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# Miscarriage and occupational activity: a systematic review and meta-analysis regarding shift work, working hours, lifting, standing, and physical workload [1]

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[1] Supplementary tables A–E

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**Supplementary table A.** Shift work and risk of miscarriage. [gw=gestational week; nd=not defined; RR=relative risk].

| Study design and reference | Number of women/ pregnancies | Exposure | | RR | 95% CI | Potential for | | Incomplete reporting | Meta-analysis [b] |
|---|---|---|---|---|---|---|---|---|---|
| | | Contrast | Timing | | | Bias [a] | Confounding | | |
| **Prospective cohort** | | | | | | | | | |
| Fenster et al, 1997 (17) | 5144/5144 | Evening/night vs day | 1 trim | 1.03 | 0.75–1.41 | +/- | No | No | Yes (A)[c] |
| Zhu et al, 2004 (35) | 33 694 / 33 694 | 3-shift vs day<br>Fixed night vs day | 1 trim | 1.10<br>1.81 | 0.78–1.57<br>0.88–3.72 | +/-<br>+/- | No<br>No | No<br>No | Yes (A)<br>Yes (B)[c] |
| **Retrospective cohort** | | | | | | | | | |
| Axelsson et al, 1984 (10) | 745/1160 | Shift work (nd) vs no shift work | 1 trim | 3.19 | 1.36–7.47 | + | No | No | No |
| Axelsson et al, 1989 (12) | 463/970 | Three shifts vs day<br>Fixed night vs day | 1 trim | 1.50<br>0.93 | 0.55–4.09<br>0.49–1.78 | +<br>+ | No<br>No | No<br>No | Yes (A)<br>Yes (B)[c] |
| Whelan et al, 2007 (33) | 7688/7688 | 3 shifts vs day<br>Fixed night vs day | 1 trim | 1.2<br>1.6 | 0.9–1.5<br>1.3–1.9 | +<br>+ | No<br>No | No<br>No | Yes (A)<br>Yes (B)[c] |
| **Case–control** | | | | | | | | | |
| Hemminki et al, 1985 (19) | 788/788 | 3-shift vs day or rotating 2-shift | 1 trim | 1.5 | 0.9–2.5 | - | No | No | Yes (A)[c] |
| Infante-Rivard et al, 1993 (20) | 1324/1324 | Fixed evening vs day<br>Fixed night vs day | Pregnancy | 4.17<br>2.68 | 2.19–7.92<br>0.53–13.43 | +/-<br>+/- | No<br>No | No<br>No | No<br>Yes (B)[c] |
| Eskenazi et al, 1994 (16) | 1344/1344 | Evening/night vs day | First 20 weeks | 0.8 | 0.5–1.2 | +/- | No | No | Yes (A)[c] |
| El Metwalli et al, 2001 (14) | 1762/1,762 | Before 08.00 and/or after 18.00 vs others | (nd) | 1.57 | 1.25–1.97 | + | Yes | Yes | No |
| **Cross-sectional** | | | | | | | | | |
| Axelsson et al, 1988 (11) | 1110/1714 | Shift work (nd) vs no shift work | 1 trim | 2.07 | 0.98–4.34 | + | No | No | No |
| McDonald et al, 1988 (25) | ?/22 613 | Changing shifts vs all women working >30 hours/week | Pregnancy | 1.45 | 1.0–1.9 | +/- | No | Yes | No |
| Swan et al, 1995 (36) | 444/444 | Night (nd) vs day | 1 trim | 1.7 | 0.73–3.7 | ++ | No | No | No |
| Axelsson et al, 1996 (13) | 1587/2667 | Three shift vs day<br>Fixed night vs day | 1 trim | 1.23<br>1.30 | 0.78–1.94<br>0.83–2.01 | +<br>+ | No<br>No | No<br>No | Yes (A)[c]<br>Yes (B)[c] |

[a] ++ inflationary bias likely; + inflationary bias possible; +/- bias unlikely; - bias towards the null possible or likely.
[b] Risk estimates for meta-analyses: A=shift work, and B=fixed night work.
[c] Included in sensitivity meta-analysis as study with lower potential for bias.

