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# Maternal and Environmental Risk Factors as Predictors of Poor Pregnancy Outcomes among Female Greenhouse Workers

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**ABSTRACT**

**Background & aim:** Maternal and environmental risk factors during pregnancy are potential threats for poor pregnancy outcomes. This study aimed to evaluate maternal and environmental risk factors as predictors of poor pregnancy outcomes in female greenhouse workers (FGW).

**Methods:** This predictive correlational study was performed on 275 Iranian FGW in Kerman, southern province of Iran in 2018. Participants were selected by census method from six rural areas with the highest level of greenhouse cultivation. A research-made instrument included demographic characteristics, maternal and environmental risk factors, and pregnancy outcomes was used to collect data through closed interview. All pregnancies were evaluated for the frequency of poor pregnancy outcomes. A binary logistic regression was used to predict the role of some environmental risk factors on pregnancy outcomes among FGW using SPSS software (version 16).

**Results:** Mean age of FGW was 33.26±7.24 years. Among poor pregnancy outcomes in FGW; abortion, stillbirth, preterm birth, and low birth weight (LBW) were predicted by several maternal and environmental risk factors (P<0.05); while abnormality was predicted by only working in a greenhouse during pregnancy (P<0.05. None of the maternal or environmental risk factors could predict post-term birth (P>0.05).

**Conclusion:** Due to both maternal and environmental risk factors being associated with poor pregnancy outcomes in FGW, preventive educational intervention programs should be considered for this population.

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## Introduction

Maternal and environmental risk factors have a major influence on fetal growth and development stages (1-2). A poor pregnancy outcome may be caused by specific characteristics and conditions that predispose a mother to a high-risk pregnancy group or may be occurred during the pregnancy process. Recent studies have demonstrated maternal factors such as young (≤ 18 years) or advanced maternal age (≥ 35 years) (3), grand multiparity (parity ≥ 5 births) (4), insufficient vitamin and mineral supplementation intake (5) first trimester bleeding (6) and consanguineous marriage (7) increase the risk of poor pregnancy outcomes. These maternal risk factors during pregnancy can result in serious complications for both the mother (e.g. spontaneous abortion, severe preeclampsia, antepartum and postpartum hemorrhage, iron deficiency

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anemia, and gestational carbohydrate intolerance) and her fetus (e.g. preterm birth, intrauterine growth retardation, fetal distress, high perinatal mortality rate, congenital malformations, and neural tube defects) (3-7).

In addition, environmental health hazards such as air pollution, smoking, exposure to ionizing radiation, heavy metals (e.g. lead, selenium, and inorganic mercury), agricultural pesticides, and moderate-to-heavy work during pregnancy are pregnancy risk factors that contribute to decreased fetal growth, gestational length, and birth defects (2, 7-11).

Pesticide exposure is one of the most important pregnancy environmental risk factors, especially among women who work in agriculture (9). For using chemical components, the amount and severity of pesticide exposure will increase in the greenhouse environment (12). Therefore, women who work in a greenhouse, especially during pregnancy are identified as a vulnerable occupational group. Furthermore, greenhouse working is often accompanied by a lack of (or improper use of) protective equipment which can increase the risk of pesticide exposure and adverse pregnancy outcomes. A cross-sectional study on Italian pregnant women in greenhouse flowers indicated that the most dangerous tasks were conducted by pregnant workers without personal protective equipment. In this study, just 50% of pregnant women who prepared and mixed pesticides and 38% of those who applied pesticides directly utilized the gloves (13). Also, Ribeiro et al. discovered that most flower greenhouse workers in Brazil used and maintained personal protective equipment incorrectly (12).

