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EFFECTS OF SOCIAL CLASS, OBESITY, AND METABOLIC SYNDROME ON FEMALE FERTILITY: A CROSS-SECTIONAL STUDY

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Abstract: Background: **Objective:** To determine the effects of social class, obesity, and metabolic syndrome on female fertility among women presenting to a tertiary care hospital and assess their association with reproductive characteristics and fertility impairment. **Methods:** This descriptive cross-sectional study was conducted at the Department of Gynecology and Obstetrics, Patel Hospital, following ethical approval from the institutional review committee. A total of 140 infertile women aged 18–45 years were enrolled through non-probability consecutive sampling. Women with congenital uterine anomalies, severe endometriosis, premature ovarian failure, malignancy, thyroid disorders, hyperprolactinemia, and confirmed male factor infertility were excluded. Demographic, socioeconomic, anthropometric, clinical, and biochemical data, including body mass index, fasting blood glucose, triglycerides, and HDL cholesterol, were recorded using a structured proforma. Metabolic syndrome was diagnosed according to the modified National Cholesterol Education Program Adult Treatment Panel III criteria. Data were analyzed using SPSS version 26.0.**Results:** The mean age of participants was 31.4±5.8 years, while the mean duration of infertility was 4.2±2.1 years. Obesity was identified in 63 (45.0%) women, and metabolic syndrome was present in 49 (35.0%) participants. Primary infertility was observed in 82 (58.6%) women, whereas menstrual irregularities were reported in 57 (40.7%) participants. Women from the lower socioeconomic class demonstrated significantly higher frequencies of obesity and metabolic syndrome. Obesity (AOR=3.41, $p<0.001$), metabolic syndrome (AOR=4.08, $p<0.001$), and lower socioeconomic status (AOR=2.63, $p=0.014$) were independent predictors of severe fertility impairment.**Conclusion:** Obesity, metabolic syndrome, and lower socioeconomic status were significantly associated with impaired female fertility and adverse reproductive outcomes.

Keywords: Female Infertility; Metabolic Syndrome; Obesity; Reproductive Health; Socioeconomic Factors.

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INTRODUCTION

As a complex public health problem impacting millions of women worldwide, infertility is monitored as the outcome of multifactorial biological, environmental, and socioeconomic causes. Worldwide, an estimated 17.5% of the adult population faces infertility during their reproductive years (1), making it a globally significant burden in both developing and developed nations, according to the World Health Organization. Obesity and metabolic syndrome are the leading causes of female reproductive system disorders, as they negatively impact hormonal functions, ovulation, insulin sensitivity, and general reproductive health. Moreover, socioeconomic disparities may interact with other pathways to modify fertility by changing diet, health care access/use, education level, and lifestyle behaviors (2).

Around the World, there has been an incredible increase in weight problems in women over the last several years. According to studies conducted on reproductive-aged women from the United States and European countries, the obesity prevalence ranges from 30% − 42%. Studies in Saudi Arabia showed that around 35% of infertile women were obese, and metabolic syndrome was present in approximately 28% of the women seeking help for fertility problems. Correspondingly, in 32% of the infertile females from India, obesity was recorded, and women with metabolic syndrome experienced morbidly heavier rates of oligomenorrhea and anovulation when compared to women without metabolic irregularity (3).

The prevalence of overweight, obesity, and metabolic syndrome is growing in Pakistan due to rapid urbanization, sedentary lifestyle, poor dietary habits, and low physical activity. In fact, over 38% of Pakistani women are either overweight or obese according to national surveys, and the prevalence of metabolic syndrome among adult females ranges between 27% - 35% (4). In Karachi and Lahore, infertility was estimated to account for 21%–22% of couples with childbearing problems, with obesity identified as an important predictor among women requesting gynecological care. Additionally, lower socioeconomic classes in females are more prone to deficiencies, deferred care, and paucity of reproductive counselling, which has detrimental effects on their fertility potential. In contrast, the combination of higher rates of obesity with low socioeconomic status among women would rather come from a change in diet and food deficiency (5).

Although there has been an increase in the burden of infertility and metabolic disorders in Pakistan, limited local data are available regarding the combined effect of social class and obesity, along with aspects of metabolic syndrome on female fertility. The interplay of these variables is crucial for designing better preventive and therapeutic approaches. Thus, this study was carried out at Patel Hospital to determine how social class, obesity, and metabolic syndrome affect female fertility in women coming to a tertiary care hospital.

