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Association Between Parity, Live Birth and the Risk of Obesity in Women

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Obesity is a rapidly increasing concern among women and men particularly in the Middle East countries. This study was aimed to determine the relation between reproductive factors and the risk of obesity, particularly abdominal obesity in women.

Materials and Methods: We conducted a population based cross-sectional study on a sample of 1800 women, aged between 20 to 70 years, using cluster sampling techniques in an urban area, in the north of Iran. The height, weight and waist circumference were measured with standard methods and information on the number of parities, live births, pregnancy, social and demographic status, and data on life style was collected during interviews.

Results: The mean (±SD) age of women was 37.5±13.0 years; 22.6% of women were nulliparous, 31.7% had 1-2, and 19.9% ≥5 pregnancies respectively. About 22.9% of women had no history of parity, and 33.8%, and 17.4% had 1-2 and ≥5 parities respectively. The overall prevalence rate of obesity and abdominal obesity was 27.7% and 46.2% respectively. In multiple logistic regression analysis, after adjustment for age, education level, marital status, parental obesity, marriage age, occupational activity, leisure time physical activity, duration of exercise per week, the risk of obesity increased significantly by 9% (adjusted OR=1.09, 95%CI: 1.01-1.18) and 10% (adjusted OR=1.10, 95% CI: 1.01-1.21) with each additional parity and live birth respectively.

Conclusion: The results of this study indicate that the risk of obesity escalates with increase in the number of parities and live births. Hence, reproductive factors should be considered as independent risk factors of obesity in women.

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Introduction

Obesity is a rapidly increasing health problem wordwide, with overall rates of obesity rising dramatically in recent decades.[1-6] It has serious effects on the development and evolution of type 2 diabetes, hypertension, osteoarthritis and cardiovascular diseases and mortality from cardiovascular diseases rises with increases in body mass index (BMI), beyond the normal range.[7-9]

Obesity increases metabolic risk and induces motor dysfunction in obese females; and excessive abdominal fat distribution appears to be a significant factor in increasing cardiovascular disease risk among obese women.[9,10]

Increasing BMI among women in the United States gives rise to concerns about associated comorbid conditions and decreases in life expectancy.[11] In the Iranian population, the prevalence of obesity, overweight, and hypertension are as high as in the US;

however, Iranian women are more obese than American women[12] Furthermore, in the Iranian population, obesity, central obesity (abdominal obesity) and metabolic syndrome are more frequent in women than in men.[8,13]

Recent increases in the prevalence of obesity worldwide are believed to be caused largely by an environment that encourages sedentary lifestyles and excessive food intake.[14] It is likely that a gene-environment interaction, in which genetically susceptible individuals respond to an environment with increased availability of palatable energy-dense foods and reduced opportunities for energy expenditure, contributes to the current high prevalence of obesity.[9]

In addition to genetic factors and changing life styles as factors of obesity, reproductive factors are also contributing factors of obesity in women, both in developed and developing countries.[15-19]

Socio-demographic and behavioral variables have been shown to modify the relationship between parity and body weight.[17,19,20] The relationship between parity and obesity was however found to be independent of other factors such as geographical area, region, marital status, occupation, smoking habits, and educational levels.[11,18,20-22]

However, the impact of factors such as low educational level, low socioeconomic status, low physical activity as proposed potential confounding factors in the parity-obesity relationship cannot be ignored, since in many geographic regions, particularly in developing countries, these factors have been documented as causes of both obesity and central obesity in women.[1, 23, 24]

The effects of reproductive factors such as parity and live births on body weight vary by race, size of place of residence and education.[16,25] The importance of parity as a predictor of overweight increases with national economic development and wealth.[23] Understanding the role of reproductive factors in the development of weight gain can help improve present strategies for prevention of obesity and central obesity during child bearing years and afterwards.