More exposure to pesticides in FGW may also be affected by environmental factors. Eating pesticide-contaminated food and drinking water, eating meals during and immediately after pesticide spraying activities, and the proximity of the greenhouse to the living area are all factors that increase pesticide intake (14-16). There is evidence that high consumption of pesticide-laden fruits and vegetables is associated with an increased risk of infertility and stillbirth (17). In the agricultural area of the south of Kerman, a large number of females participate in greenhouse activities, however, there is little information about their working conditions and health-related factors during pregnancy. Also, there are not enough research studies on the role of both maternal and environmental risk factors on birth outcomes around the world. Several studies have examined only the effects of pesticide exposure on pregnancy outcomes in particular spontaneous abortion among FGW (18-19). In the present study, we investigated the maternal and environmental risk factors and their role on pregnancy outcomes among FGW in the south of Kerman, Iran.

## Materials and Methods

Data are from a cross-sectional study of 275 Iranian FGW in Kerman, the southern province of Iran during year of 2018. South of Kerman is divided into 18 main rural areas that have greenhouse cultivation. At first, these areas were arranged according to the number of greenhouses, then the first six areas with the highest level of greenhouse cultivation were selected. Finally, the census method was utilized for data collection.

The inclusion criteria were at least one year of experience working in a greenhouse, being at least one year married, having at least one pregnancy experience, and a willingness to participate in the study. Primary infertility, serious underlying medical conditions, using of medications during pregnancy, and having any other hazardous exposures such as tobacco smoking and X-ray exposures were all exclusion criteria. The instrument included demographic characteristics and a checklist for determining pregnancy risk factors and negative pregnancy outcomes. The validity of the questionnaire was evaluated using content validity analysis; Then it was approved by six experts in reproductive health and agriculture studies (CVR=0.99, CVI= 0.92). The test-retest method was also used to assess reliability (r=0.87). In this study, pregnancy risk factors included a combination of maternal and environmental factors related to greenhouse work. Maternal risk factors included high-risk pregnancy age (≤18 and ≥ 35), high parity (five or more births), having a consanguineous marriage, vaginal bleeding during pregnancy, and not taking daily folic acid supplements. Because we only considered environmental risk factors related to pesticide exposure, female workers who had experienced

other environmental factors such as tobacco smoking, alcohol consumption, and X-ray exposure during pregnancy were excluded from the study. Finally, pesticides exposure during pregnancy through working in a greenhouse, heavy work (> 8 hour/day) in the greenhouse, daily consumption of greenhouse products, home distance less than 5 km to the greenhouse, keeping pesticides at home, working without personal protective equipment, eating or drinking while working in greenhouse and husband's occupation as a farmer were selected as environmental risk factors.

The pregnancy outcomes contained a history of abortion, stillbirth, preterm, and post-term birth, LBW, and abnormal birth. A separate checklist was completed for each pregnancy. The interviews took place in a quiet location and FGW were given enough time to recall events from their pregnancy. They were asked to answer the questions accurately, and if necessary, the information was double-checked with a trustworthy family member or medical records.

The collected data were analyzed using SPSS software, version 16 (SPSS Inc., Chicago, IL, USA, 2007). A binary logistic regression was used to predict the effect of maternal and environmental risk factors on pregnancy outcomes among FGW. P-values of <0.05 were considered statistically significant and Odds Ratio (OR) with 95% confidence interval (95% CI) was demonstrated.

## Results

The mean age of FGW was 33.26±7.24 years and the mean greenhouse working experience was 7.80 ± 5.54 years. Most participants (92.6%) had less than 12$^{th}$ grade of education and 32.4% had at least two children.

**Table 1.** Frequency distribution of pregnancy risk factors in FGW

| Variables | | N (%) |
|---|---|---|
| High-risk pregnancy age | Yes | 199 (20.4) |
| | No | 775(79.6) |
| High parity (≥5) | Yes | 130(13.35) |
| | No | 844 (86.65) |
| Not taking daily folic acid supplement | Yes | 272 (27.9) |
| | No | 702 (72.1) |
| Vaginal bleeding | Yes | 80 (8.2) |
| | No | 894 (91.8) |
| Consanguineous marriage | Yes | 378 (38.8) |
| | No | 596 (61.2) |
| Working in a greenhouse during pregnancy | Yes | 553 (54.7) |
| | No | 441 (45.3) |
| Heavy work (> 8-hour/day) | Yes | 74 (7.6) |
| | No | 900 (92.4) |
| Daily consumption of greenhouse products | Yes | 515 (52.9) |
| | No | 459 (47.1) |
| Home distance < 5 km to greenhouse | Yes | 799 (82) |
| | No | 175 (18) |
| Keeping pesticides at home | Yes | 76 (7.8) |
| | No | 898 (92.2) |
| Lock of personal protective equipment using | Yes | 781 (80.2) |
| | No | 193 (19.8) |
| Eating or drinking while working | Yes | 333 (34.2) |
| | No | 641 (65.8) |
| Husband's occupation as a farmer | Yes | 855 (87.8) |
| | No | 119 (12.2) |

