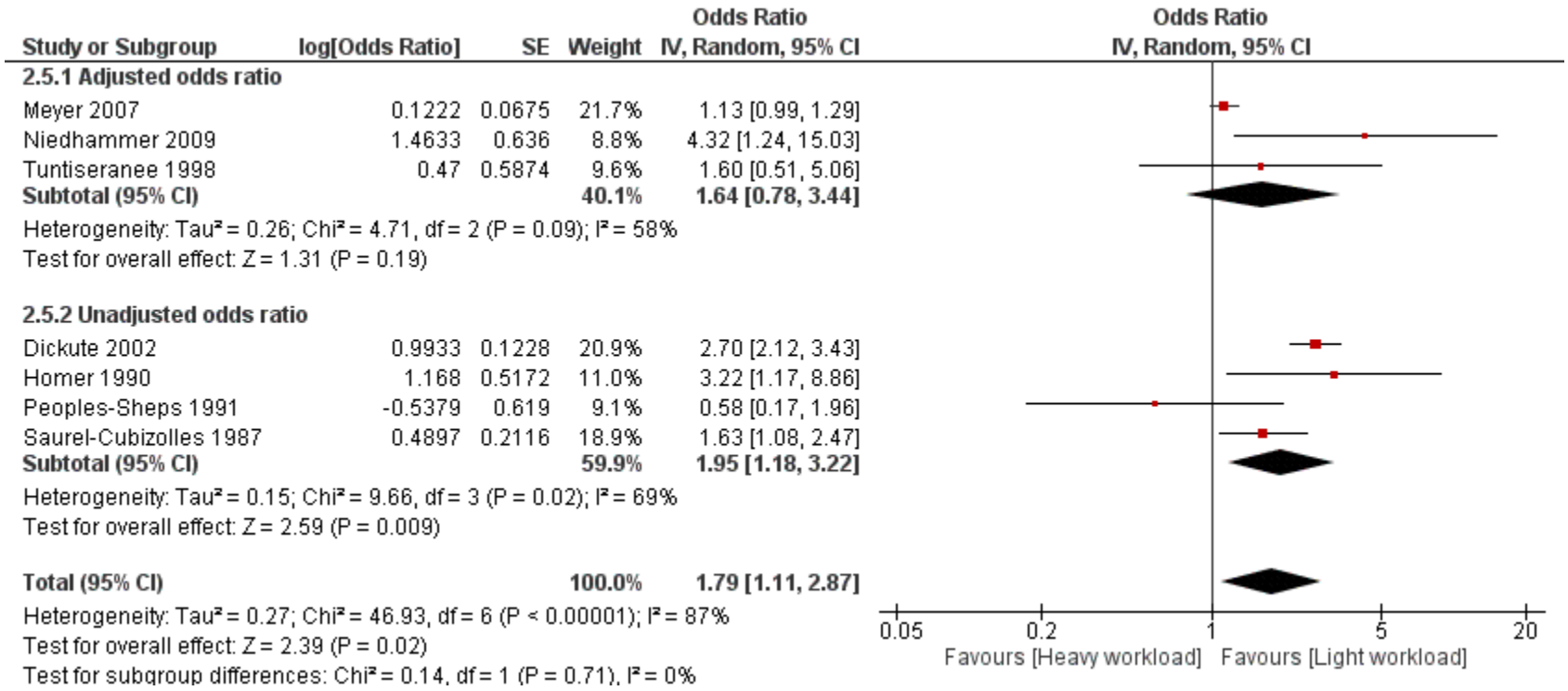

Figure 46: Effects of heavy physical workload on the odds of low birth weight (LBW). Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounders and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public

Table 11. Summary of findings from meta-analyses describing the association of work activities and low birth weight.

Subgroup factor	Subgroups	OR (with 95% CI)	Test for subgroup difference χ2
Lifting≥11kg per time			
Study design	Retrospective	1.75 (1.00 to 3.07)	
	Prospective	1.46 (0.68 to 3.13)	
	Overall	1.58 (0.98 to 2.57)	0.14
Standing			
Study design	Retrospective	1.18 (0.97 to 1.42)	
	Prospective	1.09 (0.92 to 1.65)	
	Overall	1.17 (1.02 to 1.34)	0.15
Total physical workload			
Study design	Retrospective	1.65 (0.97 to 2.80)	
	Prospective	2.55 (0.97 to 6.74)	
	Overall	1.79 (1.11 to 2.87)	0.60

Classification: Public

Intra-uterine growth restriction

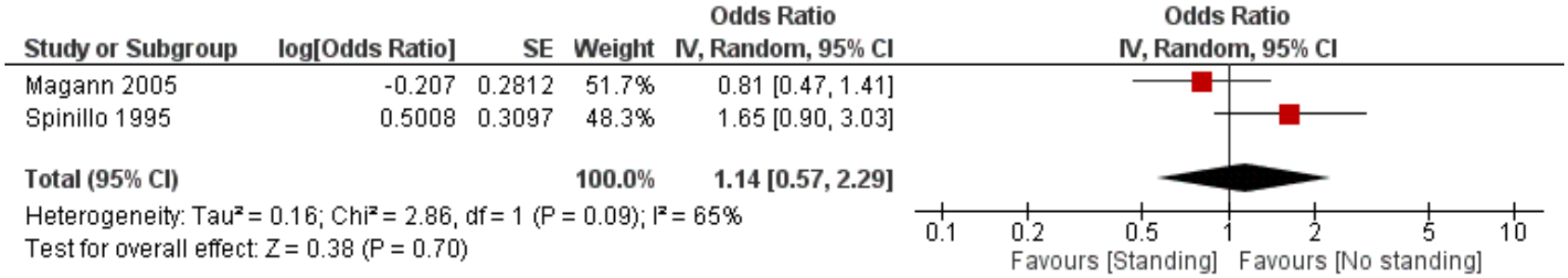

Figure 47: Effects of prolonged standing on the odds of intra-uterine growth restriction (IUGR). Sensitivity analyses were conducted with studies reported adjusted odds ratio for confounders and unadjusted odds ratio. CI, confidence interval; df, degrees of freedom; IV, inverse-variance method.

Classification: Public