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Frequency of impaired glucose tolerance and its correlates in females of reproductive age in urban slums of Lahore, 2019

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Abstract:

BACKGROUND: The prevalence of diabetes mellitus has almost reached global epidemic proportions. Fortunately, the progress of the disease can be stemmed at the prediabetic level. The objective of the present study was to determine the frequency of impaired glucose tolerance (IGT) and its predictors in females of reproductive age in the urban slums of Lahore.

MATERIALS AND METHODS: A cross-sectional study was conducted among females of reproductive age in the slums of metropolitan Lahore. The calculated sample size was 384. Data were collected using a structured questionnaire covering demographic variables, lifestyle, medical, and dietary history. The oral GT test was carried out on the study participants after a 10 hour overnight fasting. Data were entered and analyzed using Statistical Package for the Social Sciences (SPSS version 23). Frequency distributions and percentages were calculated for categorical variables, and the mean and standard deviation were calculated for continuous variables. The Chi-square test or Fisher's exact test, as appropriate, was used to determine the association between IGT and various categorical variables. Logistic regression analysis was performed to determine the correlates of IGT after adjusting for confounders.

RESULTS: The final sample size was 394 women; 17% of whom had IGT, and 8.6% had newly diagnosed diabetics. Results of logistic regression showed increased waist/hip ratio, lower literacy of father or husband, age, and low intake of pulses as significant predictors of IGT ($P < 0.05$).

CONCLUSION: The frequency of IGT is high in females of reproductive age living in the urban slums of Lahore. There is a need for targeted health promotion and educational activities to improve the health and social conditions of slum dwellers.

Keywords:

Diabetes, females, impaired glucose tolerance, prediabetes, reproductive age, slums

Introduction

Impaired glucose tolerance (IGT) is a state of higher-than-normal blood sugar levels after a glucose load, but not high enough to diagnose diabetes mellitus. However, IGT or impaired fasting glucose (IFG) is impaired in prediabetes.[1,2] Individuals with IGT are at an increased risk of developing diabetes mellitus in the first place, cardiovascular diseases,[3] and stroke in the future.[4] There is an increased risk of developing complications of diabetes even at this early stage.[5]

Although increased insulin resistance is a major contributing factor to IGT, a spectrum of events should have already been initiated to lead to increased lipogenesis and increased atherogenesis resulting in macrovascular complications.[6]

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It is predicted that the global prevalence of diabetes will be 10% by 2030 compared to the 8% that obtained in 2011.[7] The global prevalence is estimated to rise to 642 million by 2040.[3] In 2015, the global incidence of IGT was one in every 15 individuals, and one in seven had type 2 diabetes.[3] Pakistan is one of the high prevalence areas for diabetes mellitus, at about 11.7%.[8] The second National Diabetes Survey of Pakistan in 1998 reported the prevalence of diabetes at 26.35% and prediabetes at 14.4%.[9]

It is necessary to prevent type 2 diabetes at the prediabetic stage to avoid long-term complications of the disease. This makes the screening for diabetes and prediabetes mandatory for individuals and the society.[7] As shown by the Finish diabetes prevention study and diabetes prevention program,[3,10,11] irrespective of age, gender, ethnicity, and lifestyle modification[12] can prevent or delay the emergence of diabetes mellitus by as much as 58%.

Before a woman in early pregnancy realizes the need to get her blood sugar levels checked, abnormally high blood sugar levels could have serious adverse effects on both the mother and fetus to the extent of causing abortions and developmental defects.[13] Other adverse effects in females include infertility, increased risk of certain cancers, menstrual irregularities, sexual dysfunction, infections, urinary incontinence, depressive disorders, increased risk of cardiovascular diseases at a relatively younger age, worse outcomes of ischemic heart diseases, and an association with polycystic ovarian syndrome.[14]

