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Prevalence of food insecurity in pregnant women and its association with gestational weight gain pattern, neonatal birth weight, and pregnancy complications in Hamadan County, Iran, in 2018

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Abstract

Background: The results of some studies have indicated the association between food insecurity and certain adverse pregnancy outcomes. The present study aimed to investigate the prevalence of food insecurity in pregnant women and its association with pregnancy outcomes and complications.

Methods: The present cross-sectional study was conducted on 772 mothers who visited comprehensive health service centers during the first 10 days after delivery in 2018. The tools included the demographic and midwifery information questionnaire and an 18-item questionnaire devised by the U.S. Department of Agriculture. The significance level was considered to be 0.05.

Results: 67.5% of pregnant women had food insecurity. The multivariate analysis showed that birth weight decreased with the increase in the severity of food insecurity, but the reduction was not statistically significant. Based on the results, food insecurity had no statistically significant impact on the mothers' weight gain pattern ($p=0.13$). The risk of hypertension/preeclampsia and anemia was not related to food insecurity. Compared with the food-secure group, the probability of gestational diabetes was 56% lower in the food-insecure group without hunger and 61% lower in the food-insecure group with moderate hunger; however, in the food-insecure group with severe hunger, this probability was 1.5 times more than the food-secure group, which is not statistically significant.

Conclusions: The prevalence of food insecurity was high in pregnant women. Maternal weight gains during pregnancy and birth weight (despite being statistically insignificant) were affected by this condition; therefore, it is necessary to identify women with food insecurity on their first pregnancy visit; it is also crucial to take steps towards improving their health through allocating a family food basket and nutritional support for these women at least during pregnancy. Due to the limited sample size and inability to control the potential confounders, the association between food insecurity during pregnancy and the incidence of pregnancy complications could not be reached, hence the need for more studies.

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Keywords: Food insecurity, Neonatal birth weight, Preeclampsia, Gestational diabetes, Anemia

Background

The Food and Agriculture Organization of the United Nations (FAO) has defined food security as follows: "Food security at the individual, familial, national, regional and global levels is achievable when all people at all times have physical and economic access to adequate, healthy, and nutritious food to meet their nutritional needs and dietary priorities for an active and healthy life" [1]. The FAO has further stated that family food security is obtained when a family has access to sufficient and varied amounts of safe food to meet the needs of its members for a year; the family food basket per capita is to be properly selected and prepared so it is sufficient for family members; family food should also be properly cooked to provide healthy elements and materials for the internal organs of the body [2]. According to the FAO, one out of eight people worldwide, most of whom live in developing countries, suffer from chronic hunger and do not have enough food for a healthy and dynamic life [3]. The latest FAO estimates show that approximately 805 million people suffered from chronic malnutrition in 2012–14, with the prevalence of malnutrition worldwide being 11.3% and in developing countries 13.5% [4]. The prevalence of food insecurity in Iran has been studied in different studies using different questionnaires. For example, the prevalence of food insecurity in Yazd was 30.5% [5], in Shiraz 44% [6], in Tehran 52.8% [7] and Tabriz 36.3% [8]. In Iran, the overall prevalence of family food insecurity ranges from 20 to 60% in different provinces [9].

Some evidence points to the importance of food insecurity, particularly for women; furthermore, women are more likely to suffer from poor health outcomes associated with food insecurity [10]. Family food insecurity is associated with psychosocial dysfunction [11, 12], poor mental health [13, 14], and depression [12, 15]. The findings of some existing research on the impacts of family food insecurity on pregnancy suggest a relationship between neonatal birth weight and increased birth defects [16, 17]. An American study found that maternal food insecurity was associated with an increased risk of specific birth defects such as cleft palate, large vessel displacement, tetralogy of Fallot (TOF), and spina bifida [17]. In pregnant women with HIV, poor nutritional status, which can be caused by food insecurity, increased the chances of vertical transmission of HIV to children [18].

Despite the common belief that pregnancy is a health-enhancing period, more than 40% of women become overweight or obese during this period [19]. Pre-pregnancy obesity is associated with poor nutrition and overweightness [20, 21], gestational diabetes [21, 22], gestational hypertension and preeclampsia [23, 24], and postpartum anemia [25, 26]. Many of these conditions can be exacerbated by family food insecurity [27].