**Table 2.** Maternal and Environmental risk factors affecting poor pregnancy outcomes as determined by a logistic regression analysis

| Risk Factors | Abortion | | Stillbirth | | Preterm birth | | Post-term birth | | LBW | | Birth abnormality | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **OR** (95% CI) | p | **OR** (95% CI) | p | **OR** (95% CI) | p | **OR** (95% CI) | p | **OR** (95% CI) | p | **OR** (95% CI) | p |
| High-risk pregnancy age | 0.77 (0.44-1.35) | 0.37 | 2.22 (1.16-4.26) | 0.01* | 2.44 (1.21-5.31) | 0.02* | 1.11 (0.11-1.86) | 0.92 | 2.62 (1.47-4.68) | 0.001* | 1.31 (0.46-3.77) | 0.60 |
| high parity | 1.18 (1.02-3.21) | 0.04* | 2.29 (1.07-4.90) | 0.03* | 1.36 (0.48-3.86) | 0.55 | 0.64 (0.05-8.09) | 0.73 | 0.64 (0.23-1.72) | 0.38 | 1.75 (0.52-5.90) | 0.36 |
| not taking daily folic acid supplement | 0.65 (0.39-1.10) | 0.11 | 0.68 (0.33-1.37) | 0.28 | 0.40 (0.16-0.99) | 0.04* | 1.53 (0.24-9.59) | 0.64 | 0.87 (0.46-1.65) | 0.67 | 1.03 (0.37-2.86) | 0.95 |
| Vaginal bleeding | 4.47 (2.53-7.90) | <0.001* | 1.27 (0.46-3.47) | 0.63 | 0.63 (0.14-2.86) | 0.55 | 3.38 (0.33-33.89) | 0.30 | 0.56 (0.19-1.66) | 0.30 | 1.38 (0.36-5.21) | 0.63 |
| Consanguineous marriage | 1.06 (0.68-1.65) | 0.78 | 0.69 (0.37-1.30) | 0.26 | 0.63 (0.28-1.38) | 0.24 | 0.88 (0.15-5.18) | 0.88 | 1.25 (0.72-2.17) | 0.41 | 0.66 (0.25-1.69) | 0.38 |
| Working in a greenhouse during pregnancy | 1.38 (0.80-2.36) | 0.23 | 0.38 (0.16-0.90) | 0.02* | 0.59 (0.23-1.51) | 0.27 | 1.73 (0.12-23.43) | 0.67 | 2.22 (1.04-4.73) | 0.03* | 6.14 (1.50-25.03) | 0.01* |
| Heavy work (> 8-hour/day) | 0.51 (0.18-1.42) | 0.19 | 1.36 (0.35-5.32) | 0.65 | 0.38 (0.04-3.20) | 0.38 | 3.88 (0.53-28.22) | 0.18 | 0.13 (0.01-1) | 0.04* | 0.25 (0.03-2.16) | 0.21 |
| Daily consumption of greenhouse products | 0.48 (0.26-0.89) | 0.02* | 2.32 (1.07-5.02) | 0.03* | 1.04 (0.37-2.93) | 0.93 | 2.77 (0.18-41.31) | 0.45 | 1.26 (0.57-2.78) | 0.56 | 1.30 (0.39-4.29) | 0.66 |
| Home distance < 5 km to greenhouse | 2.21 (1.06-4.58) | 0.03* | 0.73 (0.35-1.49) | 0.39 | 1.97 (0.57-6.82) | 0.28 | 0.23 (04-1.36) | 0.10 | 0.95 (0.45-1.98) | 0.89 | 2.05 (0.46-9.15) | 0.34 |
| Keeping pesticides at home | 2.08 (1.02-4.24) | 0.04* | 0.31 (0.04-2.37) | 0.25 | 1.58 (0.49-5.09) | 0.43 | 1.53 (0.15-15.57) | 0.71 | 0.65 (0.22-1.95) | 0.45 | 1.39 (0.37-5.24) | 0.61 |
| Lack of personal protective equipment | 1.06 (0.62-1.82) | 0.80 | 0.82 (0.36-1.83) | 0.63 | 3.07(1.45-6.50) | 0.003* | 0.96 (0.09-10.21) | 0.97 | 1.33 (0.69-2.56) | 0.38 | 0.75 (0.23-2.43) | 0.63 |
| Eating or drinking while working | 1.27 (0.70-2.30) | 0.42 | 0.75 (0.29-1.93) | 0.56 | 1.52 (0.58-3.97) | 0.39 | 0.98 (0.15-6.15) | 0.98 | 1.93 (1-3.70) | 0.04* | 0.67 (0.25-1.76) | 0.41 |
| Husband's occupation as a farmer | 1.46 (0.77-2.76) | 0.24 | 2.57 (1.22-5.41) | 0.01* | 3.01 (1.25-7.24) | 0.01* | 1.65 (0.16-16.40) | 0.66 | 1.06 (0.45-2.51) | 0.88 | 0.42 (0.05-3.34) | 0.41 |

