The Association between Pre-Pregnancy BMI, Gestational Weight Gain and Pregnancy Outcomes: A Retrospective Cohort Study in Ahvaz, Iran

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Research article

Keywords: Hyperglycemias; Mother, Pre-pregnancy body mass index, Pregnancy Outcomes, Pregnancy Weight Gain

Posted Date: December 4th, 2020

DOI: <https://doi.org/10.21203/rs.3.rs-117813/v1>

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Abstract

Background: Maternal body mass index and maternal gestational weight gain can have positive effects on birth and maternal outcomes. We aimed to identify the effect of pre-pregnancy weight and gestational weight gain on birth outcomes.

Methods: Data of this retrospective cohort study were extracted using the 1457 out of 1800 pair health records belonged to the pregnant mother and infant at Ahvaz health care centers, from 2010 to 2018.

Result: The 3.18-fold increased risk for large for gestational age in overweight mothers, and a 2.9 fold increased risk for small for gestational age in those mothers with gestational weight gain below the guidelines. An increased risk of large for gestational age, low birth weight, and macrosomia were observed in overweight mothers with gestational weight gain out of the guidelines. The increased association was found between the maternal pre-body mass index and fasting blood sugar ($p = 0.0001$). Hence, hyperglycemia is related to a 3.58-fold incidence of macrosomia.

Conclusion: Therefore, conducting more educational programs of lifestyle intervention with respect to reproductive health care is required for all women in childbearing age (before and during pregnancy), with the purpose of reducing the adverse pregnancy outcome.

Background:

Maternal pre-pregnancy BMI (Body mass index) and maternal gestational weight gain (GWG) can have positive effects on birth and maternal outcomes [1]. The prevalence of overweight and obesity is increasing in all age groups worldwide, and it is related to non-communicable diseases [2]. Nonetheless, WHO reported more than half of the Iranian females are overweight or obese [3]. The global burden of overweight and obese pregnant women has increased in high income and middle income countries [4]. Additionally, the Islamic Republic of Iran was considered for the 20 high overweight burden countries [4]. Therefore, the pre-pregnancy BMI and GWG below or above the Institute of Medicine (IOM) guidelines are considered as two effective factors on pregnancy outcomes [1]. The prevalence of the adverse outcomes was reported as 37.2% in pregnant women, ranging from 34.7–61.1% among underweight and obese (grade 3) women, respectively. Adverse maternal and infant outcomes were affected by maternal pre-pregnancy BMI more than incremental gestational weight gain [5].

The finding of some epidemiological studies [6, 7] have reported a positive association between pre-pregnancy BMI and the prevalence of gestational diabetes mellitus (GDM), as well as higher risk of childhood obesity [8].

A meta-analysis in 2017 reported that a low GWG was positively related to small for gestational age (SGA) and preterm birth, and lower risk for large for gestational age (LGA) and macrosomia. Also, a higher risk for LGA, macrosomia, and cesarean delivery was found in excessive GWG [9]. The excessive GWG can result in adverse maternal outcomes such as cesarean delivery, GDM, preeclampsia, and postnatal weight retention [10]. In 2009, IOM has recommended the mean and range for the incremental weight gain during the 2nd and 3rd trimester by pre-pregnancy BMI class [11].

Despite the importance of adequate total GWG, the excessive GWG before 20 weeks was associated with a higher risk of LGA, regardless of total GWG [12]. Also, the early excessive GWG can lead to a higher prevalence of GDM, regardless of pre-pregnancy BMI [6]. Several epidemiological studies have provided some evidence from different regions of Iran, in terms of the role of GWG and pre-pregnancy BMI and adverse pregnancy outcomes. Hence, low birth weight (LBW) [13] more prevalent in women with GWG less than the weight gain recommended by institute of medicine (IOM) and macrosomia [14] reported in women with GWG higher than the guideline. In addition, women with pre-pregnancy obesity were associated to macrosomic infants [15] [16].

Moreover, with a corresponding rise in overweight and obesity among population, this led to an increase in GWG and adverse pregnancy outcome. Therefore, the aim of this retrospective cohort study was to evaluate the relationship between maternal pre-pregnancy BMI, Gestational Weight Gain and pregnancy outcomes.

Methods:

Data of this retrospective cohort study were extracted using the pair health records of the pregnant mother and infant at Ahvaz health care centers from 2010 to 2018. The study was approved by the Ethics Committee of Ahvaz Jundishapur University of Medical Sciences (IR.AJUMS.REC.1396.80).