Despite several studies in association with risk factors of obesity, not too many investigations have examined the relation between obesity and reproductive factors.[15,16,19-21,26,27] However, the samples of these studies were not homogeneous regarding race, place of residence, age, education, smoking habit, physical activities and other socio-demographic and behavioral factors. Hence, the results of these studies are applicable to a limited population, and cannot be generalized to populations with different socio-demographic or ethnic characteristics. To investigate the independent effect of reproductive factors on the risk of obesity and abdominal obesity, and to minimize the confounding effects of other obesity associated factors, the present study was carried out in a uniform population of women aged 20-70 years in the north of Iran, which is relatively homogenous in lifestyle, race, cultural, and religious beliefs, occupation, physical activity and eating habits as well as behavioral factors.

Materials and Methods

Study subjects and sampling techniques: in 2004 we conducted a cross-sectional population based study in urban areas of four major cities in Mazandardan, a province north of Iran,. A total of 1800 women, aged 20 to 70 years, with no chronic or acute systemic or known debilitating diseases who were resident of the geographic regions of the selected clusters, entered the study.

Pregnant women and those on weight losing diets programs were excluded. A cluster sampling technique was applied using 30 clusters for each city. Initially for cluster selection, in each city, the centers of 30 clusters were chosen randomly using systematic sampling based on cumulative frequency of family health numbers under coverage of urban health centers. Then, around the center of each cluster, 15 women aged 20 to 70 were selected with rotation from the right to the left of each cluster center. Written informed consent was obtained from all subjects prior to their participation in the study.

Data collection and measurements: We performed an indoor household survey. Anthropometric measurements of weight, height and waist circumference (WC) were measured using standard methods. WC was measured on waist diameter at the level midway between the iliac crest and lower border of the tenth rib. BMI was calculated by weight in kilograms divided by height in meters squared (kg/m^2).

A structured questionnaire was designed and data were collected, during interviews, on demographic and social characteristics such as age, marital status, age at marriage, educational level, occupational activity, history of parental obesity defined as obesity in one or both parents (obesity in parents was determined by observers if the parents were alive, otherwise the history of parental obesity was reported by the offsprings based on their comparison with other members of the family), levels of physical activity, leisure time activity and the duration of exercise per week by hour (h/w), the number of parities, and live births.

Occupational activity was categorized in to three groups, low, moderate and vigorous, based on severity of physical activity during working hours. Leisure time physical activity was also categorized into four groups based on the duration of regular exercise activity, and the duration of walking/jogging activity performed weekly; (very low: Less than 20 minutes waking per day without any exercise; low: 20-39 minutes waking per day or mild exercise with duration less than 20 minutes per day; high: 40-59 minutes waking per day or moderate exercise of 20-29 minutes per day; very high: severe waking/jogging >60 minutes per day or continuous and regular exercise over 30 minutes per day. Parity was defined as the number of live births plus still births with gestational age of >20 weeks. Marital status was defined as single (unmarried) or married (divorced and widows were included for analysis in the married group). We used standard recommended WHO criteria, BMI= or >30 kg/m^2 to define obesity and BMI of 25-29 kg/m^2 as overweight. Diagnosis of abdominal obesity was based on the cut-off value of WC>88 cm.

Statistical analysis: SPSS software version 12.0 was used for statistical analysis. First, we used univariate analysis using Chi square test for trend, to describe the prevalence of both obesity and abdominal obesity in relation to parity and the number of live birth and to estimate the crude value of odds ratio of parity on risk of obesity and abdominal obesity. Then, multiple logistic regression model was applied to estimate the adjusted odds ratio of reproductive factors on both obesity and abdominal obesity by controlling other potential confounding factors such as age, marital status, age at marriage, parental obesity, educational level, occupational activity, and leisure time physical activity, and the duration of exercise per week by hour. The 95% confidence interval of odds ratio was calculated. For likelihood ratio, Chi square test was used and P value below 5% was considered significant.