Objectives

The present study aimed to determine the prevalence of food insecurity in pregnant women and its relationship with gestational weight gain, birth weight, and pregnancy complications.

Methods

Design and participants

The present cross-sectional study was conducted on 772 women who visited the health centers of Hamadan during the first 10 days following delivery. Inclusion criteria were willingness to participate in the study and lack of chronic medical problems such as diabetes, cardiovascular and renal diseases, hypertension, epilepsy, and anemia. Eighty-eight participants did not correctly complete the questionnaires, thus excluded. To maximize socioeconomic diversity among participants, first, Hamadan city was divided into eight geographical regions. Then, three health centers were selected from each region using random cluster sampling, and in selected centers, sampling was done by available sampling. About 35–36 samples were taken from each comprehensive health center so that the number of samples obtained from each region was approximately equal.

Instruments and data collection

A researcher-made demographic questionnaire and the Household Food Security Questionnaire devised by the U.S. Department of Agriculture (USDA) were used for data collection. Demographic, contextual, and midwifery information as well as a history of obstetric complications were obtained from pregnancy health care records that were available in health centers. To determine the content validity of the demographic information questionnaire, 10 midwifery teachers of the midwifery department and midwives working in the centers were asked to read the questionnaire and offer their suggestions at the discretion of the research team.

Food insecurity was evaluated using the Food Security Questionnaire developed by the U.S. Department of Agriculture which was assessed in terms of reliability and validity in Iran. The questionnaire, which investigates household food security over the past 12 months,

was completed by interviewing the participants. The questionnaire comprises two sections, one associated with the household and the other related to the child. The second part was also completed if a household had a child under 18. The questionnaire was validated by the U.S. Department of Agriculture and was introduced as a valid questionnaire for epidemiological studies in 1995. Of note, Rafiei et al. assessed and validated the 18-item questionnaire of the USDA on the households of Isfahan city in 2009 [27]. This questionnaire is scored based on the method developed by Bickel et al. The maximum score of the questionnaire is 18 provided both sections are completed, and 10 if only the first part is filled out (no children under 18). To specify the food security status, the households are ultimately classified into food secure (score 0–2 for households with and without children under 18 years), food insecure without hunger (Score 3–7 for households with children under 18 years and Score 3–5 for households without children under 18 years), and food insecure with moderate hunger (Score 8–12 for households with children under 18 years and Score 6–8 for households without children under 18 years) and food insecure with severe hunger (Score 13–18 for households with children under 18 years and Score 9–10 for households without children under 18 years) based on the score obtained from the questionnaire [28]. In the present study, the reliability of the questionnaire was examined with test–retest method and the intraclass correlation coefficient (ICC). The questionnaire was completed by 30 pregnant women within 10 days. The ICC value in the present study was 0.73, indicating the appropriate reliability of the tool.

Statistical analysis

Stata-13 was used to analyze the data. Shapiro–Wilk test was employed to investigate the normality of the distribution of quantitative variables, and the results showed that all quantitative variables had a normal distribution. The relationship between demographic variables with infant weight and pregnancy weight gain pattern was investigated using univariate linear regression. To control for the potential confounding variables, variables with p-values less than 0.2 in univariate analyses were entered into multivariate linear regression, and their effect on birth weight and gestational weight gain pattern was controlled.

Due to the limited number of pregnancy complications and therefore insufficient sample size, control of potential confounding variables on the consequences of gestational hypertension/preeclampsia, gestational diabetes, and anemia were not performed by multivariate logistic regression, and these relationships were analyzed using of Chi-square test. Odds ratios were also reported to show the strength of these relationships. The significance level was considered to be 0.05.

Results

The mean ages of the women and their spouses were 29.41 (6.00) and 34.25 (6.22), respectively. Approximately 20% of the women were primigravida. The majority of the participants had normal BMI, and about three-quarters had wanted pregnancy. 32.5% of the pregnant women were in a secure food status, whereas 67.5% were involved in certain degrees of food insecurity (Table1).

