Executive Summary: Health Impact Review of SHB 2307

Providing Reasonable Accommodations in the Workplace for Pregnant Women

Evidence indicates that SHB 2307 has potential to improve maternal and child health and to decrease health disparities by race/ethnicity and income.

BILL INFORMATION

Sponsors: House Labor & Workplace Standards (originally sponsored by Representatives Farrell, Senn, Riccelli, Appleton, Wylie, Robinson, Tarleton, Goodman, Ormsby, Tharinger, Gregerson, Pollet, Sullivan, Stanford, Jinkins, Kuderer, Ortiz-Self, S. Hunt, Blake, Lytton, Kilduff, Fitzgibbon, Kagi, Sells, Reykdal, Walkinshaw, Rossetti, Sawyer, Orwall, Peterson, Van De Wege, McBride, Kirby, Fey, Santos, Cody, Hudgins, Bergquist, Moscoso, Frame

Summary of Bill:

- Requires employers to provide reasonable accommodation in employment for pregnancy, childbirth, or pregnancy-related health conditions, unless the accommodation would impose an undue hardship on the employer.
- Defines "reasonable accommodations" as measures that enable the proper performance of the job and enable the enjoyment of equal benefits, privileges, or terms and conditions of employment.
- Provides an example list of potential reasonable accommodations.

HEALTH IMPACT REVIEW

Summary of Findings:

This Health Impact Review found the following evidence regarding the provisions in SHB 2307:

- A fair amount of evidence that employers would comply with reasonable pregnancy accommodations policies and that employees would use reasonable accommodations when available and needed.
- Very strong evidence that some occupational environments and exposures during pregnancy can pose a risk to maternal and child health, and therefore pregnancy accommodations have potential to improve child and maternal health outcomes.
- Very strong evidence that improving maternal and child health outcomes through reasonable pregnancy accommodations would decrease health disparities by race/ethnicity and income in Washington State.

For more information contact:
(360)-236-4106 | hir@sboh.wa.gov
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Health Impact Review of SHB 2307

Providing Reasonable Accommodations in the Workplace for Pregnant Women

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Author: Sierra Rotakhina
Contributor/Reviewer: Christy Hoff
Reviewer: Michelle Davis
Reviewer: Kelie Kahler

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Introduction and Methods

A Health Impact Review is an analysis of how a proposed legislative or budgetary change will likely impact health and health disparities in Washington State (RCW 43.20.285). For the purpose of this review 'health disparities' have been defined as the differences in disease, death, and other adverse health conditions that exist between populations (RCW 43.20.270). This document provides summaries of the evidence analyzed by State Board of Health staff during the Health Impact Review of Substitute House Bill 2307 (SHB 2307).

Staff analyzed the content of SHB 2307 and created a logic model depicting possible pathways leading from the provisions of the bill to health outcomes. We conducted objective reviews of the literature for each pathway using databases including PubMed and Google Scholar.

The following pages provide a detailed analysis of the bill including the logic model, summaries of evidence, and annotated references. The logic model is presented both in text and through a flowchart (Figure 1). The logic model includes information on the strength of the evidence for each relationship. The strength-of-evidence has been defined using the following criteria:

- **Not well researched:** the literature review yielded few if any studies or only yielded studies that were poorly designed or executed or had high risk of bias.
- **A fair amount of evidence:** the literature review yielded several studies supporting the association, but a large body of evidence was not established; or the review yielded a large body of evidence but findings were inconsistent with only a slightly larger percent of the studies supporting the association; or the research did not incorporate the most robust study designs or execution or had a higher than average risk of bias.
- **Strong evidence:** the literature review yielded a large body of evidence on the relationship (a vast majority of which supported the association) but the body of evidence did contain some contradictory findings or studies that did not incorporate the most robust study designs or execution or had a higher than average risk of bias; or there were too few studies to reach the rigor of 'very strong evidence'; or some combination of these.
- **Very strong evidence:** the literature review yielded a very large body of robust evidence supporting the association with few if any contradictory findings. The evidence indicates that the scientific community largely accepts the existence of the association.

Staff made modifications to these criteria at the start of the 2015 legislative session beginning January 12, 2015. Therefore strength-of-evidence rankings may not be comparable between reviews completed before and those completed after this date.

This review was subject to time constraints, which influenced the scope of work for this review. The annotated references are only a representation of the evidence and provide examples of current research. In some cases only a few review articles or meta-analyses are referenced. One article may cite or provide analysis of dozens of other articles. Therefore the number of references included in the bibliography does not necessarily reflect the strength-of-evidence. In addition, some articles provide evidence for more than one research question so they are referenced multiple times.

Analysis of SHB 2307 and the Scientific Evidence

Summary of SHB 2307

- Requires employers to provide reasonable accommodation in employment for pregnancy, childbirth, or pregnancy-related health conditions, unless the accommodation would impose an undue hardship on the employer.
- Defines "reasonable accommodations" as measures that enable the proper performance of the job and enable the enjoyment of equal benefits, privileges, or terms and conditions of employment.
- Provides an example list of potential reasonable accommodations.

Health impact of SHB 2307

Evidence indicates that SHB 2307 has potential to improve maternal and child health and to decrease health disparities by race/ethnicity and income.