*p-value< 0.05

As shown in Table 1, among the factors for a high-risk pregnancy, environmental risk factors were observed more frequently than maternal risk factors in the participants. Pregnancies under the age of 18 years and over the age of 35 were 14.8% and 5.6% respectively. The number of parities reported by women with high parity (13.35%) ranged from 5 to 11 among women with high parity (13.35%). Lack of folic acid supplementation was 27.9% and vaginal bleeding occurred in 8.2% of pregnancies. Consanguineous marriage was responsible for more than a third of all pregnancies.

Among environmental risk factors, working in a greenhouse continued in more than half of all pregnancies with a mean of 4.71±3.64 hours per day. Only 7.6% of them worked more than eight hours per day. Greenhouse products were consumed in more than half of pregnancies and 82% of pregnancies occurred when the houses were located near greenhouses (less than 5 km). 76 pregnancies were keeping the poison at home. Most greenhouse workers stated that they did not use personal protective equipment during pregnancy.

The abortion rate for all pregnancies was 10.5% (102 cases). The pregnancy outcome in 49 cases (5%) was stillbirths and 23 cases (2.4%) was a child with abnormality. Preterm and Post-term delivery was reported in 3.4% (33 cases) and 0.6% (6 cases) respectively. Furthermore, LBW occurred 6.5% of pregnancies (63 cases).

The results of the multiple regression analyses have been reported in Table 2. Multivariable logistic regression modelling indicated that the following maternal and environmental risk factors related to greenhouse working increased poor pregnancy outcomes.

The independent variables related to abortion were high parity (p=0.04, OR= 1.18, CI 95% =1.02-3.21), vaginal bleeding (P<0.001, OR= 4.47, CI 95% = 2.53-7.90), daily consumption of greenhouse products (p=0.02, OR= 0.48, CI 95% = 0.26-0.89), home distance < 5km to greenhouse (p=0.03, OR= 2.21, CI 95% = 1.06-4.58) and keeping pesticides at home (p=0.04, OR= 2.08, CI 95% = 1.02-4.24).

Five risk factors including high-risk pregnancy age (p=0.01, OR= 2.22, CI 95% = 1.16-4.26), high parity (p=0.03, OR= 2.29, CI 95% =1.07-4.90), working in a greenhouse during pregnancy (p=0.02, OR= 0.38, CI 95% =0.16-0.90), daily consumption of greenhouse products (p=0.03, OR= 2.32, CI 95% = 1.07-5.02), and husband's occupation as a farmer (p=0.01, OR= 2.57, CI 95% =1.22-5.41) were responsible of stillbirth changes.