The final sample size has 1457 participants out of 1800 based on GWG as the main variable. The trained research assistants were comprehensively collected information. Exclusion criteria were as follows; incomplete data for maternal during pregnancy and her offspring, multiple pregnancies, preeclampsia/ eclampsia and type 2 diabetes mellitus (T2DM), and preterm pregnancy. Information included 1: maternal characteristics (age, pre-pregnancy weight and height, pre-pregnancy BMI, GWG, last delivery mode, pregnancy history (GDM, lifestyle before and during pregnancy (alcohol consumption and smoking), fasting blood sugar (FBS), was categorized into ≥ 92 and < 92 according to International Association of Diabetes and Pregnancy Study Groups (IADPSG)[17], and 2: offspring characteristics comprise of gender, birth weight, small for gestational age (SGA), large for gestational age (LGA), appropriate size for gestational age (AGA) at birth, low birth weight (LBW), normal birth weight, and macrosomia.

Measurements:

SGA and LGA new-born were defined as those whose birth weights for gestational age were $< 10^{\text{th}}$ and $> 90^{\text{th}}$ percentiles. Macrosomia and LBW were defined by a birth weight $> 4000\text{g}$ and $< 2500\text{g}$, respectively [18]. Pre-pregnancy BMI and GWG categories were estimated in terms of the IOM recommendations. Some variables were calculated as followings:

Pre-pregnancy BMI (kg / m^2): the dividing pre-pregnancy self-reported body weight (kg) by height (m^2) was measured at the first antenatal visit, ($\text{weight (kg)} / \text{height}^2 (\text{m}^2)$).

Incremental weight gain (gr / week): the difference weight 2 and weight 1 divided by weeks between weights ($\text{weight 2} - \text{weight 1}$) ($\text{gr} / \text{follow up duration (week)}$) [3].

Statistical analysis:

SPSS statistical software package, version 18.0 (SPSS, Inc, Chicago, Illinois, USA) was used for statistical analyses. P values $< .05$ were considered as statistically significant using the 2-tailed tests. The analysis of continuous variables (maternal age, GWG rate during trimester 2nd and 3rd, birth weight) was performed by the means (standard deviations (SD)). The categorical variables (FBS, pre-pregnancy BMI, GWG, last delivery mode, disease history, birth weight, gender of infant, and adverse birth weight outcomes) were analyzed by frequency (number and (%)). The spearman's correlation was performed between FBS and pre-pregnancy BMI. Chi-square test was used to evaluate the relationship between FBS and macrosomia.

The analysis of covariance (ANCOVA) with adjusting the baseline values (maternal age, maternal pre-BMI, and infant birth weight) was performed to compare the GWG during 2nd and 3rd trimester with FBS. The risk for adverse birth weight outcomes (macrosomia, LBW, SGA and LGA) in women with different pre-pregnancy BMIs and GWGs were

tested using the multivariable multinomial logistic regression analysis to estimate adjusted odds ratios (aOR) and 95% confidence intervals (95% CI). The binary logistic regression was used to estimate the risk of macrosomia in women with different FBS levels.

Results:

This study included 1457 pairs of the mother and offspring. The characteristics of the samples are shown in Table 1. The prevalence of maternal overweight and obesity were shown 56.8%. The proportion of underweight mothers was 3.5%.

Table 1
Characteristics of the studied sample of mothers and their offspring.

Maternal characteristics	
Maternal age (years), mean (SD)	28.36 (5.60)
Pre-pregnancy BMI, N (%)	43 (3.5)
• < 18.5 kg/m ²	491(39.7)
• 18.5–24.9 kg/ m ²	459 (37.2)
• 25-29.9 kg/ m ²	242 (19.6)
• > 30 kg/ m ²	
GWG, N (%)	452 (36.6)
• Below IOM guidelines	210 (17)
• Within IOM guidelines	573 (46.4)
• Above IOM guidelines	
last delivery mode	557 (47.2)
• Cesarean	622 (52.8)
• Vaginal	
Gestational Diabetes Mellitus N (%)	43 (3.5)
Pre-pregnancy BMI, mean (SD)	Incremental GWG (kg/wk)
• Underweight	2nd trimester 3rd trimester
• Normal	0.46 (0.243) 0.43 (0.643)
• Overweight	0.37 (0.408) 0.37 (0.553)
• Obesity	0.38 (0.336) 0.32 (0.561)
	0.29 (0.340) 0.22 (0.616)
• FBS Less than 92 (mg/dl) N(%)	1305 (90.6)
• FBS Equal /More than 92 (mg/dl) N(%)	135 (9.4)
Offspring characteristics	
Males, N (%)	692(52.6)

Data expressed as N (%) or mean (SD).

