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Effects of Post-Joint Comprehensive Plan of Action Sanctions on Weight Gain of Pregnant Mothers, Birth Weight, and Food Security of Their Families (2017-2020)

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ABSTRACT

Background: Sanctions against a country could be a shock to the country's economy for a specific period. Iran has been subject to various sanctions for the past 40 years, and these sanctions have intensified since 2011. Unprecedented sanctions were imposed on Iranians after the United States withdrew from the Joint Comprehensive Plan of Action (JCPOA) agreement, and a disastrous economic situation was the outcome of this international issue. The present study aims to evaluate the impact of this situation on weight gain of pregnant mothers and birth weight as well as food security of their families. M**ethods:** The data of pregnant women and newborns were extracted from Sina Electronic Health System (SinaEHR®) questionnaires. These questionnaires were completed by trained healthcare workers in comprehensive health service centers. The data of 266,182 pregnant women were collected through questionnaires from 19 comprehensive health centers related to Razavi Khorasan province and were prepared for statistical analysis. Then, data analysis was done using the statistical method of Generalized Estimating Equations (GEE) by SPSS software. **Results:** Examining the data of 266,182 pregnant mothers during the sanctions period of 2017 to 2020 in Iran shows that the weight gain of pregnant mothers (P<0.001) and the birth weight of the newborns (P<0.047) have decreased significantly. **Conclusion:** According to the results, there has been a significant reduction in the two variables of weight gain in pregnant women and newborns' birth weight, which confirms the debilitative effects of sanctions on these important outcomes.

Keywords: *Sanctions; Joint comprehensive plan of action (JCPOA); Food security; Pregnancy; Birth weight; Generalized estimation equations (GEEs).*

Introduction

In recent decades, Iran has experienced various sanctions imposed by the United States and Europe. Unfortunately, sanctions against Iran have been intensified since 2011 and the peak of these sanctions began on November 4, 2016, by the United States. With the start of sanctions post Joint Comprehensive Plan of Action (JCPOA) in Iran, drastic changes occurred in economic indicators

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such as the inflation index, consumer price index, and food price index (Shafaati *et al.*, 2023, Statistical Center of Iran). The increase in inflation and the price of food items can weaken the anthropometric status of sensitive groups, including pregnant women and infants which is very important (Garfield, 1997, Ioana, 2010). Poor nutrition during pregnancy can have short-term and long-term consequences for the mothers and newborns, such as postpartum hemorrhage, prolonged labor, spontaneous abortion, fetal abnormalities, intrauterine growth restriction, preterm birth, and low birth weight (Bloomfield, 2011, Roseboom *et al.*, 2011, Simeoni *et al.*, 2018). Infants born with poor nutrition will be exposed to diseases such as obesity, type II diabetes, hypertension, and cardiovascular diseases in the future (Simeoni *et al.*, 2018).

In a study conducted by Aloosh (Aloosh *et al.*, 2019), the author reported that sanctions adversely affect public health by impeding access to various drugs and treatments. Furthermore, Kokabisaghi (Kokabisaghi, 2018) stated that sanctions have reduced well-being due to impaired access to food and medicine. In another study (Danaei *et al.*, 2019), the author observed unfavorable access to medicine and medical services due to post-JCPOA sanctions. Notably, the sample population and outcomes of the aforementioned studies are different.

This study aims to investigate the effects of post-JCPOA sanctions on nutrition related indicators in pregnant women and infants and evaluate the food security situation in their families.

Materials and Methods

Data sources

SINA Electronic Health Record (SinaEHR®) System is an integrated health information system under the supervision of Mashhad University of Medical Sciences, which includes the health records of more than five million people in Razavi Khorasan province. Since 2015, all the health variables of those who refer to the comprehensive health centers of the province are recorded in this system. Due to the registration of all data in Sina system in a classified manner, health information of people is easily accessible.