Pathways to health impacts

The potential pathways leading from the provisions of SHB 2307 to decreased health disparities are depicted in Figure 1. There is a fair amount of evidence that employers would comply with reasonable pregnancy accommodations policies and that employees would use reasonable accommodations when available and needed.[1-4] There is very strong evidence that some occupational environments and exposures during pregnancy can pose a risk to maternal and child health, and therefore pregnancy accommodations have potential to improve child and maternal health outcomes. For example, the evidence links occupation exposures to chemicals and other substances, physically demanding work (e.g. heavy lifting and prolonged standing), and occupation stress to adverse maternal and child health outcomes. These outcomes include preeclampsia; lower back and other joint pain; reduced fetal growth rates, head circumference, fetal length, and placental weight; preterm delivery; spontaneous abortion; low birthweight; miscarriage; small for gestational age birth; stillbirth; birth defects; hemorrhage during childbirth; and fetal death.[5-14] There is very strong evidence that improving maternal and child health outcomes through reasonable pregnancy accommodations would decrease health disparities in Washington State.[6,7,9,12,15-19] Evidence indicates that workers with low socioeconomic position and workers of color are more likely to be exposed to (and be vulnerable to) occupational hazards associated with adverse maternal and child health outcomes.[6,7,9,12,16,17] Low-income mothers and mothers of color experience higher rates of adverse maternal and child health outcomes than their counterparts,[7,15,17-19] therefore improving health outcomes for these populations would help decrease health disparities by income and race/ethnicity.

Due to time limitations we only researched the most direct connections between the provisions of the bill and decreased health disparities and did not explore the evidence for all possible pathways. For example, potential pathways that were not researched include:

- Evidence for how reasonable pregnancy accommodations would likely impact maternal job security and income, and how this in turn would likely impact child and maternal health.
- Evidence for how access to time off to recover from childbirth or to receive prenatal care would likely impact child and maternal health.

Magnitude of impact

It is unclear from available data exactly how many women, children, and families would be impacted by this bill as the effect would depend on the number of women who would request and be granted

reasonable accommodation who would not have been provided with reasonable accommodations in the absence of the policy. However, the positive health impacts for pregnant women (and their infants) who would become newly eligible for reasonable accommodations under SHB 2307 are significant and include reduced risk of low birthweight, preterm birth, and fetal and infant death; as well as reduced risk of severe maternal health outcomes such as preeclampsia and hemorrhage during delivery.[5-14] SHB 2307 would not apply to nonprofit religious or sectarian organizations or employers who employ fewer than eight employees, therefore workers employed by these organizations/businesses would likely not benefit directly from the bill.

Logic Model

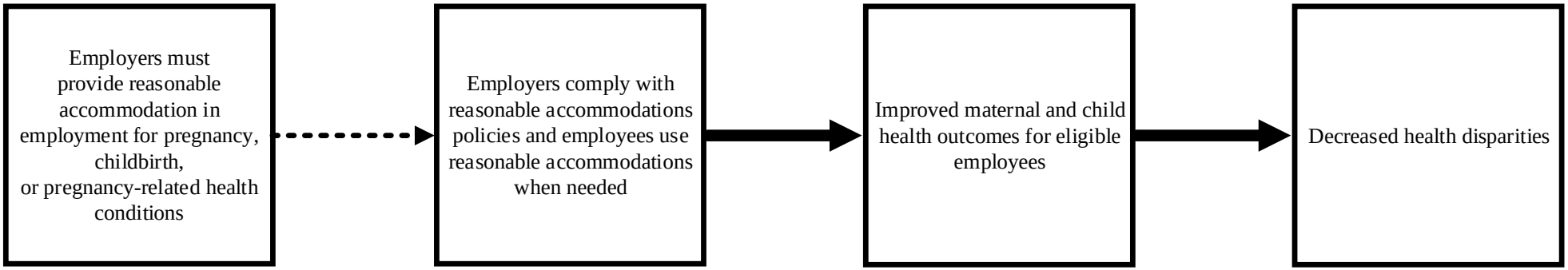
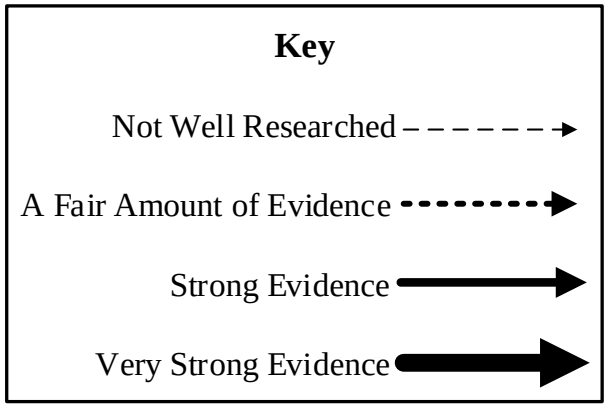


Figure 1

Providing Reasonable Accommodations in the Workplace for Pregnant Women

SHB 2307



Summaries of Findings

Will employers comply with reasonable pregnancy accommodations policies and will employees use reasonable accommodations when needed?

There is a fair amount of evidence that employers will comply with reasonable pregnancy accommodations policies and that employees will use reasonable accommodations when available and needed.[1-4] While we did not find any evidence specifically on pregnancy accommodations, the literature on accommodations required by the federal Americans with Disabilities Act (ADA) are likely generalizable in regards to compliance. This evidence does not indicate that all employers comply with these policies, but it does show that the number of employees with access to needed accommodations increases following implementation of these policies.

Will access to and use of reasonable pregnancy accommodations lead to improved child and maternal health for eligible employees?