METHODOLOGY

A cross-sectional descriptive study was conducted at the Department of Gynecology and Obstetrics, Patel Hospital from 5th December 2024 to 5th June 2025. Sample size was calculated by using the WHO sample size calculator, taking the prevalence of obesity among infertile women as 22% (5), confidence interval = 95%, margin of error = 8%, hence a minimum calculated sample size of 131. Since some women had incomplete records, and there was missing information, a total of 140 women were included using a non-probability consecutive sampling method.

The study population consisted of women aged 18–45 years with infertility. Infertility was defined as not having achieved a pregnancy after at least 12 months of vaginal intercourse without any contraceptive method. All cases of both primary and secondary infertility. Women who have never been able to conceive were defined as having primary infertility, while women who had achieved at least one pregnancy prior were considered secondary infertility. Eligible women who gave written informed consent to

participate were enrolled.
We excluded for congenital uterine anomalies, severe endometriosis, premature ovarian failure, gynecological malignancy, previous hysterectomy or bilateral oophorectomy, chronic renal disease, chronic liver disease, thyroid disorders (hypo or hyperthyroidism), hyperprolactinemia, and confirmed male factor infertility. Potential confounders impacting metabolic and reproductive parameters (e.g., women receiving hormonal therapy or corticosteroids, pregnant women, or women with a previous 3 months of fertility treatment) were also excluded.

Data Collection
Data were collected by the principal investigator using a structured and predesigned proforma after obtaining informed consent. Sociodemographic variables: age, marital duration, academic level, work status, monthly family income, and socioeconomic status. Social class was defined according to monthly household income, highest educational attainment, and occupation as lower socioeconomic status (SES), middle SES, or upper SES. Various reproductive variables, such as the type and duration of infertility, menstrual history, parity, and previous abortion status, with comorbid conditions associated with premature ovarian failure (POF), such as hypertension and diabetes mellitus, were included.
Anthropometric measurements were collected by standardized methods. Anthropometry was performed by measuring body weight in kilograms (kg) using a calibrated digital weighing machine with participants dressed in light clothing and no shoes on. The height sent was measured with a wall-mounted stadiometer in meters. BMI was calculated as weight (kg) divided by height (m) squared. According to the WHO criteria, the operational definition of obesity was a BMI≥30 kg/m². Waist circumference was taken in a standing position by means of a non-elastic measuring tape at the midpoint between the lower rib margin and iliac crest.
Blood pressure was measured in the sitting position after five minutes of rest with a standard mercury sphygmomanometer, and the average of two readings was recorded at 5-minute intervals. All venous blood samples were drawn after an overnight fast (8–12 hours) for laboratory detection of fasting blood glucose, serum triglycerides, and high-density lipoprotein (HDL) cholesterol levels. Biochemical analysis was done at the hospital laboratory with various standardized enzymatic methods.
The modified National Cholesterol Education Program Adult Treatment Panel III definition was used for the diagnosis of Metabolic syndrome. Individuals who satisfied at least three of the five following markers were classified as having metabolic syndrome: waist circumference >88 cm, fasting blood glucose ≥100 mg/dL, serum triglycerides ≥150 mg/dL, HDL cholesterol <50 mg/dL and blood pressure ≥130/85 mmHg.
Maternal obesity, metabolic syndrome and social class in relation to female fertility status: a cross-sectional survey of the 2011-2012 National Health & Nutrition Examination Survey data. Infertility was analysed based on clinical diagnosis documented by the treating gynaecologist following thorough clinical evaluation and necessary investigations.

Data Analysis
All data collected were entered and analyzed using Statistical Package for Social Sciences (SPSS) version 26. Analysis was conducted after cleaning and validating the data to reduce entry errors and missing values.
Quantitative variables such as age, BMI, duration of infertility, fasting blood glucose, triglyceride level, and HDL cholesterol were considered as mean ± standard deviation in the continuous variable. Methods: Qualitative variables such as obesity, metabolic syndrome, socioeconomic class, educational status, and menstrual irregularities were presented in frequencies and percentages; Non-vitro fertilization/ ICSI investigators online special report.
Stratification for age group, type of infertility, and socioeconomic status was performed to assess potential effect modifiers. For categorical variables, associations were assessed using the Chi-square test or Fisher's exact test as appropriate. In order to find out statistical differences among the groups, an independent sample t-test and one-way ANOVA were used for continuous variables. Multivariable logistic regression analyses were carried out to explore independent predictors of infertility whilst adjusting for confounding variables. Crude and adjusted odds ratios (with 95% confidence intervals) were computed. A p-value of ≤0.05 was deemed statistically significant at any point during the study.