Results

The mean±SD age of the study subjects was 37.5 ±13.0 years, and 83.9% of participants were married. The mean±SD age of married women was 19.2±3.8 years; in 55.8% of women, age at marriage was below 20 years. The first quartiles, median and third quartile of parity among married women were 2, 3 and 4 respectively, and the corresponding values for number of live births were 1, 2 and 4 respectively. Approximately 407 subjects (22.6%) had no history of pregnancy; 570 (31.7%) had 1-2 pregnancies, and 358 subjects (19.9%) had >5 pregnancies. Characteristics of the study subjects in relation to obesity status are presented in Table 1.

Table 1. Distribution of demographic characteristics, life style related factors, parity and live birth in obese and non-obese women

Characteristics	Obese n (%)	Non-obese n (%)	Total n (%)	P value
Age (years)				
20-29	74 (14.8)	534 (41.1)	608 (33.8)	
30-39	123 (24.6)	323 (24.9)	446 (24.8)	<0.001
40-49	154 (30.9)	218 (16.8)	372 (20.7)	
50-59	103 (20.6)	151 (11.6)	254 (14.1)	
60-70	45 (9.0)	73 (5.6)	118 (6.6)	
Education				
Illiterate	87 (17.4)	140 (10.8)	227 (12.6)	
Primary level	147 (29.5)	190 (14.6)	337 (18.7)	
Elementary level	106 (21.2)	220 (16.9)	326 (18.1)	<0.001
High school and college	134 (26.9)	520 (40.0)	654 (36.4)	
University level	25 (5.0)	229 (17.6)	254 (14.1)	
Marital status				
Single	22 (4.4)	265 (20.4)	287 (16.0)	<0.001
Married	477 (95.6)	1034 (79.6)	1511 (84.0)	
Parental obesity				
Absent	245 (49.1)	870 (67.0)	1115 (62.0)	<0.001
Present	254 (50.9)	428 (33.0)	682 (38.0)	
Exercise (hr/week)				
None	343 (69.7)	828 (64.3)	1171 (65.8)	
1-2 h	95 (19.3)	271 (21.0)	366 (20.6)	0.019
3-4 h	24 (4.9)	116 (9.0)	140 (7.9)	
≥5 h	30 (6.1)	73 (5.7)	103 (5.8)	
Occupational activity				
Low	341 (68.3)	900 (69.3)	1241 (69.0)	
Moderate	153 (30.7)	375 (28.9)	528 (29.4)	0.36
High	5 (1.0)	24 (1.8)	29 (1.6)	
Leisure time physical activity				
Very low	317 (63.5)	782 (60.2)	1099 (61.1)	
Low	106 (21.2)	329 (25.3)	435 (24.2)	0.34
High	61 (12.2)	150 (11.5)	211 (11.7)	
Very high	15 (3.0)	38 (2.9)	53 (2.9)	
Parity				
None	41 (8.2)	369 (28.5)	410 (22.8)	
1-2	133 (26.7)	475 (36.6)	608 (33.9)	<0.001
3-4	189 (38.0)	275 (21.2)	464 (25.8)	
≥5	135 (27.1)	178 (13.7)	313 (17.4)	
No. of live births				
None	42 (8.4)	377 (29.0)	419 (23.3)	
1-2	142 (28.5)	488 (37.6)	630 (35.0)	<0.001
3-4	197 (39.5)	286 (22.0)	483 (26.9)	
≥5	118 (23.6)	148 (11.4)	266 (14.8)	

Overall, 227 participants (12.6%) were illiterate, and 254 (14.1%) subjects had university level education. With regard to parity, 410 participants (22.8%) were nulliparous, 608 (33.9%) had 1-2 and 464(25.8%) had 3-4, and 313 (17.4%) participants had ≥ 5 parities. With respect to the number of live births, 419 (23.3%) participants had none, 630 (35%) subjects had 1-2, 483 (26.9%) had 3-4, and 266 participants (14.8%) had > 5 children. In terms of physical activity, 1171 participants (65.8%) had no exercise and/or sport activity, 103 (5.8%) had exercise activity at the level of 5 hours or more per week, whereas, the levels of activity in the remainder of the study population were between 1-4 hours per week. Low occupational activity was reported by 1241 (69%) subjects and low or very low leisure time physical activity was reported by 85.5% of subjects.