There is very strong evidence that some occupational environments and exposures during pregnancy can pose a risk to maternal and child health, and therefore pregnancy accommodations have potential to improve child and maternal health outcomes. For example, the evidence links occupation exposures to chemicals and other substances, physically demanding work (e.g. heavy lifting and prolonged standing), and occupation stress to adverse maternal and child health outcomes. These outcomes include preeclampsia; lower back and other joint pain; reduced fetal growth rates, head circumference, fetal length, and placental weight; preterm delivery; spontaneous abortion; low birthweight; miscarriage; small for gestational age birth; stillbirth; birth defects; hemorrhage during childbirth; and fetal death.[5-14] While the strength of the evidence for the relationship between any one exposure and a given child or maternal health outcome varies substantially, when considering the body of evidence in aggregate it is clear that there are occupational risks that are specific to pregnant women and that accommodations to reduce these exposures could improve child and maternal health outcomes.

Due to time limitations and the large variation in potential pregnancy accommodations that could be allowed under SHB 2307, we were not able to review the potential impacts of every possible accommodation. However, we analyzed the literature for the likely impacts of several possible accommodations: accommodations to reduce occupational exposure to toxic substances, accommodations to reduce risk from physical strain, and accommodations to reduce occupational stress.

Accommodations to reduce occupational exposure to toxic substances

Evidence clearly shows that occupational exposure to toxic substances such as pesticides, solvents, and heavy metals are associated with adverse fetal outcomes such as reduced fetal growth rates, head circumference, fetal length, and placental weight; low birthweight; small for gestational age birth; preterm delivery; spontaneous abortions, birth defects, miscarriage, preeclampsia, hemorrhage during childbirth, stillbirth, and neonatal death.[6,8,11] Providing accommodations for pregnant women to reduce their exposure to these harmful substances has potential to protect the mother and developing fetus from these adverse outcomes.

Accommodations to reduce risk from physical strain

The relationships between occupational physical strain (such as heavy lifting, prolonged standing, shift-work, and physical workload) and adverse maternal and child health outcomes have been extensively studied. Recent meta-analyses and review articles suggest that there are associations between shift work (such as working nights), long work weeks, prolonged standing, physical workload, and increased risk of miscarriage.[5]

The findings on the association between occupational lifting and adverse birth outcomes are not conclusive because the results have been conflicting and many studies have explored lifting burdens close to that encountered in daily living, which may not be reflective of heavy, repetitive occupational lifting. However some studies have found associations between heavy occupational lifting/high physical workload and low birthweight, preterm delivery, miscarriage, and small for gestational age births.[5,7,10]

The National Institute for Occupational Safety and Health (NIOSH) took the available literature into account to develop recommended weight limits for pregnant workers with uncomplicated pregnancies. These recommendations take the following factors found in the literature into account: pregnancy is associated with increased joint laxity, potential spinal instability, changes in balance and center of mass, increased abdominal mass, and a change in the location of the external load in front of the body (i.e. pregnancy requires the lifter to hold the load out in front of them to avoid their abdomen rather than holding the load close to the body thereby increasing spinal loading); postural adaptations associated with pregnancy may increase muscle fatigue and increase the risk of slips and falls; and joint laxity may lead to pregnancy-related pelvic girdle, knee, and lower back pain. Using this evidence the authors recommend that the weight limits for pregnant women with uncomplicated pregnancies reflect those for the general working population with the following adaptations: "no lifting/lowering from the floor with hands below mid-shin or lifting/lowering with the hands overhead." It is important to note that these recommendations are specific to uncomplicated pregnancies and would likely not be protective enough for complicated or high risk pregnancies.[13]

The evidence on the relationship between prolonged occupation standing and adverse maternal and child health outcomes is also conflicting, though a recent meta-analysis suggests that standing for more than four hours per day is associated with at least a slightly increased risk of preterm birth and low birthweight. While the evidence of the impacts of prolonged standing on child health outcomes are less conclusive, at least some studies have found it to be associated with spontaneous abortions, increased risk of preterm birth, and reduced birthweight. Evidence also shows that prolonged occupational standing is associated with lower back pain, poor cardiovascular health outcomes (such as high blood pressure, varicose veins, and swelling in the legs and feet), and fatigue and discomfort in the general working population. It is worth noting that these are symptoms that are frequently exacerbated as a result of pregnancy.[12]

Accommodations to reduce occupational stress

Evidence suggests that occupational stress (such as low control over work and break schedules and pace of work) are associated with preeclampsia, as well as adverse birth outcomes such as low birthweight, small for gestational age birth, very low birthweight, very preterm birth, and extremely preterm birth.[7,9,14] The evidence for the relationship between occupational stress and

adverse birth outcomes is less consistent than that supporting the link with preeclampsia, as some studies have found an association while others have found no association.[7,9] Providing accommodations for pregnant women, such as increased flexibility over bathroom breaks or more flexible work schedules, could potentially help decreased the risks associated with job strain and low levels of job control.

Will improved health outcomes for employees eligible for reasonable pregnancy accommodations under SHB 2307 lead to decreased health disparities?

There is very strong evidence that improving maternal and child health outcomes through reasonable pregnancy accommodations would decrease health disparities in Washington State.[6,7,9,12,15-19] Evidence indicates that workers with low socioeconomic position, workers of color, and immigrant workers are more likely to be exposed to job insecurity and job hazards and to work in jobs with elevated occupational hazards such as janitorial services and agricultural jobs.[6,7,12,16,17] In addition, these groups may be more vulnerable to harmful occupational exposures than their counterparts, indicating that not only is their risk of exposure higher, but when exposed to occupational hazards, low-income workers, workers of color, and immigrant workers are also more likely to experience adverse health outcomes as a result.[9,16,17] For example, one study found that while White participants did not experience elevated risk of preterm birth as a result of exposure to high job strain, Black participants did.[9] Another study found an increased odds of preterm birth related to certain types of maternal work, and that the risk was more pronounced for Hispanic women.[17] Low-income mothers and mothers of color experience higher rates of adverse maternal and child health outcomes than their counterparts,[7,15,17-19] therefore improving health outcomes for these populations would help decrease health disparities by income and race/ethnicity.