RESULTS
A total of 140 women presenting with infertility were included in the study. The mean age of the participants was 31.4 ± 5.8 years, while the mean duration of infertility was 4.2 ± 2.1 years. Most participants belonged to the age group of 26–35 years (62.1%), followed by ≤25 years (20.7%) and >35 years (17.1%). Primary infertility was observed in 82 (58.6%) women, whereas secondary infertility was reported in 58 (41.4%) participants. Regarding socioeconomic distribution, 54 (38.6%) women belonged to the lower class, 61 (43.6%) to the middle class, and 25

(17.9%) to the upper class. Obesity was identified in 63 (45.0%) participants, while metabolic syndrome was diagnosed in 49 (35.0%) women. Menstrual irregularities were present in 57 (40.7%) participants. (Table 1)

Table 1: Baseline Demographic and Clinical Characteristics of Study Participants (n=140)

Variable	Frequency (%)
Age Group (years)	
≤25	29 (20.7)
26–35	87 (62.1)
>35	24 (17.1)
Type of Infertility	
Primary infertility	82 (58.6)
Secondary infertility	58 (41.4)
Socioeconomic Class	
Lower	54 (38.6)
Middle	61 (43.6)
Upper	25 (17.9)
Obesity Status	
Obese	63 (45.0)
Non-obese	77 (55.0)
Metabolic Syndrome	
Present	49 (35.0)
Absent	91 (65.0)
Menstrual Irregularities	
Present	57 (40.7)
Absent	83 (59.3)

Women with obesity had significantly higher frequencies of metabolic syndrome, menstrual irregularities, hypertension, and prolonged infertility duration compared to non-obese women. Metabolic syndrome was observed in 41 (65.1%) obese participants compared to only 8 (10.4%) non-obese women ($p<0.001$). Similarly, menstrual irregularities were significantly more common among obese women than non-obese women (58.7% vs. 26.0%, $p<0.001$). Obese women also demonstrated significantly higher mean fasting blood glucose, triglyceride levels, waist circumference, and systolic blood pressure. (Table 2)

Table 2: Comparison of Clinical and Metabolic Variables According to Obesity Status

Parameters	Obese (n=63)	Non-obese (n=77)	p-value
Metabolic syndrome present	41 (65.1%)	8 (10.4%)	<0.001
Menstrual irregularities	37 (58.7%)	20 (26.0%)	<0.001
Hypertension	24 (38.1%)	9 (11.7%)	0.001
Mean fasting glucose (mg/dL)	112.5 ± 18.3	91.6 ± 11.4	<0.001
Mean triglycerides (mg/dL)	181.2 ± 36.8	132.7 ± 29.5	<0.001
Mean waist circumference (cm)	95.7 ± 7.9	79.4 ± 6.1	<0.001
Mean systolic BP (mmHg)	134.8 ± 12.5	118.3 ± 10.6	<0.001

Analysis according to socioeconomic class demonstrated that women belonging to the lower socioeconomic class had significantly higher frequencies of obesity and metabolic syndrome compared to women from middle and upper classes. Obesity was present in 57.4% of women from the lower class compared to 42.6% in the middle class and 24.0% in the upper class ($p=0.011$). Similarly, metabolic syndrome was identified in 48.1% of lower-class participants compared to 32.8% and 16.0% in middle- and upper-class women, respectively ($p=0.018$). Lower socioeconomic status was also significantly associated with longer infertility duration and reduced educational attainment. (Table 3)

Table 3: Association of Socioeconomic Class with Obesity and Metabolic Syndrome

Parameters	Lower Class (n=54)	Middle Class (n=61)	Upper Class (n=25)	p-value
Obesity	31 (57.4%)	26 (42.6%)	6 (24.0%)	0.011
Metabolic syndrome	26 (48.1%)	20 (32.8%)	4 (16.0%)	0.018