Results of the univariate analysis showed that infant weight in the food-insecure group without hunger was 105.25 g ($p=0.02$) higher than the food-secure group; in the severe food insecurity group, the infant weight was 218.77 g ($p=0.005$) lower than the secure food group. The multivariate analysis results revealed that the infant weight was 92.34 g in the food-insecure group without hunger, 179.77 g in the food-insecure group with

Table 1 Descriptions of demographic, contextual, and midwifery variables of the study participants

Variables		Mean (SD) OR N (%)
Age (year)		29.41 (6.00)
Husband age (year)		34.25 (6.22)
Education	Illiterate	15 (1.9)
	Primary	171(22.2)
	Secondary	238 (30.8)
	Diploma	267 (34.6)
	Academic	81 (10.5)
Husband education	Illiterate	9 (1.2)
	Primary	158 (20.5)
	Secondary	282 (36.5)
	Diploma	245 (31.7)
	Academic	76 (9.8)
Job	Unemployed	736 (95.3)
	Employed	21 (2.7)
Husband job	Unemployed	28 (3.6)
	Employed	733 (94.9)
Pregnancy number		2.62 (1.18)
Pre-pregnancy BMI		24.42 (3.93)
The sex of the fetus	Female	421 (54.5)
	Male	350 (45.3)
Pregnancy status	Wanted	578 (74.9)
	Unwanted	183 (23.7)
Food security status	Food security	251 (32.5)
	Hunger-free food insecurity	238 (30.8)
	Medium-hunger food insecurity	230 (29.8)
	Severe-hunger food insecurity	53 (6.9)
Income (Rial*10^4)		1308.53 (817.99)

moderate hunger, and 204.38 g in the food-insecure group with severe hunger, but the reduction was not statistically significant (Table 2).

Based on the results of univariate analysis gestational weight gain in the severe food insecurity group was 1.5 kg less than the food-secure group ($P=0.02$). The findings of multivariate analysis showed that the weight gain in the food-insecure group with severe hunger was 1.52 kg lower than the food-secure group, but the difference was not statistically significant ($P=0.13$) (Table 3).

The assessment of the association between hypertension/preeclampsia in pregnancy and food security status indicated that despite the reduction in the rate of hypertension/preeclampsia with worsening food insecurity, the reduction had no statistically significant difference (P = 0.27). According to the results, the probability of developing hypertension/preeclampsia in the food-insecure group without hunger, the food-insecure group with moderate hunger, and the food-insecure group with severe hunger was 14%, 57%, and 47% lower than the food-secure group, respectively. (p = 0.08) (Table 4).

A comparison of gestational diabetes mellitus among the food security groups indicated a significant relationship between the food security status of pregnant women and the gestational diabetes mellitus rate ($P=0.03$). The rates of OR revealed that the probability of gestational diabetes in the food-insecure group without hunger and the food-insecure group with moderate hunger were 56% and 61% lower than the food-secure group, respectively, but this rate was 52% higher in the food-insecure group with severe hunger than the food-secure group. The results showed a statistically

Table 2 Results of univariate and multivariate analysis of the relationship between neonatal weight and food security status of pregnant women

Food security status	Unadjusted $R^2=0.03$				Adjusted* $R^2=0.11$			
	b	t	*p* value	Beta	b	t	*p* value	Beta
Food security	Reference							
Hunger-free food insecurity	105.25	2.28	0.02	0.09	− 92.34	− 1.11	0.26	0.07
Medium-hunger food insecurity	− 73.37	− 1.58	0.11	− 0.07	− 179.77	− 1.84	0.06	− 0.12
Severe-hunger food insecurity	− 218.77	− 2.84	0.005	− 0.11	− 204.38	− 1.19	0.23	0.07

*Adjusted for age, spouse's age, spouse's education, spouse's occupation, fetal gender, pregnancy status, and income

Table 3 Results of univariate and multivariate analysis of the relationship between pregnancy weight gain and food security of pregnant women

Food security status	Unadjusted $R^2=0.03$				Adjusted* $R^2=0.11$			
	b	t	*p* value	Beta	b	t	*p* value	Beta
Food security	Reference							
Hunger-free food insecurity	− 0.01	− 0.04	0.96	− 0.001	− 0.36	− 0.60	0.54	− 0.03
Medium-hunger food insecurity	− 0.16	− 0.41	0.67	− 0.01	− 0.46	0.64	0.52	− 0.04
Severe-hunger food insecurity	− 1.50	− 2.30	0.02	− 0.08	− 1.52	− 1.49	0.13	− 0.08