Other considerations

We also explored the potential impacts of the bill on businesses as economic health can affect human health. We ultimately did not include this pathway in the logic model on page four of this review because the available evidence suggests that the risks of negative impacts on business from workplace accommodations are minimal and in some cases the impacts may be positive. Several studies have attempted to measure the financial costs of providing workplace accommodations for employees with or without disabilities and have consistently concluded that these accommodations are low cost, no cost, or cost neutral with only a small percentage of accommodations having costs of $5,000 or more. Evidence also suggests that providing accommodations is associated with benefits to the employer such as retaining qualified employees, increased productivity, eliminating the cost of training a new employee, improved employee attendance, improved interactions with coworkers, and improved company morale. A recent study by Schur et al. included rough estimates that there are net benefits or no net costs in about 69% of accommodations.[20] In addition, SHB 2307 allows employers to refuse to make reasonable accommodations if they can demonstrate that doing so would impose an undue hardship, thereby providing further protections for employers.

Annotated References

1. Bruyère SM, Erickson WA, Vanlooy S. Comparative study of workplace policy and practices contributing to disability nondiscrimination. *Rehabilitation Psychology.* 2004;49(1):28-38.

Bruyère et al. conducted interviews with stratified (by organization size) random samples of members of business organization groups—the Society of Human Resource Management in the United States (n=813, 73% response rate) and the Chartered Institute of Personnel and Development in the United Kingdom (n=802, response rate 60%). Ninety-three percent of all respondents noted that their company had made at least one of the types of accommodations asked about during the interview. When only the responses for those who reported receiving an accommodations request are considered, the authors indicate that 90% of U.S. and U.K. respondents reported making the requested accommodation. These findings do not provide the employee perspective.

2. Burkhauser R, Nicholas L, Schmeiser M. The importance of state anti-discrimination laws on employer accommodation and the movement of their employees onto Social Security Disability Insurance. *IDEAS Working Paper Series from RePEc.* 2011.

Burkhauser et al. analyzed data from the Health and Retirement Study to determine the effects of anti-discrimination laws on workplace accommodation. The data set included data from three cohorts: men and women born between 1931 and 1941 ("baseline cohort"), those born between 1942 and 1947; and those born between 1948 and 1953. These cohorts were first interviewed in 1992, 1998, and 2004 respectively. The authors looked at the data for three distinct worker groups: those who experienced the onset of disability after 1992 when the Americans with Disabilities Act (ADA) went into effect; those who experienced the onset of disability prior to 1992, but who lived in a state with some type of state anti-discrimination law (either reasonable accommodation or other anti-discrimination policies) in place; and those who experienced the onset of a disability prior to 1992 and who lived in a state without a state anti-discrimination policy in place. This is important because a federal ADA law would likely have a smaller effect in states with a state-level anti-discrimination policy already in place. The authors found that 26.0% of workers were accommodated prior to 1992, and that this has increased significantly to 29.9%. After controlling for the presence of a state anti-discrimination law, if the disability was a result of a work-related injury, demographic characteristics, human capital effects, health conditions, employment conditions, and time trends the authors found that the ADA resulted in an estimated significant six percentage point increase in the probability that an employee would receive an accommodation.

3. Charles K. The extent and effect of employer compliance with the accommodations mandates of the Americans with Disabilities Act. *Journal of Disability Policy Studies.* 2004;15(2):86-96.

Charles analyzed data from the Health and Retirement Study, 1931-1941 birth cohort (wave one survey 1992, wave two survey 1994, wave three survey 1998). The author only included data from respondents who were between 20 and 62 years of age at the onset of their disability (n=1,604). The data show that 28% of workers reported receiving accommodations before passage of the ADA, and 33% reported receiving accommodations after passage of the policy. After controlling for demographic variables, the author found that there was a significant

increase (by about five percentage points) in accommodations after implementation of the ADA. The author also used these data to estimate impacts of receiving an accommodation on wages, and speculated that the data provide modest evidence that the cost of accommodations may have resulted in lower wages for these workers. These data also suggest that accommodations were effective in lowering job separation rates (e.g. increasing job attachment).

4. Hoffman S. Settling the matter: Does Title I of the ADA work? *Alabama Law Review.* 2008;59:305-1725.

Hoffman summarized and analyzed the effects of the ADA, including studies which have analyzed the implementation of the employer accommodation provisions. The author summarized four studies and reports which have found that the majority of respondents (employers) report providing accommodations, and/or that the majority of accommodation requests are fulfilled. For example, a report of ADA compliance by Minnesota State agencies in 2005 indicated that of the 368 accommodations requested between July 2004 and June 2005, only 7.61% were denied.

5. Bonde J, Jørgensen K, Bonzini M, Palmer K. Miscarriage and occupational activity: A systematic review and meta- analysis regarding shift work, working hours, lifting, standing, and physical workload. *Scandinavian Journal of Work, Environment & Health.* 2013;39(4):325-334.