Prevalence rates of obesity and abdominal obesity in relation to parity and number of live birth are summarized in Table 2. The overall rates of obesity and abdominal obesity were 27.7% and 46.2% respectively. The prevalence rate of obesity as well as abdominal obesity has also risen with a significant trend of a dose response relationship by increasing the number of parities and live births (from 10% in nulliparous women to 43.1% in multiparous women with 5 or more live births (Table 2).

Table 2. Prevalence of obesity and abdominal obesity with respect to parity and number of live births in women

Reproductive factors	Obese† n (%)	Non-obese n (%)	Abdominally obese‡ n (%)	Not abdominally obese n(%)
Parity				
none	41 (10.0)	369 (90.0)	102 (24.8)	310 (75.2)
1-2	133 (21.9)	475 (78.1)	225 (37.0)	383 (63.0)
3-4	189 (40.7)	275 (59.3)	286 (61.6)	178 (38.4)
≥ 5	135 (43.1)	178 (56.9)	217 (69.3)	96 (30.7)
Total	498 (27.7)	1297 (72.3)	830 (46.2)	967 (53.8)
Live births				
none	42 (10.0)	377 (90.0)	106 (25.2)	315 (74.8)
1-2	142 (22.5)	488 (77.5)	236 (37.5)	394 (62.5)
3-4	197 (40.8)	286 (59.2)	307 (63.6)	176 (36.4)
≥ 5	118 (44.4)	148 (55.9)	182 (68.4)	84 (31.6)
Total	499 (27.8)	1299 (72.2)	831 (46.2)	969 (53.8)

†Obesity was defined as BMI≥30 kg/m2; ‡ Abdominal obesity was based on the cut-off values of WC>88 cm.

In addition, the overall mean (±SD) BMI was 26.9±5.3 kg/m^2. In relation to age, the mean BMI and the prevalence of rates of both obesity and abdominal obesity increased with increasing age up to the age of 60 years, with the highest rates of 40.6% and 66.5% for obesity and abdominal obesity respectively seen in the age range of 50-59 years.

The results of logistic regression analysis are presented in Table 3.

When parity and the number of live births entered into the model as quantitative scale, the crude estimates of odds ratio for risk of obesity increased by 29% (OR=1.29, 95% CI: 1.23-1.35) and 33% (OR=1.33, 95% CI: 1.26-1.40) with each additional parity and live birth respectively. After adjusting for age, educational level, marital status, parental obesity, marriage age, occupational activity, leisure time physical activity, and the dura tion of exercise by hour per week, the risk of

Table 3. Estimated crude odds ratio (OR) and adjusted odds ratio of parity and live births on a quantitative scale with 95% confidence interval (CI) using logistic regression model

Binary outcome	Independent* variables	Crude OR (95%CI)	Adjusted OR** (95% CI)
Obesity†	Parity	1.29(1.23-1.35)	1.09(1.01-1.18)
	Live birth	1.33(1.26-1.40)	1.10(1.01-1.21)
Abdominal obesity‡	Parity	1.37(1.30-1.44)	1.09(1.0-1.18)
	Live birth	1.41(1.33-1.48)	1.09(0.99-1.20)

† Obesity was defined as BMI⩾30 kg/m^2; ; ‡Abdominal obesity was based on the cut-off values of WC>88 cm; * The odds ratio was estimated for each additional parity and live birth;** The odds ratio was adjusted for age, education, marital status, parental obesity, occupational activity, leisure time physical activity, exercise (h/ week) and marriage age

obesity increased by 9% (adjusted OR=1.09, 95%CI: 1.01-1.18) and 10% (adjusted OR=1.10, 95% CI: 1.01-1.21) for each additional parity and live birth respectively. When parity and live birth entered into the model as categorical variables, the results of regression analysis showed a dose response relationship for parity and live birth for obesity and abdominal obesity (Table 4).