**Supplementary table B.** Working hours and risk of miscarriage. [nd=not defined; gw=gestational week; RR=relative risk; trim=trimester]

| Study design and reference | Number of women/ pregnancies | Exposure | | RR | 95% CI | Potential for | | Incomplete reporting | Meta-analysis [b] |
|---|---|---|---|---|---|---|---|---|---|
| | | Contrast | Timing | | | Bias [a] | Confounding | | |
| **Prospective cohort** | | | | | | | | | |
| Fenster et al, 1997 (17) | 5144/5144 | Hours worked/week | 1 trim | | | | | | |
| | | 31–35 vs ≤30 | | 0.86 | 0.59–1.26 | +/- | No | No | No |
| | | 36–40 vs 30 | | 0.87 | 0.67–1.13 | +/- | No | No | No |
| | | >40 vs ≤30 | | 0.82 | 0.57–1.17 | +/- | No | No | Yes [c] |
| **Retrospective cohort** | | | | | | | | | |
| Whelan et al, 2007 (33) | 7688/7688 | Hours worked/week | 1 trim | | | | | | |
| | | ≥41 vs 21–40 | | 1.5 | 1.3–1.7 | + | No | No | Yes [c] |
| **Case–control** | | | | | | | | | |
| Eskenazi et al, 1994 (16) | 1344/1344 | Hours worked/week | First 20 | | | | | | |
| | | 30–35 vs <30 | weeks | 1.3 | 0.8–2.2 | +/- | No | No | No |
| | | 36–40 vs <30 | | 1.5 | 1.0–2.1 | +/- | No | No | No |
| | | >40 vs <30 | | 1.2 | 0.8–1.9 | +/- | No | No | Yes [c] |
| **Cross-sectional** | | | | | | | | | |
| McDonald et al, 1988 (25) | ?/22 613 | Working >46 hours/ week vs all women | Pregnancy | 1.33 | 0.9–1.8 | +/- | No | No | Yes |
| Klebanoff et al, 1990 (21) | 2787/2787 | In average 74 hours/ week vs 38 hours/week | (nd) | 1.17 | 0.94–1.45 | + | No | Yes | Yes |
| John et al, 1994 (37) | 376/376 | Hours worked/week | 1 trim | | | | | | |
| | | ≥41 vs 35-40 | | 1.8 | 0.9–3.8 | ++ | No | No | Yes |
| Swan et al, 1995 (36) | 444/444 | Hours worked/day | 1 trim | | | | | | |
| | | ≥9 vs <9 | | 1.2 | 0.61–2.2 | ++ | No | No | Yes |
| Schenker et al, 1997 (38) | 345/711 | Hours worked/week | 1 trim | | | | | | |
| | | 35–45 vs <35 | | 1.5 | 0.8–2.9 | ++ | No | No | No |
| | | >45 vs <35 | | 3.1 | 1.4–6.9 | | No | No | Yes |
| Shiranga et al, 2008 (29) | 442/940 | Hours worked/week | Few months | | | | | | |
| | | >45 vs ≤45 | before pregnancy | 1.09 | 0.69–1.71 | ++ | No | No | Yes |
| Lee et al, 2012 (23) | 1000/? | Hours worked/week | Pregnancy | | | | | | |
| | | 44–47 vs <44 | | 2.05 | 1.15–3.63 | ++ | No | No | No |
| | | 48–51 vs <44 | | 1.81 | 1.02–3.22 | ++ | No | No | No |
| | | ≥52 vs <44 | | 2.08 | 1.16–3.74 | ++ | No | No | Yes |

[a] ++ inflationary bias likely; + inflationary bias possible; +/- bias unlikely; - bias towards the null possible or likely.
[b] Women working ≥40–52 hrs/wk.
[c] Included in sensitivity meta-analysis as study with lower potential for bias.

**Supplementary table C.** Occupational lifting and risk of miscarriage. [nd=not defined; gw=gestational week; RR=relative risk; trim=trimester]