Diabetes country profile 2016 showed increased mortality of Pakistani females from diabetes.[15] The quality of the life of females is influenced by social and cultural factors that result in the delay of seeking healthcare. Besides, females are more prone to undernutrition and obesity which aggravates the condition.[16] Various studies have provided evidence that risk factors during fetal life or early infancy are associated with the development of hypertension, IGT, obesity, and dyslipidemia in later adult life. The proposed mechanism is a relative excess of fat compared to low muscular mass leading to insulin resistance.[17]

The effect of low neighborhood score is found on all individuals residing there, despite their own increased personal socioeconomic status.[18] Being a resident in a slum has profound effects, including an increased risk for noncommunicable diseases on health indicators, particularly on females.[19] The psychosocial stress factors specifically affecting females include lower level of education, gender bias in accessing healthcare, stress, and poverty.[19]

Access to healthcare is not universally available in Pakistan, and the cost of curative care is beyond the reach of most of the population. Prevention of diabetes and health promotion is cost-effective. Improvement of the health status of females can have a profound effect on the health of families and the community. The purpose of this study was, therefore, to determine the frequency of IGT and its correlates in females of reproductive age in the urban slums of Lahore. The study findings will provide a basis for planning and policy-making for the prevention of type 2 diabetes mellitus and the prevention of future physical, social, and economic ill effects of diabetes on the health of a vulnerable yet important group of the population, i.e. females.

Materials and Methods

A community-based cross-sectional study was conducted in 2017–2018 in the slums of Lahore, the second-largest city in Pakistan, with a population of around 13 million (13,095,166) living on an area of 1772 km^2.[20] For administrative purposes, it is divided into nine towns and 147 union councils. According to a report by Lahore Development Authority, Lahore, 30% of the urban population live in slums.[21] Ethical approval was obtained from the Institute of Public Health vide Letter No. 435 dated 22/07/2016 and informed written consent was taken from every study participant before enrollment. All participants were counseled on the prevention of diabetes. After the results were obtained, the participants were informed and advised about diet and exercise and referred to the hospital as necessary.

For the selection of the sample (for selection of houses from slum areas), we first randomly selected three out of nine towns in Lahore. Then, from each town, a minimum of two union councils were selected by simple random sampling. After that, one socioeconomically deprived (urban slum) area was selected from each union council. The sample size was calculated as 384 using the formula for population proportions.

The inclusion criteria entailed females of reproductive age living in selected urban slums of Lahore, pregnant females diagnosed with diabetes mellitus, or females on steroids or oral contraceptive pills, and those unable to comply with the study requirements owing to chronic disabling disease were excluded.

Data were collected using a structured questionnaire. Independent variables included age, education, occupation, husband's/father's education, husband's/father's occupation, per-capita income/day, and consumption of various food items. The consumption of each food item weekly, fortnightly, monthly, or never was categorized as "seldom intake," whereas consuming daily or on alternate days was considered "frequent intake." Other variables included physical activity, body mass index (BMI), waist circumference (normal for women <88 cm^2), and waist/hip ratio (normal for women ≤0.85/25). IGT and IFG were dependent variables.

Diabetes mellitus was defined by the WHO as having a fasting plasma glucose ≥126 mg/dl (7 mmol/L) or 2 h plasma glucose ≥200 mg/dl (11 mmol/L) or hemoglobin A1c ≥6.5 mg/dl.[22] Prediabetes is IGT and/or IFG.[22] IGT is defined by the WHO as having a plasma glucose of 140–199 mg/dl (7.8–11 mmol/L) 2 h after glucose load with a fasting plasma glucose <126 mg/dl (<7 mmol/L).[22]

After official permission, information regarding the geographic distribution of the different towns of Lahore was obtained from the District Health Office. The lady health supervisors and workers in the selected towns of Lahore were contacted to identify the slum areas, obtain lists of houses, and discuss the purpose and procedure of the study.