Bonde et al. conducted a systematic review of the literature published between 1966 and June of 2012 on the relationship between shift work, standing, occupational lifting, physical workload, and miscarriage. Thirty studies met their inclusion criteria. Thirteen studies analyzed the relationship between shift work and miscarriage, eleven of which found an association between shift work an increased risk of miscarriage. The odds ratios (OR) of the five highest quality studies were pooled, and working fixed night shifts compared to day shifts was associated with 1.51 times higher odds (95% CI 1.27-1.78) of miscarriage. Ten studies evaluated the risk of long work weeks (40-52 hours per week versus <40-44 hours) on miscarriage. The pooled OR was 1.36 (95% CI 1.25-1.49), but the authors note that the results varied widely and when only the three highest quality studies were pooled the risk estimate remained above one but the level of precision decreased. Eighteen studies evaluated the risk of occupational lifting. The authors found that studies used a wide range of definitions of heavy lifting (less than 5kg to over 20kg)—resulting in relative risks ranging from less than 0.5 to over 3.5. Bonde et al. defined heavy lifting as lifting at least 100kg (~220 pounds) per day. Using this definition they calculated a pooled OR of 1.32 (95% CI 0.93-1.87). However when they only used the five highest quality studies this number approached one. The authors identified six studies that considered the risk of standing at least 6-8 hours per day at work compared to standing less than this many hours. The pooled OR for these six studies was 1.16 (95% CI 1.01-1.32). The two highest quality studies had relative risks of 1.03 and 1.6. The five studies analyzing the impacts of physical workload on risk of miscarriage defined workload differently and therefore could not be pooled. The median relative risk across all studies was 1.12. The authors highlight the potential limitations of the available literature and conclude that a moderately increased risk of miscarriage was found among fixed night workers, in relation to long working hours (though the risk estimates were lower when only the highest quality study designs were considered), prolonged standing at work (though earlier studies found a moderately increased risk while more recent studies found a risk below 1). The authors note that the findings on the connections between occupation lifting and

miscarriage were inconsistent, potentially as a result of studies using different definitions of heavy lifting. They conclude that while the highest quality studies did not identify an increase in risk associated with occupational lifting, the lifting burden used was a modest exposure (close to the lifting exposure encountered in daily living), indicating that the studies are not informative regarding the risk from heavy lifting.

6. Engel LS, Meara ES, Schwartz SM. Maternal occupation in agriculture and risk of limb defects in Washington State, 1980— 1993. *Scandinavian Journal of Work, Environment & Health.* 2000;26(3):193-198.Engel et al. analyzed Washington State birth certificate data from 1980 through 1993 in order to determine the relationship between maternal exposure to agricultural chemicals and limb defects among their offspring. They used an occupation in agriculture (coded on the birth certificate) as a proxy for exposure to agricultural chemicals and included a sample of 4,466 births to women employed in agricultural occupations. The authors included two control groups: 1) randomly sampled births to employed women where neither the mother or father worked in agricultural occupations (n=23,512 births), 2) all births to women employed outside of the agriculture industry where the father worked in agriculture (n=5,994 births). The authors found that there was a much higher percentage of Hispanic mothers in the exposed group than in either of the comparison groups. The data showed that maternal employment in agriculture was associated with an elevated risk of limb defects in their offspring, with a significant crude prevalence ratio of 2.5 (95% CI 1.1-5.4) compared to the control group with neither parent working in agriculture and a prevalence ratio of 3.0 (95% CI 0.9-9.6) compared to the control group where only the father worked in agriculture. These trends remained even after controlling for potential confounding factors such as maternal age, alcohol and tobacco use, prenatal care, and ethnicity.

7. Gisselmann MD, Hemstrom O. The contribution of maternal working conditions to socio- economic inequalities in birth outcome. *Social Science & Medicine.* 2008;66(6):1297. Gisselmann and Hemstrom (not included in Larsen's review of the literature summarized in this Health Impact Review) cite evidence for disparities in birth outcomes, indicating that infants born to women from a higher social class, educational status, or income have better birth outcomes than their counterparts. They also cite evidence that working conditions contribute to the inequalities in health outcomes for men and women as well as disparities in birth outcomes. They summarize studies which indicate that manual labor is associated with greater job hazards and physical demands and lower job control than non-manual labor. The authors' study aims were to investigate the connection between working conditions and birth outcomes and the extent to which working conditions might contribute to disparities in birth outcomes. They linked data from the 1980 Swedish census and the Medical Birth Registry and used data from all singleton births in 1980 born to working women above age 19 (n=279,757 women with 359,610 births) to evaluate risks for the following birth outcomes: fetal death; perinatal death; neonatal death; low and very low birthweight; small for gestational age birth; preterm, very preterm, and extremely preterm birth. Their analysis found that job control tended to be highest in non-manual classes and lowest in manual manufacturing classes, and low job control was significantly associated with low birthweight, very low birthweight, small for gestational age birth, very preterm birth, and extremely preterm births (though not with neonatal death) after adjusting for maternal age and number of previous births. They found a dose-response relationship with the risk decreasing with increasing job control. The data also indicate that higher job hazards were

associated with higher risk for all birth outcomes but the mortality outcomes. Higher physical demand was associated with greater risk of all of the adverse birth outcomes except fetal death (death before or during delivery) and perinatal death (fetal death or death within seven days of delivery). The authors also found that manual and lower non-manual classes had increased risk for all of the studied negative birth outcomes, most of which were significant. They indicate that for some of the birth outcomes these trends were explained by low job control, job hazards, and physical demand.

8. Kumar S. Occupational, environmental and lifestyle factors associated with spontaneous abortion. *Reproductive Sciences.* 2011;18(10):915-930.

Kumar conducted a review of the literature on the relationship between maternal and paternal occupational exposures and adverse birth outcomes. Kumar cites evidence that maternal occupational exposure to agricultural chemicals is associated with increased risk of spontaneous abortions, preterm delivery, small for gestational age birth, and birth defects. Exposure to solvents (such as those used in industrial processes and the dry cleaning industry) are associated with miscarriage, preeclampsia, and spontaneous abortion. Kumar also cites studies which have found that prenatal exposure to heavy metals (such as lead, cadmium, and mercury) are associated with spontaneous abortion, preterm delivery, stillbirth, preeclampsia, and hemorrhage during childbirth. Evidence also suggests that occupational exposure to ionizing radiation (such as that among some hospital workers) may be associated with stillbirth and neonatal death.