Also two maternal risk factors including high-risk pregnancy age (p=0.02, OR= 2.44, CI 95% =1.21-5.31) and not taking daily folic acid supplement (p=0.04, OR= 0.40, CI 95% =0.16-0.99); and two environmental risk factors including lack of personal protective equipment (p=0.003, OR= 3.07, CI 95% =1.45-6.50) and husband's occupation as a farmer (p=0.01, OR= 3.01, CI 95% =1.25-7.24) could predict preterm birth changes.

Although post-term birth not associated with any risk factors, pregnancies is accompanied with LBW had a significantly increased risk of high-risk pregnancy age (p=0.001, OR= 2.62, CI 95% =1.47-4.68), working in a greenhouse during pregnancy (p=0.03, OR= 2.22, CI 95% =1.04-4.73), having heavy work (p=0.04, OR= 0.13, CI 95% =0.01-1) and eating or drinking while working (p=0.04, OR= 1.93, CI 95% =1-3.70).

Finally, only working in a greenhouse during pregnancy (p=0.01, OR= 6.14, CI 95% =1.50-25.39) was as a predictor of abnormality birth.

## Discussion

In this study, we examined the predictors of poor pregnancy outcomes in FGW in the south of Kerman, Iran. Abortion, LBW, stillbirth, preterm birth, birth abnormality, and post-term birth had the highest frequency, respectively.

High-risk pregnancy age and working in a greenhouse during pregnancy were the most common maternal and environmental risk factors as predictors of any adverse pregnancy. Except post-term birth, the probability of any poor pregnancy outcome was associated with at least one of the maternal or environmental risk factors. The lower percentage of post-term births can be attributed to the lack of statistical significance.

The prevalence of maternal factors for a high-risk pregnancy on FGW has received less attention, and most studies have focused on environmental risk factors especially pesticides exposure, and their effect on pregnancy

outcomes. However, the results of such studies suggest that greenhouse workers should be more educated about healthy pregnancy conditions (20-22). However, there are barriers to achieving this goal, For example, Kelley et al. (year) stated that an appropriate occupational and environmental health assessment should be included in health service programs provided by health care providers, however, health care providers do not receive specialized education about occupational exposure and its harmful effects on adverse reproductive outcomes to be able to educate reproductive-aged women (21).

Our findings revealed that abortion occurred among FGW as a result of both maternal risk factors such as high parity and vaginal bleeding; and environmental risk factors such as daily consumption of greenhouse products, the proximity of women's residence to the greenhouse, and keeping pesticides at home during pregnancy. First-trimester vaginal bleeding and high parity have been reported as strong maternal risk factors for spontaneous abortion in some studies. As a result of a community-based pregnancy cohort study on 4510 females with 27% vaginal bleeding or spotting showed heavy bleeding in the first trimester is associated with a higher risk of abortion (23). Also, Al-Shaikh et al. indicated a history of abortion was significantly higher in grand multiparity (4).

Many studies (18-19, 24) have found a link between pesticide exposure and spontaneous abortion. Consistent with our findings Vazirinejad et al. (2012) mentioned the role of farmers' residence and reported that the risk of spontaneous abortion among Iranian pregnant women living inside pistachio farms was 6.7 times higher than the others (19). Although there is no direct link between keeping pesticides at home and consuming greenhouse products with the occurrence of abortion, some studies argued that these variables can increase the likelihood of adverse health consequences and other pregnancy outcomes (25-26). Therefore, it can be concluded any condition that increased exposure to pesticides may cause spontaneous abortion among FGW.