For this study, the authors collected data related to demographic, anthropometric, laboratory, and food security variables of pregnant mothers. The variable of "Food Security Score" is the score obtained from the Household Food Insecurity Access Scale (HFIAS) (Khorramrouz *et al.*, 2020, Mirzadehahari *et al.*, 2015, Nejati *et al.*, 2017). HFIAS provides a simple and user-friendly approach for measuring the impacts of the development of food aid programs on the access component of household food insecurity. The guide includes a standardized questionnaire, data collection, and analysis instructions. HFIAS is composed of a set of 9 questions that have been used in several countries and appear to distinguish food- insecure households from food-secure ones across different cultural contexts. The information generated by HFIAS can be used to assess the prevalence of household food insecurity and detect changes in food insecurity situation of a population over time. The "mothers taking supplements" variable shows the percentage of mothers who have received and consumed special supplements during pregnancy (including iron, folic acid, and multivitamins). The authors measured it because supplements were eliminated or occasionally distributed in some centers. The "food pattern rating" variable is obtained through a 6-item questionnaire designed by the Iranian Ministry of Health. This questionnaire evaluates the status of consumption of fruits, vegetables, dairy products, salt, fast foods, and oils in the pregnant mother, and the resulting information shows a general view of the food pattern of the family and the pregnant mother.

Study design

At first, all the questionnaires related to pregnant women and newborns, which are completed by health workers, were checked, and the data required for the study were extracted from March 2017 to March 2020 (36 months). The data included all pregnant women who visited the

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health service centers of Khorasan Razavi province (including 19 main centers of the province) on this date. Based on the period, data from 19 centers were classified as before the sanctions (from March 21, 2017, to February 19, 2019) and after the sanctions (from February 20, 2019, to March 19, 2020). Then, data were analyzed using the Generalized Estimation Equations (GEEs) statistical method. To divide the period before and after the sanctions, the total inflation index and the food inflation index published by the National Statistics Center of Iran were used (**Figure 1**).

Ethical considerations

The Ethics Committee of Mashhad University of Medical Sciences approved the study under the code of IR.MUMS.MEDICAL.REC.1399.108

Data analysis

After collecting the required data from SINA electronic health record system, data analysis was performed in Excel and then SPSS software using descriptive and analytical statistics. From the line chart, simple and dispersion indices (mean, SD, median, and interquartile range) were used to describe data and consider the correlation and relationship between variables. In addition, the research hypotheses were tested using GEEs (Geert, 2006). Studies have shown that for the analysis of this type of data, GEEs provide better results compared to other methods (Zeger and Liang, 1992). Data were interpreted at a significance level of 5%.

Results

The authors have shown a general description of the population in the tables and figures. **Table 1** describes the quantitative and qualitative variables of the population.

Figure 2 depicts the trend of the percentage of mothers with appropriate weight gain during 36 months during 3 years. A decreasing trend could be observed since April 2019. At the beginning of 2019, 70% of the mothers had proper weight gain, while only 60% had proper weight gain at the end of 2019 (P<0.001).

Figure 3 shows the trend of changes in birth weight of infants during 36 months. A decreasing trend could be observed with a very slow slope, while changes in the mean weight of the infants were 100 grams (range: 3.14-3.24 kg) over 3 years, with a relatively small range of change.

Maternal weight gain, birth weight, and maternal supplementation use showed significant differences before and after the sanctions (P≤0.001, P=0.047, and P=0.006, respectively). The odds ratio (OR) of these variables was estimated at 0.955(0.935-0.976), 0.985(0.969-0.999), and 1.005(1.002-1.009), respectively.