BMI, Body Mass Index; GWG, Gestational weight gain; GDM, Gestational Diabetes Mellitus; FBS, fasting blood sugar; LBW, low birth weight; AGA, Appropriate for gestational age; SGA, small-for-gestational age; LGA, large -for-gestational age;

Maternal characteristics	
Birth weight (kg), mean (SD)	3271.37 (486.57)
• LBW N (%)	65(4.5)
• Normal birth weight N (%)	1286(89.3)
• Macrosomia N (%)	89(6.2%)
• SGA N (%)	145 (10.1)
• AGA N (%)	1166 (81)
• LGA N (%)	129 (9)
Data expressed as N (%) or mean (SD).	
BMI, Body Mass Index; GWG, Gestational weight gain; GDM, Gestational Diabetes Mellitus; FBS, fasting blood sugar; LBW, low birth weight; AGA, Appropriate for gestational age; SGA, small-for-gestational age; LGA, large -for-gestational age;	

36.6% and 46.4% of mothers had GWG below and above IOM guidelines, respectively. The normal birth weight and appropriate gestational for age (AGA) were reported as 89.3% and 81%, respectively. Also, no preterm birth was reported in the present study. Moreover, the prevalence of LBW, SGA, LGA and macrosomia were 4.5%, 10.1%, 9% and 6.2% respectively (Table 1).

Also, GWG above IOM guidelines was found 56.3% and 51% in overweight and obese mothers, respectively. The prevalence of inadequate GWG and excessive weight gain in normal-weight mothers were 39.7% and 37.3%, respectively.

The FBS level ≥ 92 mg/dl was 9.4%. The association was found between maternal pre-pregnancy BMI and FBS level ($p = 0.0001$). The increase in prevalence rate of macrosomia was found as 11.9% and 5.6% in the mothers with FBS $\geq$ and less than 92 mg/dl, respectively ($p = 0.004$). FBS ≥ 92 mg/dl is related to a higher incidence of macrosomia (OR 2.75, 95% CI 1.43 – 5.25), especially with adjusted variables (pre-pregnancy BMI, maternal age, hemoglobin, delivery mode, and GWG in the 2nd and 3rd trimester) (aOR 3.58, 95% CI 1.69 – 7.58). GWG during 2nd and 3rd trimester was higher in mothers with FBS ≥ 92 mg/dl in comparison to FBS less than 92 mg/dl (0.358 gr/week vs. 0.235 g/ week, $p = 0.01$). (Not present in table)

In comparing normal weight mothers, overweight mothers were at increased risk of LGA Mothers with GWG below the IOM guideline were at the increased risk for compared to GWG within IOM guideline (Table2).

Table 2

Adverse birth weight outcomes associated with maternal pre-pregnancy BMI and Gestational Weight Gain according to Institute of Medicine guidelines.

Pre-pregnancy BMI	Macrosomia OR (95% CI)	P	LBW OR (95% CI)	P	LGA OR (95% CI)	P	SGA OR (95% CI)	P
Normal	1		1		1		1	
Underweight	0.42 (0.05–3.68)	0.43	1.58 (0.39–6.33)	0.51	0.21 (0.02–1.74)	0.14	1.27 (0.3–4.95)	0.78
Overweight	0.52 (0.199–1.38)	0.19	1.93 (0.51–7.38)	0.33	3.18 (1.45–7.29)	0.007	1.26 (0.56–2.82)	0.56
Obese	0.77 (0.31–1.89)	0.56	1.63 (0.71–5.69)	0.45	1.1 (0.85–1.4)	0.12	1.21 (0.54–2.7)	0.63
GWG								
Within IOM guideline	1		1		1		1	
Below IOM guideline	0.47 (0.125–1.79)	0.88	3.17 (0.77–13.14)	0.11	1.11 (0.4–3.07)	0.83	2.9 (1.16–7.45)	0.02
Above IOM guideline	1.09 (0.33–3.57)	0.27	0.855 (0.16–4.51)	0.85	0.46 (0.14–1.45)	0.18	1.7 (0.77–4.19)	0.17
Data presented as OR (95% CI)								
GWG ,Gestational Weight Gain; IOM, Institute of Medicine.								
Adjusted for gestational weight gain during trimester 2 ^{sd} and 3rd, maternal age, gravity, maternal fasting blood sugar, delivery mode and infant gender.								