9. Larsen AD. The effect of maternal exposure to psychosocial job strain on pregnancy outcomes and child development. *Danish Medical Journal.* 2015;62(2).

Larsen summarizes the literature and the mechanisms linking maternal stress during pregnancy to adverse impacts on the fetus before presenting her own research results. The author identified studies which specifically analyzed the connection between job-related stress ("job strain") during pregnancy and birth outcomes. Job strain integrates considerations of job demands and job control—where a job with high demand and low control (e.g. not having control over work or break schedules or work pace) is considered "high strain." The author notes that the literature has found an association between psychosocial stress unrelated to work and preterm birth, but that the studies specific to work strain are less conclusive. Larsen identified eleven studies analyzing this connection. Four of these were cohort studies, none of which found a significant association between job strain and preterm birth, though one study did find that a higher effort-reward imbalance was associated with lower gestational age at birth. Five of the eleven studies were case-control studies, one of which found an association between job strain and preterm birth, one which found an association among the Black participants but not the White participants, and one found no significant association. The remaining two case-control studies looked at the risk associated with mentally demanding jobs (not job strain), and self-perceived work stress and found no significant association. The two cross-sectional studies found an association between job stress and preterm birth. The author also identified ten studies on the relationship between job strain during pregnancy and the newborn being small for gestational age (SGA) or at a low birthweight. Four studies (three prospective studies and one case-control study) found an association between job stress and risk of SGA or low birthweight. The remaining six studies (three prospective studies, one case-control study, and two cross-sectional studies) found no significant association. Larsen analyzed data from the Danish National Birth Cohort. Information was first gathered for this cohort (n=100,418 pregnancies) from 1996 to

2002. Women were invited to participate in the study by the general practitioner. About 50% of the general practitioners agreed to invite women into the study, and of invited women about 60% agreed to participate. The dataset includes data from five phone interviews conducted with the mother (one at 12-14 weeks gestation, one at 30-32 weeks gestation, one six months after birth, and one 18 months after birth, and one seven years after birth); two blood samples drawn during pregnancy, and one cord blood sample. Just under 67,000 mothers were still participating at the 18 month interview, and just under 54,000 were still participation at the seven year interview. The authors also used data from the Danish Civil Registration System. The authors found no association between high job strain and preterm birth or SGA after controlling for potential confounding factors.

10. Runge SB, Pedersen JK, Svendsen SW, Juhl M, Bonde JP, Nybo Andersen A-M. Occupational lifting of heavy loads and preterm birth: A study within the Danish National Birth Cohort. *Occupational and Environmental Medicine.* 2013;70(11):782.
Runge et al. summarized previous research on the relationship between occupational lifting and preterm birth. They cite one meta-anslysis (Mozurkewith et al, 2000) of 21 studies which looked at physically demanding work including lifting and found an OR of 1.22 (95% CI 1.16 to 1.29). The authors also cite a review by Bonzini et al (2007) which found that 11 of the 12 reported relative risk estimates were below 1.35 (95% CI 0.81 to 1.49), and that none of the results showed a statistically significant relationship. These studies usually defined heavy lifting as more than 11-12 kg, but the frequencies of lifting varied substantially. They cite additional studies which indicate the relationship between lifting and preterm birth is conflicting. Runge et al. also conducted their own research analyzing the relationship between occupational lifting of heavy loads and extremely preterm birth (before 28 weeks), very preterm birth (28-32 weeks), and moderately preterm birth (33-37 weeks) using data from the Danish National Birth Cohort data from 1996 to 2002 (n=62,803; 60% participation rate representing 35% of all pregnancies in the Nation during that period). Data were collected through telephone interviews with women, where they self-reported their occupational lifting. Over 26% of respondents reported lifting heavy loads at work. The authors controlled for potential confounding factors and found that as daily lifting increased the odds of preterm birth increased. They found an OR of 1.50 (95% CI 1.03-2.19) associated with lifting over 1000kg/day (~2,204 pounds/day). When looking at extremely and very preterm births the association with heavy lifting was ever stronger. Lifting loads of greater than 20kg (~44 pounds), more than 10 times per day was also associated with increased odds of preterm birth (OR 2.03 [95% CI 1.14 to 3.62]).

11. Snijder CA, Roeleveld N, te Velde E, et al. Occupational exposure to chemicals and fetal growth: The Generation R Study. *Human Reproduction.* 2012;27(3):910-920.
Snijder et al. cite evidence that exposure to chemicals (such as lead and other heavy metals, phthalates, and pesticides) during fetal development can lead to adverse infant health outcomes such as low birthweight, small for gestational age birth, and preterm delivery. The authors analyzed data from a prospective cohort study in the Netherlands in order to determine if occupational exposure to various chemicals impacts intrauterine growth and placental weight. A total of 9,778 women (response rate 61%) participated in the study. Data were collected throughout the participants' pregnancies through physical examinations, questionnaires, interviews, and biological samples. Seventy-seven percent of participants filled out the occupational information in the questionnaire. After excluding women that did not fit their

inclusion criteria, the authors ended up with a final sample of 4,680 women. After controlling for potential confounding factors, they found that maternal occupational exposure to several chemicals including polycyclic aromatic hydrocarbons, phthalates, alkylphenolic compounds, and pesticides adversely impacted fetal growth rates, head circumference, fetal length, and placental weight.