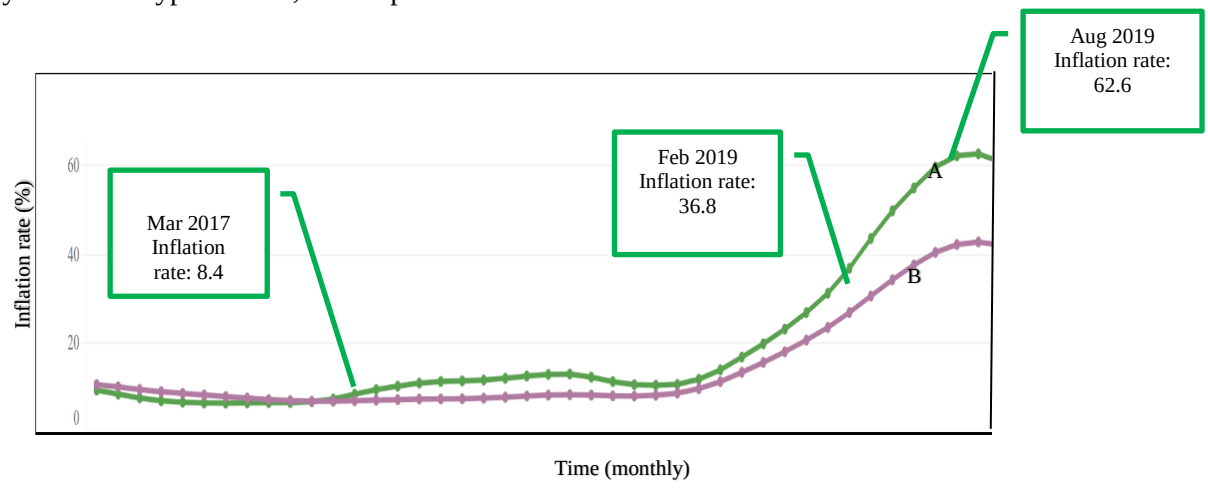

Figure 1. Status of Food Inflation Index (A) and Total Inflation Index (B) Based on the Data of National Statistics Center of Iran (March 20, 2016-August 2019).

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Table 1. Descriptive information of the study population.

Variables	Before sanctions	After sanctions
Mother's age (year)	29.90±1.28[a]	29.10±0.90
Newborn's birth weight (kg)	3.18±0.08	3.17±0.05
Mother's education (years)	12.80±0.80	12.50±0.74
Maternal body mass index (kg/m^2)	24.78±1.03	24.76±0.70
Food security score	2.74±3.51	2.11±2.11
Food pattern score	9.90±0.49	9.78±0.56
Maternal hemoglobin (g/dl)	12.78±0.27	12.79±0.26
Gender of the boy	52(7.0)[b]	51(5.0)
Non-alcoholic mothers	99(0.1)	99(0.1)
Non-smoking mothers	99(0.1)	99(0.1)
Maternal anemia	0.4(1.0)	0.1(1.0)
Normal delivery	60(15.0)	59(14.0)
Mothers with appropriate weight gain (%)	70 (7.0)	60 (8.0)
Employed mothers	16(7.0)	22(6.0)
Mothers taking supplements	97(3.0)	97(2.0)

[a]: Mean ± SD; [b]: n (%).

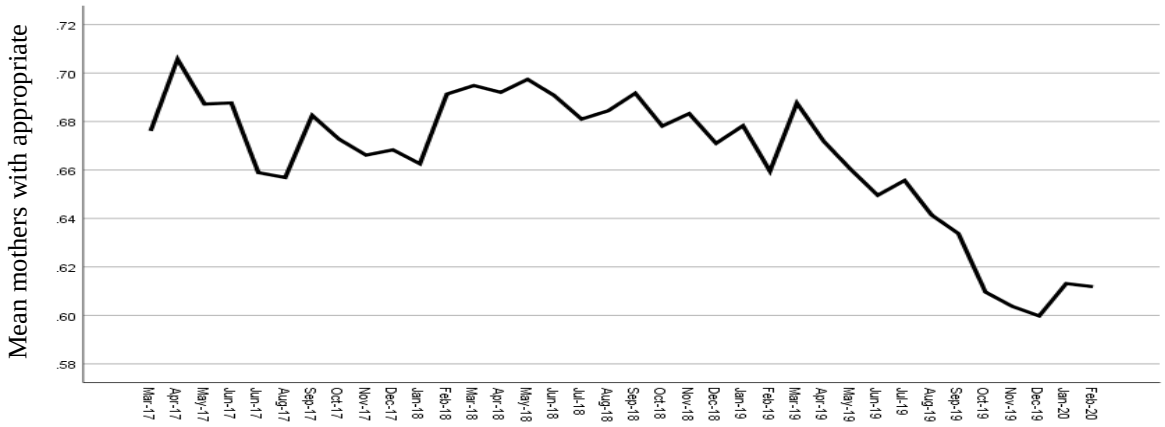

Figure 2. Trend of weight gain status of pregnant women during 36 months.