The birth weight was increased along with higher pre-pregnancy BMI (p = 0.04)(Table 3).

Table 3
The association between birth weight with pre-pregnancy BMI and Gestational Weight Gain according to Institute of Medicine guidelines.

Pre-pregnancy BMI, (N)	Birth weight, Mean (SD)
Underweight (42)	3194.28 (398.16)
Normal (488)	3244.54 (479.2)
Overweight (456)	3265.13 (499.39)
Obese (239)	3346.59 (508.13)
p-value	0.04
GWG (N)	
Below IOM guideline	3265.90 (496.13)
Within IOM guideline	3246.31(445.38)
Above IOM guideline	3282.74 (503.37)
p-value	0.64
Data presented as Mean (SD)	
GWG, Gestational Weight Gain; IOM, Institute of Medicine.	

GWG less than the IOM guidelines were associated with higher rates of SGA for mothers with a pre-pregnancy normal BMI. For overweight mothers, GWG less than the IOM guidelines were associated with higher rates of macrosomia, LBW and LGA, in comparison with the overweight mothers with GWG within the IOM guidelines. In addition, for overweight mothers, GWG above the IOM guidelines were associated with higher risks of macrosomia, LBW, and LGA in comparison to the overweight mothers with GWG within the IOM guidelines (Table 4).

Table 4

The birth weight associated with gestational weight gain according to Institute of Medicine (IOM) guidelines in women with pre-pregnancy BMI.

Maternal BMI	Outcome	Below IOM guidelines ^a	Within IOM guidelines ^a	Above IOM guidelines ^a	Below vs. Within Adjusted OR (95% CI) ^b	P	above vs. Within Adjusted OR (95% CI) ^b	P
underweight	Normal birth weight	0	0	0	-	-	-	-
	Macrosomia	1 (4.8)	0	0	-	-	-	-
	LBW	20 (95.2)	12 (100)	9 (100)	-	-	-	-
	AGA	17 (81)	2 (16.7)	0	-	-	-	-
	SGA	2 (9.5)	10 (83.3)	9 (100)	-	-	-	-
	LGA	2 (9.5)	0	0	-	-	-	-
normal weight	Normal birth weight	13 (6.7)	14 (12.5)	6 (3.3)	1		1	
	Macrosomia	8 (4.1)	4 (3.6)	13 (7.2)	1.204 (0.138–10.48)	0.86	0.845 (0.105–6.804)	0.87
	LBW	174 (89.2)	105 (93.8)	162 (89.5)	5.98 (0.504–70.960)	0.15	0.351 (0.016–7.925)	0.51
	AGA	27 (13.8)	13 (9)	14 (12.5)	1		1	
	SGA	156 (80)	117 (81.3)	94 (83.9)	5.4 (1.02–28.4)	0.04	0.418 (0.096–1.818)	0.24
	LGA	12 (6.2)	14 (9.7)	4 (3.6)	0.665 (0.084–5.24)	0.69	2.48 (0.348–17.72)	0.36
Overweight	Normal birth weight	6 (4.2)	2 (3.6)	13 (5.1)	1		1	
	Macrosomia	10 (6.9)	3 (5.5)	17 (6.6)	10.3 (7.84–54.01)	< 0.001	13.3 (13.327–13.33)	0.0001
	LBW	128 (88.9)	50 (90.9)	227 (88.3)	5.4 (2.73–32.7)	< 0.001	11.23 (11.22–11.25)	0.0001
	AGA	3 (9)	5 (9.1)	25 (9.7)	1		1	

multivariable multinomial logistic regression analysis.

^a Data presented as N (%). ^b Data presented as OR (95% CI).

Adjusted for gestational weight gain during trimester 2nd and 3rd, maternal age, gravity, maternal fasting blood sugar, delivery mode and infant gender.