| Study design and reference | Number of women/ pregnancies | Exposure | | RR | 95% CI | Potential for | | Incomplete reporting | Meta-analysis [b] |
|---|---|---|---|---|---|---|---|---|---|
| | | Contrast | Timing | | | Bias [a] | Confounding | | |
| **Prospective cohort** | | | | | | | | | |
| Ahlborg et al, 1990 (9) | 3906/3906 | Any weight | 1 trim | | | | | | |
| | | <10 (times/week) vs 0 | | 1.03 | 0.70–1.53 | +/- | No | No | No |
| | | <12 kg ≥10 vs 0 | | 0.97 | 0.53–1.78 | +/- | No | No | No |
| | | ≥12 kg 10–50 vs 0 | | 1.11 | 0.77–1.58 | +/- | No | No | No |
| | | ≥12 kg >50 vs 0 | | 1.06 | 0.62–1.81 | +/- | No | No | Yes [c] |
| Florack et al, 1993 (18) | 170/170 | Lifting ≥1hour/day vs <1 hour/day | 1 trim | 1.07 | 0.34–3.35 | +/- | No | No | Yes [c] |
| Fenster et al, 1997 (17) | 5144/5144 | Lifting >7 kg (times/day) | 1 trim | | | | | | |
| | | 1–9 vs 0 | | 1.14 | 0.77–1.70 | +/- | No | No | No |
| | | 10–15 vs 0 | | 0.99 | 0.47–2.10 | +/- | No | No | No |
| | | >15 or constantly vs 0 | | 0.40 | 0.16–1.00 | +/- | No | No | Yes [c] |
| **Retrospective cohort** | | | | | | | | | |
| Axelson et al, 1984 (10) | 745/1160 | Heavy lifting (nd) vs other | 1 trim | 1.36 | 0.91–2.02 | ++ | No | No | No |
| Axelson et al, 1989 (12) | 463/970 | Heavy lifting (nd) vs no heavy lifting | 1 trim | 0.99 | 0.75–1.31 | ++ | No | No | No |
| **Case–control** | | | | | | | | | |
| Taskinen et al, 1986 (30) | 160/160 | Lifting >10kg continuously vs no lifting | 1 trim | 3.6 | 1.0–13.7 | + | No | No | Yes [c] |
| Kyyrönen et al, 1989 (22) | 419/419 | Lifting >20kg >6 times/day or equivalent | 1 trim | 1.9 | 1.0–2.8 | ++ | No | No | Yes |
| Taskinen et al, 1989 (31) | 371/371 | Lifting >25kg/day vs <25 kg/day | 1 trim | 1.7 | 1.0–2.8 | ++ | No | No | No |
| Taskinen et al, 1990 (32) | 687/687 | Lifting >10 kg or patient-transfer (times/week) | 1 trim | | | | | | |
| | | 5–49 vs <5 | | 1.2 | 0.8–1.7 | ++ | No | No | No |
| | | ≥50 vs <5 | | 3.5 | 1.1–9.0 | ++ | No | No | Yes |
| Eskenazi et al, 1994 (16) | 1344/1344 | Lifting >7.5 kg (times/day) | First 20 weeks | | | | | | |
| | | 1–9 vs 0 | | 1.3 | 0.9–1.7 | + | No | No | No |
| | | 10–15 vs 0 | | 0.6 | 0.3–1.3 | + | No | No | No |
| | | >15 vs 0 | | 1.1 | 0.6–2.0 | + | No | No | Yes [c] |
| Elliott et al, 1999 (15) | 116/116 | Lifting heavy objects Yes/no | 1 trim | 0.69 | 0.31–1.53 | ++ | No | Yes | No |
| El Metwalli et al, 2001 (14) | 1762/1762 | Lifting (nd) yes/no | (nd) | 2.04 | 1.66–2.49 | ++ | Yes | Yes | No |
| Maconochie et al, 2007 (24) | ?/4142 | Lifting heavy objects or people (nd) yes/no | 1 trim | 1.08 | 0.85–1.38 | ++ | No | No | No |
| **Cross-sectional** | | | | | | | | | |
| Axelsson et al, 1988 (11) | 1110/1459 | Heavy lifting (nd) vs no heavy lifting | 1 trim | 1.15 | 0.78–1.72 | ++ | No | No | No |
| McDonald et al, 1988 (25) | ?/22,613 | Lifting heavy weights >15 times/day vs other pregnant women | Pregnancy | 2.0 | 1.5–2.5 | + | No | Yes | Yes |
| Swan et al, 1995 (36) | 444/444 | Lifting >7 kg ≥1 time/day vs none | 1 trim | 1.5 | 0.84–2.8 | ++ | No | No | Yes |
| Axelson et al, 1996 (13) | 1587/2667 | Lifting >10kg (times/week) | 1 trim | | | | | | |
| | | <10 vs seldom | | 0.93 | 0.71–1.22 | ++ | No | No | No |
| | | 10–50 vs seldom | | 0.84 | 0.62–1.13 | ++ | No | No | No |
| | | >50 vs seldom | | 0.74 | 0.46–1.19 | ++ | No | No | Yes |
| Lee et al, 2012 (23) | 1000/? | Lifting >5kg vs ≤5 kg | Pregnancy | 3.39 | 2.06–5.6 | ++ | No | No | No |

[a] ++ inflationary bias likely; + inflationary bias possible; +/- bias unlikely; - bias towards the null possible or likely.
[b] Lifting ≥100 kg/day.
[c] Included in sensitivity meta-analysis as study with lower potential for bias.