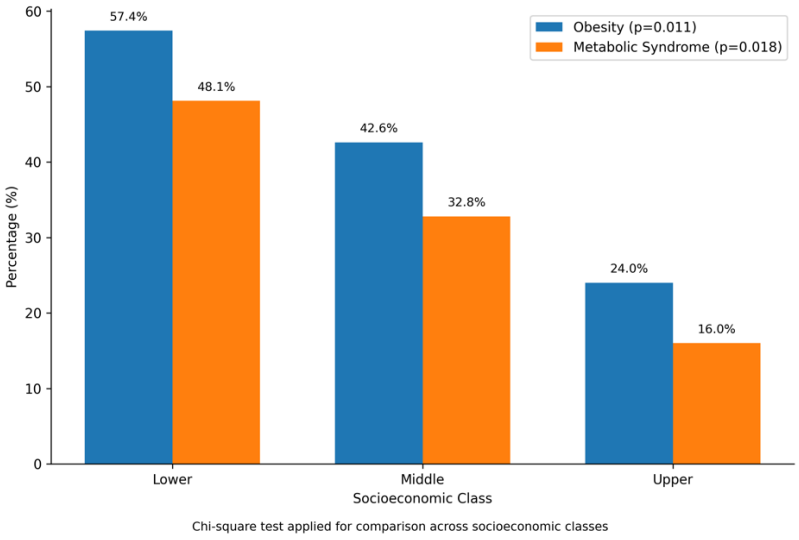
Mean infertility duration (years)	5.1 ± 2.3	4.0 ± 1.8	3.1 ± 1.4	0.003
Low educational status	37 (68.5%)	28 (45.9%)	5 (20.0%)	<0.001

Multivariable logistic regression analysis demonstrated that obesity, metabolic syndrome, and lower socioeconomic status were independent predictors of severe fertility impairment after adjustment for age and comorbid conditions. Obese women had approximately 3.4 times higher odds of severe fertility impairment compared to non-obese women (AOR=3.41, 95% CI: 1.72–6.79, p<0.001). Similarly, women with metabolic syndrome had nearly 4.1 times increased odds of fertility impairment (AOR=4.08, 95% CI: 1.98–8.39, p<0.001). Lower socioeconomic status also remained independently associated with adverse fertility outcomes (AOR=2.63, 95% CI: 1.21–5.71, p=0.014). (Table 4)

Table 4: Multivariable Logistic Regression Analysis for Predictors of Severe Fertility Impairment

Variable	COR	95% CI	p-value	AOR	95% CI	p-value
Obesity	3.88	2.01–7.49	<0.001	3.41	1.72–6.79	<0.001
Metabolic syndrome	4.56	2.28–9.11	<0.001	4.08	1.98–8.39	<0.001
Lower socioeconomic class	2.94	1.42–6.06	0.003	2.63	1.21–5.71	0.014
Hypertension	2.17	1.01–4.63	0.046	1.72	0.76–3.91	0.194
Menstrual irregularities	2.86	1.45–5.63	0.002	2.11	1.01–4.39	0.047

Obesity and metabolic syndrome were more frequent among women belonging to the lower socioeconomic class compared to middle and upper socioeconomic groups. Significant associations were observed between socioeconomic status and obesity (p=0.011) as



well as metabolic syndrome (p=0.018). (Figure 1)

Figure 1: Frequency of Obesity and Metabolic Syndrome According to Socioeconomic Class

DISCUSSION

This study aimed to assess the relationship of social class, obesity, and metabolic syndrome with female fertility in women presented at Patel Hospital. The results of the study did show a significant association between obesity, metabolic syndrome, and poor fertility outcomes, with lower socioeconomic status, but no statistically significant associations were found across the distribution of socioeconomic status. More menstrual irregularities, hypertension, and longer infertility duration were found among obese women and those with metabolic syndrome than in normal weight or non-metabolic women, and lower socioeconomic groups carried the highest burden of obesity and metabolic derangements. Obesity, metabolic syndrome, and lower levels of socio-economic status all proved to be independently associated with a higher risk of fertility impairment through multivariable logistic regression analysis.