Table 4. Estimated crude odds ratio (OR) and adjusted odds ratio of parity and live birth on a categorical scale with 95% confidence interval (CI) using logistic regression model

Binary outcome	Independent* Variable		Crude OR (95%CI)	Adjusted OR** (95% CI)
Obesity†	Parity			
		none	1 (-)	1 (-)
		1-2	2.52 (1.73-3.67)	1.17 (0.68-2.01)
		3-4	6.18 (4.26-8.97)	1.82 (1.01-3.30)
		≥ 5	6.82 (4.61-10.11)	1.85 (0.96-3.56)
	Live birth			
		none	1 (-)	1 (-)
		1-2	2.61 (1.80-3.88)	1.19 (0.70-2.63)
		3-4	6.18 (4.28-8.92)	1.82 (1.01-3.31)
		≥ 5	7.15 (4.79-10.67)	2.11 (1.08-4.09)
Abdominal obesity‡	Parity			
		none	1 (-)	1 (-)
		1-2	1.78 (1.35-2.35)	0.96 (0.62-1.50)
		3-4	4.88 (3.65-6.53)	1.51 (0.91-2.52)
		≥5	6.87(4.44-9.53)	1.76 (0.97-3.18)
	Live birth			
		none	1 (-)	0 (-)
		1-2	1.78 (1.35-2.33)	0.92 (0.59-1.42)
		3-4	5.18 (3.88-6.91)	1.51 (0.92-2.57)
		≥5	6.44 (4.58-9.04)	1.55 (0.85-2.83)

† Obesity was defined as BMI⩾30 kg/m2; ‡ Abdominal obesity was based on the cut-off values of WC>88 cm;
* Parity and live birth were entered into the model as categorical variables with 1st level (none) as a reference category;
** The odds ratio was adjusted for age, education, marital status, parental obesity, occupational activity, leisure time physical activity, exercise (h/ week) and marriage age

After adjustment, the odds ratio of parity for risk of obesity in women with >5 parities compared with nulliparous women was 1.85 (adjusted OR=1.85, 95% CI: 0.96- 3.56) and for live birth was 2.11 (adjusted OR=2.11; 95%CI: 1.08- 4.09).

The corresponding odds ratio of abdominal obesity in terms of quantitative and categorical scales of parity and live birth are shown in Tables 3 and 4. The crude estimates tend to increase significantly with increases in both parity and live birth. However, the adjusted odds ratio did not reach a significant level.

Discussion

The findings of this study indicate that reproductive factors exert a significant independent effect on risk of obesity and abdominal obesity in women. There is a dose–response relationship between both parity and number of live births and risk of obesity and abdominal obesity. The rates of obesity and abdominal obesity increase with increases in the number of parities and live births.

Based on the results of logistic regression model, the adjusted odds ratio of parity and live birth for abdominal obesity did not reach a statistically significant level by categorical scale. This may be due to the lower power of statistical test on a categorical scale as compared to a quantitative scale, since the estimate of effect measured on a quantitative scale is usually more precise (less standard error) than on the categorical scale, some information being lost by categorization.

The results of this study are consistent with the results of other published studies in terms of obesity and abdominal obesity; a dose-responsive independent relationship between reproductive factors and obesity has been also reported in some populations of previous studies. [15, 21, 26, 27]

In the Weng et al, study, an association between number of children and obesity was observed among middle-aged women; in this study, a 7% increase in risk of obesity was noted for each additional child, after adjusting for age, race, household income, work status, physical activity, tobacco and alcohol use.[15]

A dose-response relationship between increasing numbers of children and rate of obesity was observed in another study of women aged 66-102 years. In this study, the risk of obesity increased by 11% with each additional live birth.[27] In another study of 17688 non-pregnant women aged 25-84 years, parity was found to be closely related to prevalence of obesity and adiposity.[26]