Stillbirth is another poor pregnancy outcome that is influenced by both maternal (high-risk pregnancy age and high parity) and environmental risk factors (working in a greenhouse during pregnancy, daily consumption of greenhouse products, husband's occupation as a farmer). Waldenström et al. stated advanced maternal age is an independent risk factor for stillbirth in nulliparous women (26). Also, the result of a study in Northern Tanzania over eight years, with a prevalence of 9.44% grand multiparity presented that the grand multiparous women had an increased risk of stillbirth when compared to women in the lower parity group (27). Stillbirth is affected by environmental exposure; Razi et al. (?) reported that the likelihood of stillbirth increases with factors such as living in a residential area near the pistachio garden, and any experience spraying pistachio. They stated that the OR of stillbirth was 14.1 and 5 for the women who lived in pistachio gardens and the mothers involved in spraying pesticides during pregnancy respectively (16). There is also evidence that proves paternal exposure to agricultural pesticides increases the risk of fetal death due to congenital anomalies. Regidor et al. explained the offspring of male agricultural workers had the highest risk of fetal death from congenital anomalies in the area with the highest using pesticide. (28).

The results of this study revealed that preterm births were more common in women who became pregnant at an inappropriate age, did not receive daily folic acid supplementation, and did not use personal protective equipment while working, as well as, women whose husbands were farmers. There are strong evidences that show the effect of maternal age on the time of delivery (29, 3). These studies suggest pregnant women should be aware of the risks of pregnancy at a young or advanced age in order to reduce complications associated with high-risk pregnancies. The outcome of studies on maternal folate status is still unidentified. For example, the findings of a Norwegian cohort study demonstrate the amount of supplemental folate intake was not significantly associated with the risk of spontaneous preterm delivery and moreover taking folic acid supplements before 8 weeks of pregnancy is associated with an increased risk of spontaneous preterm delivery (30). However, Li et al. in a meta-analysis study concluded that with increasing

maternal folate levels and folic acid supplementation, preterm birth decreases significantly (31). In this study, FGW who had farmer husbands were three times more likely to experience preterm birth. According to some studies on male exposure with a variety of pesticides was associated with odds ratios of two or greater for preterm delivery (32).

We found that LBW is affected by maternal age at pregnancy and some environmental factors such as working in a greenhouse during pregnancy, heavy work, and eating or drinking while working. According to other researches, both young and advanced maternal age are associated with adverse pregnancy outcomes such as LBW (3, 33). Thus, community members should be educated on the consequences of treating infants with LBW in order to prevent teenage pregnancies and prevention of pregnancies after the age of 35 years. In addition, the results of two studies conducted by Ochoa-Acuña et.al (34) and Burdorf et.al (35) confirm this study. They showed that not only direct exposure to pesticides during pregnancy can be associated with LBW, but also high concentrations of agricultural pesticides in soil, water, and air accompanied by it. Ochoa-Acu˜na et.al indicated that a high concentration of Atrazine in the drinking water of pregnant women in the third trimester was associated with an increase of 17–19% in the prevalence of LBW (34). Moreover, Jurewicz et.al stated the mean birth weight of infants of women who performed heavy work inside the greenhouse during pregnancy was lower than the infants whose mothers worked outside of the greenhouse (36).

Finally, our results show that working in a greenhouse during pregnancy increases the risk of abnormal birth. This finding is consistent with findings recent that higher pesticide exposure increases the risk of abnormal birth among pregnant women (9, 37).

## Conclusion

The results of this study showed that a high prevalence of maternal and environmental pregnancy risk factor among FGW have a negative effect on pregnancy outcomes. Therefore, health planners and policy makers should develop interventions that focus on risk reduction strategies. These interventions can include educational interventions, workplace improvements, legislation regarding the need to use protective equipment, and continuous research of reproductive results and its factors. Also, agencies related to agricultural activities should measure the risk of environmental hazards on a regular basis and improve procedures to protect workers from pesticide exposure.

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This study approved by the Research Ethics Committee of Jiroft University of Medical Sciences (IR.JMU.REC.1397.1). All methods were performed in accordance with the relevant guidelines and regulations. A written informed consent was taken from all of the participants.

## Conflicts of interest

Authors declared no conflicts of interest.

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