*Adjusted for age, spouse age, pregnancy number, BMI, fetal gender

Table 4 Comparison of the status of hypertension/preeclampsia by food security status

Food security status	Hypertension/preeclampsia in pregnancy		Odds ratio (95% CI)	*Statistical analyses
	Yes N (%)	No N (%)		
Food security	17 (42.5)	234 (32.0)	1	*P* value = 0.27 *F* = 3.88
Hunger-free food insecurity	14 (35.0)	224 (30.6)	0.86 (0.41, 1.78)	
Medium-hunger food insecurity	7 (17.5)	223 (30.5)	0.43 (0.17, 1.06)	
Severe-hunger food insecurity	2 (5.0)	51 (7.0)	0.53 (0.12, 2.40)	

*Chi-square test

significant relationship between gestational diabetes and food security status (Table 5).

A comparison of pregnancy anemia among different food safety groups indicated no statistically significant relationship between the two variables ($p=0.45$). Based on the OR rates, the risk of anemia in the food-insecure group without hunger, the food-secure group with moderate hunger, and the food-insecure group were 2.15 times and 2 times and only 6% higher than the food security group, respectively. However, the trend of odds indicated no significant relationship ($p=0.33$) (Table 6).

Discussion

The present study aimed to determine the prevalence of food insecurity in pregnant women and its association with gestational weight gain, neonatal birth weight, and pregnancy complications in Hamadan County in 2018. According to the findings, 32.5% of pregnant women had food security, and 67.5% had different degrees of food insecurity varying from food insecurity without hunger to severe hunger. In a study performed by Kazemi et al. in Qazvin, approximately 44% of pregnant women had food insecurity according to the Household Food Insecurity Access Scale (HFIAS) [29]. According to the HFIAS scale, the rate of food insecurity was 36.6% in pregnant women in Nova Scotia province of Canada [30]. In Ogun State, Nigeria, the short form of the Food Security Survey (six items) showed that 46.4% of the pregnant women had food insecurity [31]. In a study conducted in North Carolina, food insecurity was only 8% in pregnant women. Similar to the present research, the foregoing study used an 18-item USDA questionnaire [10]. As shown by the above-mentioned studies, there exist significant differences in the prevalence of food insecurity among pregnant women around the world. Such differences might be attributed to the various scales used to assess the food security status, leading to disparate reports on the prevalence of food insecurity in pregnant women. Another reason is the impact of numerous factors on the food security status of the household. Household food security is affected by myriad demographic and contextual factors, including socioeconomic status, ethnicity, age, education, head of household, job loss, no fixed job, no savings, single-parent households, increased size of household, age composition of family members, children under 18 years of age in the family, monthly household income, residential home ownership status, chronic illness of family members, and smoking habit of a family member [9]. In general, it can be said that the elements of food security include availability, access, and utilization. The presence of each element is necessary, but not sufficient for food security. Availability is related to the production, import, distribution, and exchange of food in the community. Access is based on factors such as family income and purchasing power, and utilization is dependent on the adequacy and health of the food, preparation, processing, and cooking of food, the nutritional attitudes of family members about food selection, and personal health [32, 33]. Nevertheless, the most common indicators of food security pertain to food consumption,

Table 5 Comparison of gestational diabetes status by food security status

Food security status	Gestational diabetic		Odds ratio (95% CI)	*Statistical analyses
	Yes n (%)	No n (%)		
Food security	16 (47.1)	235 (31.8)	1	*P* value = 0.03 *F* = 8.47
Hunger-free food insecurity	7 (20.6)	231 (31.3)	0.44 (0.17, 1.10)	
Medium-hunger food insecurity	6 (17.6)	224 (30.4)	0.39 (0.15, 1.02)	
Severe-hunger food insecurity	5 (14.7)	48 (6.5)	1.52 (0.53, 4.37)	

*Chi-square test

Table 6 Comparison of pregnancy anemia status by food security status

Food security status	Pregnancy anemia		Odds ratio (95% CI)	*Statistical analyses
	Yes N (%)	No N (%)		
Food security	5 (20.0)	246 (32.9)	1	*P* value = 0.45 *F* = 2.59
Hunger-free food insecurity	10 (40.0)	228 (30.5)	2.15 (0.72, 6.40)	
Medium-hunger food insecurity	9 (36.0)	221 (29.6)	2.00 (0.66, 6.06)	
Severe-hunger food insecurity	1 (4.0)	52 (7.0)	0.94 (0.10, 8.26)	

*Chi-square test

measuring only part of the physiological adequacy of food security [34]. Food security may not be accounted for in these factors, and many confounding variables may play a role in household food security; therefore, it is not possible to definitively determine the prevalence of food insecurity.