Maternal BMI	Outcome	Below IOM guidelines ^a	Within IOM guidelines ^a	Above IOM guidelines ^a	Below vs. Within Adjusted OR (95% CI) ^b	P	above vs. Within Adjusted OR (95% CI) ^b	P
	SGA	117 (85.5)	47 (85.5)	205 (79.8)	2.19 (0.38–12.67)	0.38	1.415 (0.254–7.88)	0.69
	LGA	14 (9.7)	3 (5.5)	27 (10.5)	4.61 (2.91–8.53)	0.0001	6.6 (2.6–32.1)	0.0001
Obesity	Normal birth weight	2 (2.3)	1 (3.4)	6 (4.9)	1		1	
	Macrosomia	10 (11.4)	3 (10.3)	6 (4.9)	0.605 (0.34–10.74)	0.73	4.01 (0.24–65.02)	0.33
	LBW	76 (86.4)	25 (86.2)	110 (90.2)	1.2 (0.21–80.6)	0.9	0.064 (0.000–19.02)	0.34
	AGA	7 (8)	5 (17.2)	10 (8.2)	1		1	
	SGA	70 (79.5)	20 (69)	98 (80.3)	2.3 (0.23–23.24)	0.47	0.036 (0.001–1.12)	0.05
	LGA	11 (12.5)	4 (13.8)	14 (11.5)	0.387 (0.042–3.55)	0.4	2.21 (0.293–16.67)	0.44
multivariable multinomial logistic regression analysis.								
^a Data presented as N (%). ^b Data presented as OR (95% CI).								
Adjusted for gestational weight gain during trimester 2 ^{sd} and 3rd, maternal age, gravity, maternal fasting blood sugar, delivery mode and infant gender.								

The mean (SD) of the maternal age was 28.36 (5.60) years old. The increasing trend of pre-pregnancy BMI was observed along with the increasing of maternal age. Female gender showed a positive association with LBW in pre-pregnancy normal-weight mothers (p = 0.04).

Discussion:

The findings of present retrospective cohort study indicated an increased risk for LGA, LBW and macrosomia in overweight mothers and an increased risk of SGA in the mothers with GWG below IOM guidelines.

The average of GWG was similar to the IOM recommendations in normal BMI mothers during, the 2nd and 3rd trimester of pregnancy, and was different with IOM guidelines in other groups of pre-gestational BMI during mid- or late-pregnancy.

Due to the little number of underweight mothers, it was not possible to make an association between GWG, pre-pregnancy BMI and birth weight status. In normal weight mothers, a high risk of SGA was significantly associated with

inadequate GWG. In agreement with the previous studies, an increased risk of LGA[19, 20], LBW[21], and macrosomia [21, 22] was observed in overweight mothers with GWG outside guidelines, significantly.

The prevalence of GWG above the IOM recommendations was more common, in comparison with the below one, which is in agreement with the results reported by Power et al.[20]. In our study 46.4% had weight gain greater than IOM recommendation. Also, in recent systematic meta-analysis reported 47% GWG above guidelines [9].

Inadequate GWG was related to a high risk of SGA and LBW, consistent with a longitudinal cohort studies in China [23], Taiwan[24], and higher pre-gestational BMI increased risk for LGA and macrosomia were reported in overweight/obese mothers [25], which are in agreement with the findings of the present study.

in our study higher pre-BMI was associated with higher risk of adverse birth weight. In agreement, lima et al. [26], showed an increasing trend for the birth weight across higher pre-pregnancy BMI.

Moreover, the prevalence of macrosomia (6.2%) was higher in Ahvaz than the mean of Iran (5.2%) [27] and lower than a previous retrospective hospital-based (2007–2011) study conducted in Razi Hospital, Ahvaz city was reported 9% [15].

Likewise, increasing pre-pregnancy BMI was associated with the risk of higher fasting blood glucose between 24–28 weeks of pregnancy. In addition, higher risk of GDM was associated with higher rate of macrosomia. Consistent with our findings, a study among 256 pregnant women in the United Arabia Emirate reported that pre-pregnancy BMI ≥ 25 kg/m² were at higher risk of having GDM [28]. In agreement with our findings, a meta-analysis of 33 observational studies indicated that risk of GDM is positively associated with pre-pregnancy BMI [29]. however, the result of a study on Asian indicated that obese Thai women were not at increased risk for gestational diabetes mellitus was in contrast with result of present study [30]. The possible reason of this difference is due to the WHO's recommended BMI for Asians was used to define obesity.

In addition, our study and another studies [31, 32] showed that gestational hyperglycemia had a positive association with macrosomia.

The possible mechanisms of the high risk of adverse birth weight in high weight mothers could be due to the stimulating of insulin production in overweight mothers, therefore, lipogenesis and fat deposition would be increased in their offspring, so it can alter the growth of the fetus [33].

In the present study, we attempted for having large possible sample size from different health care centers to cover all ethnic groups together including Fars, Lure, Arab, and Bakhtiari. However, the exact number of different ethnic groups is not included in maternal records. So, we had limitation to explore ethnic differences in pre-pregnancy BMI, prevalence of GWG below or outside IOM guidelines and pregnancy outcomes.