12. Waters TR, Dick RB. Evidence of health risks associated with prolonged standing at work and intervention effectiveness. *Rehabilitation Nursing.* 2015;40(3):148-165.
Waters and Dick conducted a review of the literature published since 1990 on the health consequences of prolonged occupational standing—with a section specifically on the impacts for pregnant women. The authors cite evidence that low-income workers in Canada were more likely than their counterparts to stand at work. They summarize evidence that prolonged occupational standing is associated with lower back pain, poor cardiovascular health outcomes (such as high blood pressure, varicose veins, and swelling in the legs and feet), and fatigue and discomfort. It is worth noting that these symptoms of prolonged standing were found among the general working population and were not specific to pregnant women. However, these are symptoms that are frequently exacerbated as a result of pregnancy. Waters and Dick also summarized the evidence on the adverse impacts of prolonged standing on pregnancy outcomes. They identified eleven studies (two of which were meta-analyses) on the impacts of standing on birth outcomes. The findings of the nine primary research articles include an association between prolonged standing and: spontaneous abortions (two studies found an association), increased risk of preterm birth (three studies found an association and two found no significant association); reduced birth weight (two studies found an association and three found no significant association). The authors also summarized the findings of the two meta-analyses. A 2000 meta-analysis by Mozurkewich et al. identified 29 studies conducted with a total of 160,988 women which found that prolonged standing was associated with an increased risk of preterm birth (RR 1.26 [95% CI 1.13-1.40]). A 2013 meta-analysis by Palmer et al. found a slightly increased risk of preterm birth and low birth weight associated with standing more than four hours per day.

13. Waters TR, MacDonald LA, Hudock SD, Goddard DE. Provisional recommended weight limits for manual lifting during pregnancy. *Human Factors: The Journal of Human Factors and Ergonomics Society.* 2014;56(1):203-214.
The National Institute for Occupational Safety and Health (NIOSH) adapted the Revised Lifting Equation to develop recommended weight limits for pregnant workers with uncomplicated pregnancies. Note that these guidelines would not apply to complicated or high risk pregnancies. The authors reviewed the available evidence on pregnancy and lifting as well as the anatomic changes in pregnancy that effect lifting. They indicate that pregnancy is associated with increased joint laxity, potential spinal instability, changes in balance and center of mass, increased abdominal mass, and the location of the external load in front of the body (i.e. pregnancy requires the lifter to hold the load out in front of them to avoid her abdomen rather than holding the load close to the body thereby increasing spinal loading). Waters et al. also highlight evidence indicating that postural adaptations associated with pregnancy may increase muscle fatigue and increase the risk of slips and falls. They also site evidence that joint laxity may lead to pregnancy-related pelvic girdle, knee, and lower back pain. Using this evidence the authors recommend that the weight limits for pregnant women with uncomplicated pregnancies reflect those for the general working population with the following adaptations: “no

lifting/lowering from the floor with hands below mid-shin or lifting/lowering with the hands overhead."

14. Zhang S, Ding Z, Liu H, et al. Association between mental stress and gestational hypertension/ preeclampsia: A meta- analysis. *Obstetrical & Gynecological Survey.* 2013;68(12):825.

Zhang et al. conducted a meta-analysis using 13 studies examining the relationship between mental stress and preeclampsia in pregnant women (which is associated with maternal and child morbidity and mortality). They also conducted a meta-analysis using the four studies (one cohort study and three case-control studies) which looked at work stress specifically (such as stress from quantity and type of work and job control) and found that work stress was associated with 1.5 times higher odds of preeclampsia (95% CI 1.08-3.25).

15. Governor's Intergancy Council on Health Disparities. *June 2015 Update: State Action Plan to Eliminate Health Disparities.* 2015.

This report provides a recent summary of the data on disparities in birth outcomes in Washington State. This summary indicates that 2011 data reports show that infant mortality rates were higher for American Indian/Alaska Native (AI/AN) and Black mothers than for their Asian or White counterparts. Pacific Islander and Hispanic mothers also had higher infant mortality rates than their Asian counterparts. The overall infant mortality rate has been declining in Washington state over the past decade, however the rate among AI/ANs has actually been increasing. These disparities tend to exist even after controlling for potential confounding factors such as income, education, and socioeconomic status. The report emphasizes that "it's important to note that due to a lack of finer disaggregation, these data likely mask important disparities that may exist for racial/ethnic subgroups, among U.S. born versus foreign born and/or by acculturation status, and by language spoken."

16. Landsbergis PA, Grzywacz JG, Lamontagne AD. Work organization, job insecurity, and occupational health disparities. Vol 572014:495-515.

Landsbergis et al., at the request of NIOSH, synthesized the available literature on the role that work organization plays in creating and exacerbating occupational health disparities. They explored two primary mechanisms for differential impact on unique subpopulations—differential exposure and differential vulnerability (some groups of workers may be more vulnerable to the effects of exposure to an occupation health or safety issue). The authors identified 103 articles published between 1990 and 2010 which met their inclusion criteria. The authors summarize the evidence indicating that job insecurity is consistently associated with adverse mental health outcomes and that some evidence also suggests that job insecurity is associated with adverse physical health outcomes. In regards to differential exposure, the literature consistently shows that low socioeconomic position (SEP) is associated with greater job insecurity and greater exposure to occupational hazards such as low-control and exposure to organizational injustice. Evidence also indicates that workers of color are more likely than their white counterparts to experience job insecurity, concerns about possible job loss, actual involuntary job loss, and workplace discrimination. Data also indicate that immigrant day laborers are exposed to more occupational hazards then their counterparts and that workers of color and immigrants disproportionally work in dangerous sectors like agriculture and construction. Immigrant workers also have more difficulty accessing occupational health and safety rights and

entitlements. In regards to differential vulnerability, some evidence suggests that workers in manual jobs and workers of color are more negatively impacted by job insecurity (e.g. perceived threats of unemployment) than their counterparts. For example, one study found that Latino workers were not only at higher risk for severe occupational injuries, but that they were also less likely to have insurance, and had greater difficulty than White workers resolving workers' compensation claims.