**Supplementary table D.** Standing at work and risk of miscarriage. [nd=not defined; gw=gestational week; RR=relative risk; trim=trimester]

| Study design and reference | Number of women/ pregnancies | Exposure | | RR | 95% CI | Potential for | | Incomplete reporting | Meta-analysis [b] |
|---|---|---|---|---|---|---|---|---|---|
| | | Contrast | Timing | | | Bias [a] | Confounding | | |
| **Prospective cohort** | | | | | | | | | |
| Fenster et al, 1997 (17) | 5144/5144 | Standing (hours/day) | 1 trim | | | | | | |
| | | 3–7 vs <3 | | 0.90 | 0.71–1.13 | +/- | No | No | No |
| | | >7 vs <3 | | 1.03 | 0.73–1.46 | +/- | No | No | Yes [c] |
| **Case–control** | | | | | | | | | |
| Taskinen et al, 1986 (30) | 162/162 | Standing (nd) vs sedentary work | 1 trim | 1.4 | 0.5–4.4 | + | No | No | No |
| Eskenazi et al, 1994 (16) | 1344/1344 | Standing (hours/day) | First 20 | | | | | | |
| | | 3–7 vs <3 | weeks | 1.1 | 0.8–1.4 | + | No | No | No |
| | | ≥8 vs < 3 | | 1.6 | 1.1–2.3 | + | No | No | Yes [c] |
| Savitz et al, 1996 (28) | 421/421 | Standing (nd) vs non-hazardous jobs | 2–6 weeks after conception | 0.8 | 0.5–1.5 | + | No | No | No |
| Maconochie et al, 2007 (24) | ?/4192 | Standing > 6 hours day (yes vs no) | 1 trim | 0.89 | 0.69–1.14 | ++ | No | No | Yes |
| **Cross-sectional** | | | | | | | | | |
| McDonald et al, 1988 (25) | ?/22 613 | Standing >8 hours/day vs all women | Pregnancy | 1.32 | 1.1–3.5 | + | No | Yes | Yes |
| John et al, 1994 (37) | 376/376 | Standing (hours/day) | 1 trim | | | | | | |
| | | 7–8 vs <7 | | 0.9 | 0.4–1.9 | ++ | No | No | No |
| | | ≥9 vs <7 | | 1.0 | 0.4–2.6 | ++ | No | No | Yes |
| Ronda et al, 2010 (27) | 94/94 | Standing (hours/day) | 1 trim | | | | | | |
| | | ≥8 vs <8 | | 1.3 | 0.1–12.3 | ++ | No | No | Yes |

[a] ++ inflationary bias likely; + inflationary bias possible; +/- bias unlikely; - bias towards the null possible or likely.
[b] Standing 6–8 hours/day).
[c] Included in sensitivity meta-analysis as study with lower potential for bias.

**Supplementary table E.** Physical workload and risk of miscarriage. [nd=not defined; gw=gestational week; RR=relative risk; trim=trimester]

| Study design and reference | Number of women/ pregnancies | Exposure | | RR | 95% CI | Potential for | | Incomplete reporting | Meta-analysis |
|---|---|---|---|---|---|---|---|---|---|
| | | Contrast | Timing | | | Bias [a] | Confounding | | |
| **Prospective cohort** | | | | | | | | | |
| Florack et al, 1993 (18) | 170/170 | >3.5 × basal metabolic rate vs ≤3.5 × basal metabolic rate | 1 trim | 1.2 | 0.5–2.6 | +/- | No | No | No |
| Fenster et al, 1997 (17) | 5144/5144 | Physical intensity at job Very strenuous vs somewhat, not very or not at all strenuous | 1 trim | 1.12 | 0.74–1.71 | +/- | No | No | No |
| **Case–control** | | | | | | | | | |
| Wong et al, 2010 (34) | 1752/3006 | Physical activity | ≤20 gw | | | | | | |
| | | Light vs sedentary | | 0.32 | 0.17–0.61 | + | No | No | No |
| | | Medium vs sedentary | | 0.43 | 0.23–0.80 | + | No | No | No |
| | | Heavy vs sedentary | | 0.44 | 0.16–1.23 | + | No | No | No |
| **Cross-sectional** | | | | | | | | | |
| McDonald et al, 1988 (25) | ?/22 613 | Physical effort (nd) vs all women | Pregnancy | 1.87 | 1.4–2.3 | + | No | Yes | No |
| Naidoo, et al 2011 (26) | 887/4796 | Physical exertion score ≥6 on a 1–9 scale | (nd) | 1.5 | 1.0–2.2 | ++ | Yes | Yes | No |

[a] ++ inflationary bias likely; + inflationary bias possible; +/- bias unlikely; - bias towards the null possible or likely.

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