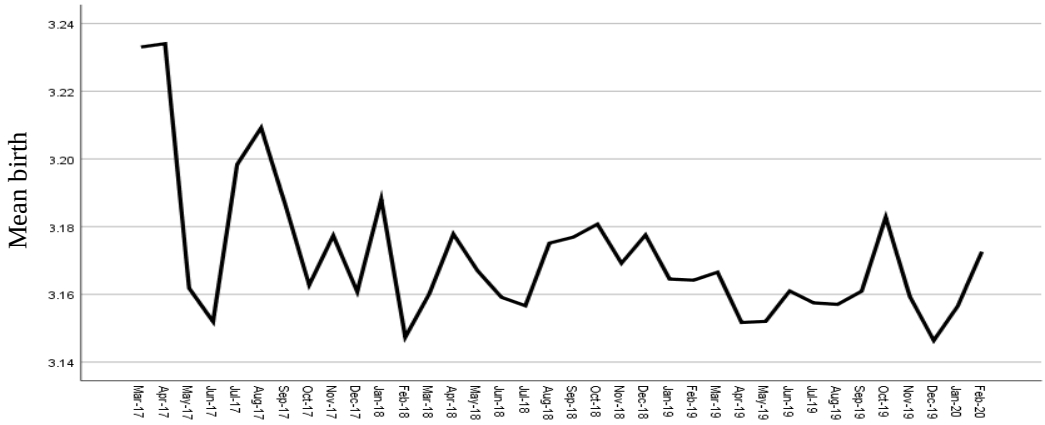

Figure 3. Trend of Birth Weight of Infants during 36 Months.

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Table 2. Results of Data Analysis Using the GEE Model.

Dependent variables	SE	B	OR (95% confidence interval)	P-value
Maternal weight gain[a]	0.0100	-0.044	0.955(0.935-0.976)	<0.001
Birth weight[b]	0.0077	-0.015	0.985(0.969-0.999)	0.047
Maternal supplementation[c]	0.0020	0.005	1.005(1.002-1.009)	0.006
Maternal diet score	0.1009	-0.089	0.907(0.668 – 1.103)	0.378
Food security score	0.3256	-0.638	0.528(0.279-1.000)	0.072
Preterm birth	0.0070	- 0.004	0.996(0.982-1.010)	0.559
Maternal body mass index	0.1159	0.137	1.128(0.906-1.305)	0.236
Maternal hemoglobin	0.0336	0.038	1.038(0.972-1.099)	0.254

[a]:Adjusted effects of maternal underlying diseases, maternal anemia, stillbirth history, maternal alcohol consumption, maternal smoking habits, maternal drug use, maternal education level, maternal occupation status, and maternal age ;[b]: Adjusted effects of neonatal gender, maternal BMI, number of pregnancies, maternal alcohol consumption, maternal smoking habits, maternal underlying diseases, maternal anemia, stillbirth history, mode of delivery, maternal education level, maternal occupation status, maternal age, and maternal drug use; [c]: Adjusted effects of maternal age, maternal education level, maternal occupation status, and maternal underlying diseases

Discussion

According to the results of the present study, post-JCPOA sanctions have had a negative impact on maternal weight gain and birth weight of babies born during sanctions. These results were expected due to extreme changes in economic indicators after the sanctions. Similar studies also investigated the effects of sanctions on the Iranian population in areas such as public health, welfare (Danaei *et al.*, 2019, Hufbauer *et al.*, 1990, Kokabisaghi, 2018, Moret, 2015), and health systems and services (Gorji, 2014, Madani-Lavassani, 2020, Massoumi and Koduri, 2015); however, to date, no study has examined negative effects of sanctions on pregnant mothers and fetal development.

The findings of this study indicated a downward trend in the studied variables. At the beginning of 2017, 70% of the mothers had proper weight gain, while at the end of 2019, only 60% had proper weight gain during pregnancy. The number of pregnant mothers with appropriate weight gain in post-sanction period has decreased. In other words, according to the odds ratio, for every 1,000 mothers, 45 more mothers suffer from inappropriate weight gain compared to the pre-sanctions period.