In a study of 5707 women, conducted by Wolfe et al, parity-associated weight differed by factors, such as race, employment, smoking, level of physical activity and marital status[20] The modifying effects of sociodemographic and behavioral factors on parity-associated weight gain was observed in another Wolfe et al study conducted in 2952 white or African-American non-pregnant women aged 25-45 years at baseline, who were re-measured approximately 10 y later.[17]

In a study by Lee. et al.,[16] there was a significant relationship between parity and body weight only in black women in metropolitan areas and white women in non-metropolitan areas. In another study of 1452 African-American and 1268 Caucasian non-pregnant women aged 18 to 30, parity was associated with BMI in women aged 25-30 years but not in 18-24 year old women.[19]

In a study of 2045 pre-menopausal health women aged 35-50, the relationship between increasing number of childbirths and female BMI was observed among women of lower social status.[21] The association between increasing number of children and BMI has also been reported in other studies.[18,28,29]

The present study differs from other studies with respect to uniformity of the study population in terms of race, cultural and sociodemographic characteristics, religious belief, occupation, physical activity, eating habits as well as behavioral factors, making its results generalizable to other populations as well. Whereas the results of previously mentioned studies[15,16,19-21,26,27] are applicable to limited populations due to their non-homogeneous samples. Furthermore, using standard sampling techniques in subject selection and data collection by trained interviewers and using a multiple logistic regression model in a population with large samples for each category of variables, provide more reliable data and more power to support the relationship between reproductive factors and obesity.

Several mechanisms such as, insulin resistance are associated with pregnancies.[27] Hormonal alterations secondary to fewer ovulatory cycles, glucocorticoid activity and excess deposit of fat tissue in the femoral area during pregnancies, have been proposed to explain the association of parity and obesity among women.[3] Additionally, changes in diet and physical activities may also be among associated factors.

A high maternal insulin concentration is associated with increased gestational weight gain and increased weight retention during the postpartum period. High insulin concentration may contribute to pregnancy-related changes in weight and thus may be linked to maternal overweight.[27,30] Pregnancy may be associated with a permanent increase in maternal body weight, simply because it is a period of positive energy balance during which some women gain excessive weight.[29] Factors such as pre-pregnancy weight and excessive gestational weight gain, have been known as risk factors for postpartum weight retention.[31] Weight gain during pregnancy and weight retention up to 1 year after delivery is of predictive value for weight gain in the second pregnancy; women with considerable weight gain have a higher risk of weight increase in the subsequent pregnancies.[32] Parity reduces the effect of lactation-associated weight loss, although the effects of parity and lactation are few. However, weight change associated to reproduction is highly dependent on BMI prior to pregnancy.[33]

In addition to the above factors, reduced physical activity during the postpartum period, appropriate nutrition, utilizing high energy food to enrich breast milk and sustained breast feeding, along with prolonged periods of breast feeding may contribute to weight gain and obesity after delivery. Although we did not provide data for duration of breast feeding, but in the geographic areas of this study, breast feeding for a 1.5-2 year period is usual, unless it is hindered by other problems.

The results of this cross-sectional study do not indicate reproductive factors to be a cause of obesity in women, but they do support a significant association between reproductive factors and obesity. One limitation this study had, was in providing data with respect to dietary intake, which may be an important factor concerning obesity and weight gain. We did not provide data for dietary intake due to uniformity of diet in our urban population; dietary intake was not considered as a confounding factor in regression analysis, nor was smoking, since smoking among the female population of this area is unusual. History of parental obesity in a proportion of study subjects was assessed by the participants, which may not be as reliable as that determined during interviews. However, this issue does not affect the results of analysis since both obese and non–obese groups were assessed similarly.

In conclusion, we have shown an association between number of parity and live births with obesity in women independent of known risk factors of obesity and abdominal obesity such as age, physical activity, educational level, and other socio-demographic characteristics. Further studies are needed to clarify the relationship and causality between reproductive factors and obesity.

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