The prevalence of obesity was 45.0% and metabolic syndrome 35.0% in the current study among infertile

women. Similar findings have been observed in national and international studies. A study from Lahore found 42% of infertile women were obese, and as high as 30% to 37% of women referred to infertility clinics in another Pakistani study had metabolic syndrome (6, 7). Similar observations, with a high prevalence of obesity in an international dataset (35%–48%), were reported among infertile females from Saudi Arabia (8) and the United States (9). Increase in sedentary lifestyles, poor diets, urbanization, and decrease of physical activity in women within childbearing age may explain the similarity among such findings. Furthermore, obesity-related insulin resistance triggers hormonal imbalance, ovulation dysfunction, and alteration of endometrial receptivity and may also contribute to subfertility (10, 11).

Menstrual irregularities were significantly higher in obese women than in non-obese women ($P < 0.001$) in the current study. Such results have also been observed in previously conducted studies from Korea (12) and the United States, showing a strong association between obesity, anovulation, and irregular menstrual cycles. Hyperinsulinemia and estrogen metabolism dysregulation, as related to obesity, is thought to interfere with the hypothalamic-pituitary-ovarian axis, resulting in menstrual irregularities and infertility (13, 14). Similar mechanisms may account for the association between obesity and long duration of infertility that was found to be strong in our study.

The most significant result of the current study was the confirmed association between infertility and metabolic syndrome. Severe fertility impairment in women who had metabolic syndrome compared with women without metabolic abnormalities was substantially increased. Similar results have been reported in China (15) and Iran (16), demonstrating an independent association with metabolic syndrome on ovulatory dysfunction, poor reproductive outcomes, and increased infertility rates. It may relate to underlying chronic inflammation, insulin resistance, endothelial dysfunction, and dyslipidemia present in women with metabolic syndrome that adversely influence ovarian function and implantation potential.

In our study, a significant association was also noted for obesity and infertility with the degree of socioeconomic status. Obesity, metabolic syndrome, and duration of infertility were clinically more frequent in women from lower socioeconomic classes as compared with controls from middle and upper socioeconomic groups. Research conducted in Pakistan (17), Bangladesh (18), and Nigeria (19) reported similar observations. A combination of low nutritional knowledge, poor access to healthcare facilities, poverty-related delayed medical consultation, and lower levels of education among poorer populations explains a major excess of reproductive and metabolic disorders. On the other hand, among Western populations, sedentary work and overconsumption have led to a higher prevalence of obesity in upper socioeconomic groups (20). These differences possibly present the contrast of culture, accessibility to the health care system, dietary changes, and economic development between Western and lower developed countries.

The evidence for the independent role of obesity and metabolic syndrome in impaired fertility was reinforced by the findings presented in this study through multivariable logistic regression analysis, controlling for confounding variables. The risk of severe fertility impairment was more than three times higher in the obese group, and those with metabolic syndrome had a risk nearly five times higher for adverse reproductive outcomes. Such findings have also been shown in studies from Europe and the Middle East, highlighting further evidence that metabolic health is an important contributing factor to female reproductive function (21-23). Our results highlight the critical importance of screening, metabolic control, and lifestyle modification beginning early in development in women who present with infertility.

There are certain limitations of this study. Foremost importantly, the cross-sectional design limits the ability of our study to ascertain causal relations between obesity, metabolic syndrome, socioeconomic status, and infertility. Second, we didn't assess lifestyle factors such as diet, exercise, stress, and smoking status. Lastly, hormonal profiles and comprehensive ovulatory assessments were not performed, which might have offered better insight into the mechanisms connecting metabolic derangements and fertility impairment. Notwithstanding the above limitations, this study adds hormones to the local evidence of social and metabolic determinants acting concurrently on female fertility in women living in Pakistan.

CONCLUSION

In addition, in the current study, impaired female fertility was significantly associated with three variables: obesity, metabolic syndrome, and lower socio-economic status. In conclusion, obese women with metabolic abnormalities had more menstrual irregularities, longer duration of infertility, and poorer reproductive outcomes. The lower social class only aggravated the increased metabolic risk and decreased reproductive potential. Conclusion: With embryo quality being affected by metabolic disturbances, lifestyle changes, and targeted constellations of reproductive health interventions might have the potential to increase fertility outcomes among women of reproductive age.

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