Another objective of the current study was to investigate the association between food insecurity in pregnant women and their gestational weight gain. Based on the results, the increase in the severity of food insecurity reduced the gestational weight gain; thus, food insecurity had a negative impact on mothers' gestational weight gain by controlling the possible confounding variables. Mothers with "food insecurity with severe hunger" had around 1.5 kg less gestational weight gain compared with the "food secure" group, which is in contrast to the results of Laraia et al. In their study, food insecurity was assessed using a USDA questionnaire, and after controlling the confounding variables, it was shown that pregnant women with food insecurity had 1.87 kg more weight gain in comparison with food-secure pregnant women [10]. Another study reported that the probability of obesity in food-insecure pregnant women was 1.9 times higher than those without food insecurity [35]. A number of mechanisms influence the association between gestational weight gain and food insecurity: (i) food-insecure women might be economically dependent on low-cost, processed, and high-calorie foods; (ii) consumption of low-calorie and processed foods can entail weight gain over time; (iii) stress from food insecurity can lead to opting for "comfortable" foods or fat-rich, high sugar, and sodium-rich foods; and (iv) eating high-fat foods under stressful conditions is associated with visceral fat accumulation and weight gain in animals as well as humans [36]. However, there is further evidence indicating that food insecurity lowers the diet quality among women of childbearing age, reducing micronutrients and their energy intake by 50% [37]; this possibly corroborates the results of the present study. In addition, the inconsistency between the results of these studies and the present research is probably ascribed to the cultural differences in terms of dealing with these conditions. Moreover, different studies consider different classifications of food security and make use of various types of tools to assess the food security status.

The present study aimed to examine the relationship between food insecurity in pregnant women and their neonatal birth weight. The results showed that compared to food-secure mothers, the infants of those with food insecurity were born with lower weights, and the reduction was even more intense among different degrees of food insecurity. The maternal weight gain during pregnancy was another factor affecting the neonatal birth weight. The results seemed to be reasonable given that maternal weight gain was reduced with the increase in the severity of food insecurity. There is compelling evidence that poor maternal nutrition during pregnancy results in intrauterine growth restriction and weight loss at birth [38–42]. There was a statistically significant relationship between low birth weight and food insecurity in a study by Borders et al. [16]. In another study, carried out by Chowdhury et al. in Bangladesh, mothers with food insecurity had 38% higher odds of delivering babies with low birth weights compared with food-secure mothers [43].

Investigating the relationship between food insecurity in pregnant women and pregnancy complications was another purpose of the present study. Hypertension/preeclampsia, gestational diabetes, and anemia were the complications of pregnancy considered in the current research. The studied correlation between food insecurity and hypertension/preeclampsia revealed that with the increase in the severity of food insecurity, the number of hypertensive/preeclampsia patients decreased, such that the highest percentage of patients belonged to the food security group. The study of ORs showed that the probability of hypertension/preeclampsia in the food-insecure group without hunger, the food-insecure group with moderate hunger and the food-insecure group with severe hunger was 14, 57, and 47% lower than the secure group, respectively, but the trend was not statistically significant. In a study performed on 860 postpartum women in Qazvin, the risk of pregnancy hypertension and preeclampsia in the food-insecure group was 24% and about 4 times higher than the food-secure group [44]. The reason for such inconsistency might be attributed to the differences in the scale used for measuring the food insecurity of pregnant women and the approach by which the variable was classified. In the study conducted in Qazvin, the HFIAS was employed to classify the participants into food-secure and food-insecure groups. Meanwhile, it was not possible to control the possible confounding variables using multivariate regression due to the small number of hypertensive/preeclampsia individuals. In a study by Laraia et al., the probability of hypertension in the food-insecure group was 23% higher than the food-secure group after controlling the confounding variables, but the increase was not significant. Despite the common belief that pregnancy-induced hypertension is caused by metabolic disorders and, possibly, pre-pregnancy obesity, this condition might be less affected by diet, the effect of excessive weight gain during pregnancy or other causes might be greater than dietary status [10]. Food insecurity had similar relationships with gestational diabetes and hypertension/preeclampsia. In the present study, approximately 50% of the participants with gestational diabetes