17. Von Ehrenstein OS, Wilhelm M, Wang A, Ritz B. Preterm birth and prenatal maternal occupation: The role of Hispanic ethnicity and nativity in a population- based sample in Los Angeles, California. *American Journal of Public Health.* 2014;104 Suppl 1:S65.

Von Ehrenstein et al. cite evidence that Hispanic women are at greater risk of preterm birth than non-Hispanic White women. They also cite previous studies which have suggested that working as a building cleaner, mechanic, food manufacturer, electrical equipment worker, or janitor were associated with increased risk for preterm birth. Von Ehrenstein et al. conducted a case-control study using data from the University of California, Los Angeles, Environment and Pregnancy Outcome study. Their data set included 58,316 births is Los Angeles County, California in 2003. From this cohort they selected all low birthweight and preterm births and an equal number of randomly selected controls. They conducted interviews in English or Spanish with 2,543 of the 6,374 women originally selected from the cohort (~40%) three to six months postpartum. The participants answered questions about their occupation and an Industrial Hygienist used this data to rate their likelihood of exposure to strenuous physical labor (lifting, prolonged standing, etc.), psychologically demanding work, shift work, toxic substances, diseases, and indoor air pollutants. The authors used office and administrative support occupations as the reference group. They found higher odds of preterm birth related to likely physically demanding work and likely shift work (with pronounced effects among US-born but not among foreign-born Hispanic women), but no association with the other likely exposures. They included potential confounding factors in their model and found that increased odds of preterm birth among health care practitioners and technical occupations, with greater effects among Hispanic women. They also found increased odds of preterm birth among foreign-born Hispanic building and grounds cleaning and maintenance workers. The authors conclude that these findings indicate that increased odds of preterm birth are related to certain types of maternal work, and that the risk is more pronounced for Hispanic women (with effect modifications for nativity), suggesting that prenatal occupational exposures likely contribute to ethnic disparities in premature birth rates.

18. Washington State Department of Health. *Health of Washington State Report: Singleton Low Birth Weight.* 2008.

Washington State birth certificate data from 2003-2005 indicate that the rate of low birthweight singleton births was significantly higher for AI/AN, Asian/Pacific Islander, Black, and Hispanic infants than for White infants. The rate for Black infants was over twice the rate for White infants. These birth certificate data also indicate that babies born to low-income households (using Medicaid as a proxy for income) had significantly higher singleton low birthweight rates than babies born into higher income households.

19. Wasserman C, Taylor P. *Health of Washington State Report: Infant Mortality.* 2013.

Washington State data from the First Steps Database (2008-2011) indicate that women receiving Temporary Assistance for Needy Families (TANF) and or Medicaid (proxies for low-income) experienced significantly higher infant mortality rates than women who were not receiving these benefits (i.e. higher income women).

20. Schur L, Nishii L, Adya M, Kruse D, Bruyère SM, Blanck P. Accommodating employees with and without disabilities. *Human Resource Management.* 2014;53(4):593-621.

Schur et al. summarized previous studies which have attempted to measure the financial costs of providing workplace accommodations under the ADA and concluded that these studies have found that most accommodations have low cost, no cost, or are cost neutral—with only a small percentage having high costs of $5,000 or more. The authors also cite evidence of the benefits of disability accommodations including: retaining qualified employees, increased productivity, eliminating the cost of training a new employee, improved employee attendance, improved interactions with coworkers, and improved company morale. Schur et al. worked in consultation with the US Department of Labor's Office of Disability Employment Policy to analyze the likely impacts of ADA accommodations (as well as accommodations made for employees without disabilities) on employers and employees. The authors collected survey, interview, and focus group data from employees and employers (managers) from six companies and interview and focus group data from two additional companies. These companies had from 38 to 38,000 employees and were from the following sectors: pharmaceutical, hospital, disability service organization, financial services company, consumer products manufacturer, supermarket chain, restaurant, and infrastructure service company. The authors found that both employees and managers reported that the majority of disability accommodations had zero or small monetary costs. Thirty-seven percent of managers reported that one-time costs of accommodations were zero, 23% reported that they were less than $500, and less than 6% reported that they were more than $5,000. In addition, 54% of managers reported that the annual ongoing costs of disability accommodations were zero, and only 7% reported that they were more than $5,000 per year. These were similar for the figures reported for accommodations made for employees without disabilities. Employers and employees also reported benefits of accommodation including employee retention (72% of employees and 68% of managers), increased employee morale or job satisfaction (71% of employees and 72% of managers), decreased employee stress at work (65% of employers and 62% of managers), and increased productivity of the employee (77% of employees and 59% of managers). These trends were also reported by accommodated employees without a disability. When managers were asked to assign a dollar value to the benefits of accommodation, about 40% reported that they were unsure, 20-25% reported zero monetary benefits, and 15% reported benefits over $5,000. Using manager responses to cost and benefit questions, the authors made some rough calculations which indicate that reported benefits equal reported costs in 40.1% of cases, benefits exceed costs in 29.2% of cases, and costs exceed benefits in 19.0% of cases (the cost-benefit relationship was indeterminate in 11.7% of cases). This indicates that there is either net benefit or no net cost in roughly 69% of cases.