In addition, pairs of mother and child document since 2010 to 2018 were taken into account and it could be highly reflect the current situation. pre-pregnancy weight was recorded from antenatal records, and it may be measured by health member or self-reported leading to the risk of recall bias, which is in line with other studies [26]. However, they were valid to be used in epidemiologic study [34]. Moreover, in the current study the 2009 IOM guideline was applied for GWG based on pre-pregnancy BMI. Furthermore, the recent meta-analysis [35] included 23 studies, explored ethnic differences based on IOM guidelines and regional guidelines in maternal pre-pregnancy BMI and GWG on pregnancy outcome across the USA, Western Europe and East Asia. However, there was data restriction from Middle East. In fact, the IOM approaches are primarily based on USA-dwelling, showed limited data on ethnic differences in associations between GWG and pregnancy outcomes. Then, led to heterogeneity and diminished the chance of comparisons across

regions. Asia is the most inhabitant of the world's population. In 2004 WHO consultation group [36] reported, Asians may have higher odds of disease at a BMI cut-off (lower than 25 kg/m²). Likewise, Asians are likely to have a higher percent of adipose tissue, especially visceral adiposity, at lower BMI cut-off points than that stated by the WHO as standard cut-off points [37]. In particular, finding of recent study showed that Iranians are at higher risks of morbidity related to metabolic factors at a lower BMI cut-off with an estimated 38.8% of the population having metabolic syndrome [38]. Importantly, the significant difference in Asian countries is based on ethnic and cultural subgroups, degrees of urbanization, social and economic conditions, and nutrition transitions [36]. Therefore, establishing a new guideline and GWG recommendation for Asian populations is necessary for optimal risk reduction during pregnancy [24].

In the present study the information related to socio-demographic and lifestyle characteristics (alcohol consumption and smoking) were not accurate due to their social beliefs.

According to the literature, this is the first study in public health care centers in South-west of Iran that present the association between GWG and pre-pregnancy BMI with adverse pregnancy outcome.

Thus, screening for overweight and obesity is an important preventive approach. It seems that along with all gestational monitoring and nutrition counseling, more educational programs in the health care centers are vital, due to the presence of multiple ethnic groups in Ahvaz city with different cultural habits.

Conclusion:

The important results of this study were the higher prevalence of maternal overweight, obesity, and excessive GWG. The most adverse birth weight was observed in overweight mothers with inappropriate GWG. Accordingly, the expanded programs of the healthy lifestyle education are required for the women in childbearing age (before and during pregnancy) to improve the pregnancy outcomes.

Abbreviations

Body mass index; BMI, gestational weight gain;GWG, gestational diabetes mellitus;GDM, ,large for gestational age; LGA, small for gestational age;SGA, appropriate size for gestational age;AGA, low birth weight;LBW, type 2 diabetes mellitus;T2DM, fasting blood sugar;FBS, IOM;institute of medicine, standard deviations;SD, analysis of covariance;ANCOVA, adjusted odds ratios;aOR, International Association of Diabetes and Pregnancy Study Groups;IADPSG

Declarations

Ethics approval and consent to participate:

This study is retrospective cohort which has been approved with ethical number (IR.AJUMS.REC. 1396.80) by Research Deputy of Ahvaz Jundishapur University of Medical Sciences and Social Determinants of Health Research Center.

Consent for publication:

the present retrospective study has been approved by Ethic committee of Jundishapur University of medical sciences.

Availability of data and materials:

The data that support the findings of this study are available on request from the corresponding author.

Competing interests :

All authors report no conflicts of interests and have no relevant disclosures.

Funding:

This research was supported by the Research Deputy of Ahvaz Jundishapur University of Medical Sciences and Social Determinants of Health Research Center to provide the funding of this research project (IR.AJUMS.REC. 1396.80).

Author Contributions:

F Borazjani designed the study question, supervised data collection, data analysis, assisted in writing the manuscript ; M Azhdari cooperate in data collection and assisted in writing the manuscript ; P Shahri cooperate in data collection and conducted the literature review; K.A. Angali designed the study and all statistical modelling and interpretation of data; M Cheraghi supervise data collection and assisted in research design; S Salmanzadeh managed data collection and conducted the literature review. All authors in concept and design of study, revising it critically for important intellectual content and final approval of manuscript.

Acknowledgments:

We highly appreciate the Research Deputy of Ahvaz Jundishapur University of Medical Sciences and Social Determinants of Health Research Center to approve this research project (IR.AJUMS.REC. 1396.80).

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