mellitus were food secure; furthermore, their number decreased with the increase in the severity of food insecurity, and the differences were statistically significant. The ORs showed that the probability of gestational diabetes in the food-insecure group without hunger, the insecure group with moderate hunger, and the food-insecure group with severe hunger was 56, 61, and 1.5 times lower than the food-secure group, respectively, but the trend was not statistically significant. Laraia et al. reported inconsistent results with the present study. In their research, after controlling the confounding variables, the probability of gestational diabetes in women with food insecurity was 2.35 times higher than those with food security [10]. In the present study, it was impossible to control the possible confounding variables, possibly explaining the inconsistency existing between the foregoing study and the present one. However, Khosravi et al. observed no significant association between gestational diabetes and food insecurity [45]. The association between food insecurity and gestational diabetes might be negatively correlated with poor health behavior and an unhealthy diet involving high fat intake during pregnancy [46]. Therefore, eating culture in any society may be a determinant of the incidence of gestational diabetes.

Another objective of the present study was to examine the relationship between food insecurity during pregnancy and anemia. The ORs revealed that the probability of anemia in the food-insecure group without hunger and the insecure group with moderate hunger was around 2 times higher than the food-secure group; however, this probability was reduced by 6% in the food-insecure group with severe hunger in comparison to the food-secure group. This result is confirmed by a study on the association between the second-trimester anemia and food insecurity. Their results showed that women with moderately secure food status were 2 times more likely to develop anemia compared to those with food security; this probability was 24% higher in women with food insecurity in comparison to those with food security. After controlling the confounding factors, the rate was 75% higher in women with relatively secure food status than those with food insecurity; moreover, this rate was 6% lower in food-insecure women compared to those with food security [10] Anemia during pregnancy might be more affected by higher blood volume, pregnancy nausea and vomiting, and lack of iron supplementation rather than dietary status [25]. Therefore, in both studies, anemia did not increase in individuals with food insecurity compared to food secure.

With every 10–30 positive outcomes, it is necessary to include a variable in the model to perform the logistic regression; due to the limited number of people with hypertension/preeclampsia, gestational diabetes, and anemia, it was impossible to perform logistic regression and control the effects of possible confounding variables on the research outcomes, which was one of the limitations of the current study. Furthermore, despite the significant relationship between the variables and certain demographic and midwifery variables, it was not possible to perform the logistic regression and control the effects of probable confounding variables on the research result. To obtain better results, more studies with appropriate sample sizes should be conducted to investigate the relationship between these complications and food insecurity in pregnancy.

Conclusion

The results of the present study indicated the high prevalence of food insecurity in pregnant women. However, it might not be possible to consider all the dimensions of food security. Many confounding variables may play a role in household food security, which leads to uncertain measurements of food insecurity prevalence.

Given that maternal weight gain during pregnancy and neonatal birth weight were affected by food security status, women with food insecurity should be identified in their first pregnancy visit; further steps should be taken towards improving their health by donating a household food basket at least during pregnancy. Because of the limited sample size mentioned in the previous section, no reliable conclusion can be drawn regarding the relationship between food insecurity during pregnancy and the incidence of pregnancy complications, hence the need for future studies with larger sample sizes.

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Authors' contributions
Analysis and interpretation of data: FK and SZM; drafting of the manuscript: AS; critical revision of the manuscript for important intellectual content: SZM and SZSY; statistical analysis: FK. All authors read and approved the final manuscript.

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Availability of data and materials
Data that support findings of this study are available upon request through the corresponding author.

Ethical approval and consent to participate
The study design was explained Deputy of Research and Technology of Hamadan University of medical sciences for their permission and support. The study was fully explained to respondents to obtain consent. Information was collected after securing consent from the study participant. Data obtained from each study participant were kept confidential, and all peoples who participated in the study were acknowledged. The consent form has been read to me and voluntarily I agree to participate in this study.

Consent for publication
Hamadan University of Medical Sciences has obtained permission to publish the article.

Competing interests
The authors declare that they have no competing interests.

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