Moreover, it was found that sanctions were associated with the birth weight of the newborns, which was significantly lower after sanctions, compared to before sanctions. In this regard, in a comprehensive study (Ioana, 2010), studies conducted in 69 countries regarding sanctions were reviewed, and it was concluded that sanctions causes the birth of neonates with LBW; they were reported to have developmental disorders and even face early death in the future. In the mentioned study, the most significant impact of sanctions was reported on mothers and infants who were exposed to the first 2 years of the sanction period. The findings of this study were in line with the study by Ioana (Ioana, 2010) regarding the severity of post-JCPOA sanctions.

In the current research, it was found that the number of mothers using supplements had a significant upward trend and increased by 5 per 1000 people in the post-sanction period. These changes can be explained by the fact that the consumption of supplements has increased over time due to poor nutrition, and pregnant women cannot compensate for their nutritional deficiencies.

Maternal BMI before pregnancy is a key indicator of maternal nutritional status before the onset of pregnancy (Khosravi *et al.*, 2005). Some studies have examined the effects of sanctions on anthropometric indices (e.g., BMI, height, weight) in pregnant women, which indicated that the BMI of the mothers who were able to reproduce significantly decreased after sanctions, and

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sanctions adversely affected proper BMI (Ioana, 2010, Mulder-Sibanda, 1998). However, maternal BMI showed no significant difference before and after the sanctions in the present study. Therefore, since blood biomarkers are more valuable than some other variables like food items (Ali Babaei *et al.*, 2016), it is suggested that similar studies would repeat on blood biomarkers based on the data of SINA system or other similar data.

The food security index obtained through HFIAS questionnaire (Mirzadehahari *et al.*, 2015) was another important variable in this study, which showed no significant difference before and after sanctions. This was inconsistent with the previous findings conducted by Heydari and Hejazi (Heidari, 2018, Hejazi and Emamgholipour, 2020), which demonstrated a significant decrease in daily caloric intake and household food security after sanctions. In Heydari's study, the author predicts that daily calorie intake and food security of the household will decrease significantly with prolongation of sanctions after the JCPOA. The difference between food security index in the research by Heydari and this study is that Heydari used FAO food security index (i.e., average household food security index), which is based on calorie and protein intake of households, and is usually calculated with the help of food frequency questionnaire data (Sangsefidi *et al.*, 2020). However, the authors used the food security index of the Health Ministry (HFIAS). In the current study, no significant changes were observed in food security. Unfortunately, due to COVID-19pandemic since the end of 2019 and its coincidence with post-JCPOA sanctions, the data from this period were not included in the study. If it was possible to use the data, the authors could probably find a decrease in food security scores. In the study by Hejazi, food security was estimated by calculating the share of household food expenditure. The costs regarding a healthy diet based on food pyramid were estimated, and the manual of Smith and Subandoro was also employed to classify food insecurity (Hejazi and Emamgholipour, 2020). The authors concluded that food insecurity had increased among urban and rural households during the post-JCPOA sanctions period compared to before that time. The data required to assess food security in the study by Hejazi addressed the amount of household income and expenditure to provide food for that family, which are completely different from the assessment method of food security in the present study (HFIAS). Notably, studies in this regard are limited, and further investigations are recommended.

One of the main limitations of this study was the prevalence of COVID-19, which made it impossible to enter the data for late 2019 and shorten the period of the study. Another limitation was the lack of division of sample population into different groups in terms of economic status. In addition, we use HFIAS because it was in SINA, although it assessed food security of household not individuals.

Conclusion

According to the results, post-JCPOA sanctions have negatively affected the weight gain of pregnant women and neonates' birth weight. These damages are likely to have the greatest impact on individuals with poor socioeconomic status and may predispose Iranians to multiple serious health problems in the near future. Evidence is scarce regarding the impact of sanctions on different aspects of health at various stages of life. Therefore, further investigations are required to ensure that sanctions do not violate fundamental health rights.

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Authors' contributions

Khosravi M and Gohari M designed the research, and Gohari M conducted it; Khadem-Rezaiyan M provided essential materials; Jamali J and Gohari M analyzed data and performed statistical analysis; Khosravi M and Gohari M wrote the paper, and Khosravi M had primary

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responsibility for final content. Moreover, Ranjbar G and Khorramrouz F helped in writing the final manuscript. All the authors read and approved the final manuscript.

Conflict of Interest

The authors declared no conflict of interest

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