After the selection of the areas, a team consisting of a researcher, phlebotomist, a lady health worker, and two trained helpers to take anthropometric measurements was formed. Females in the inclusion criteria were chosen from every 10th house. In the event of failing to meet the inclusion criteria, participants were recruited from the next house to the right. The study participants were asked to come in the morning after 3 days of unrestricted diet and 10 h of overnight fast.

A fasting venous sample was drawn on the day of their visit after an overnight fast for basic sugar level (BSL) and lipid profile (fasting time of 10 h was verified by the study participants). The study participants were asked to consume a glucose drink with 75 g glucose in 300 ml of water for 5 min. Later, they were interviewed on lifestyle, demographics, and medical and family history through a structured questionnaire.

Weight, waist and hip circumferences, and blood pressure were measured. Waist circumference was measured at the midpoint between the lower rib cage and the iliac crest. Hip circumference was measured at the maximum width. Weight was measured in kg with the individual standing. Blood pressure was measured after 5 min of being in the sitting position, when the study participant was relaxed. If the 1st reading showed the blood pressure as high, a second reading was taken. Per-person income/day, BMI, and low-density lipoprotein were calculated using the following formulae: Income/person/day = Total family income per day/family size; BMI = Weight in Kg/Height in meters squared.

Another blood sample was taken to test for glucose 2 h after consuming the glucose drink. Blood samples were tested at the pathology laboratory of Fatima Jinnah Medical University using the turbidimetry method.

Data were entered and analyzed using Statistical Package for the Social Sciences (SPSS Inc., Chicago, IL, USA) version 23. Frequency distributions and percentages were calculated for categorical variables. The mean and standard deviation were calculated for continuous variables. Data were analyzed for normality, and the Mann–Whitney test was applied where required. Furthermore, the Chi-square or Fisher's exact test was done to determine the association of categorical variables with IGT. Logistic regression analysis was performed to determine the correlates of IGT after adjusting for confounders; backward elimination method was used to select the final model. All tests were performed at 0.05 significance level.

Results

Initially, 475 participants were enrolled in the study according to the inclusion criteria. Some participants were excluded from the final analysis as their fasting blood sugar level was in the diabetic range, and others were excluded for nonresponsiveness to the study procedure, or a discarded blood sample. The final sample was 394 participants, for whom blood tests 2 h after glucose ingestion were available. For bivariate analysis to determine the correlates of IGT, 52 participants with blood sugar in the diabetic range were excluded. This is the reason for varied sample size in different tables.

Table 1 shows the demographic characteristics of the study participants. The majority of women were housewives (82.7%), married (77.1%), were 15–35 years old (63.2%), and had high school or higher education (50.1%). The fathers or husbands of 46.6% of the women had high school or higher education and 97% had businesses or technical jobs. About 67.1% belonged to lower-lower class and 20.6% to lower class. None of the study participants reported that they smoked, 24.8% habitually walked daily, 29.2% were overweight, and 35.6% were obese.

History of hypertension was reported by 16.2% of women, but the blood pressure of 88% was controlled. A history of chronic illness other than hypertension and diabetes was given by 25.4%, 44.2% had a family history of diabetes mellitus, and 2.7% reported a history of gestational diabetes.

All the women reported that they consumed carbohydrates and fats on a daily basis. All the respondents (100%) consumed carbohydrates (roti and porridge) daily. Fats were also consumed by 100% on a daily basis.

About 43% of the women reported that they frequently (daily or on alternate days) consumed proteins (meat and eggs), 92.4% consumed vegetables frequently, and 45.5% consumed fruits frequently. Pulses were consumed daily by 8% and on alternate days by 61.8%, while 38.5% consumed milk or milk products daily and 10.9% on alternate days. Only 12.2% reported that they consumed fried foods frequently.

About 85% of women had fasting blood glucose level within the normal range, 6.2% had IFG levels, and 9% had fasting blood glucose levels in the diabetic range [Table 2]. As regards blood sugar levels 2 h after the ingestion of glucose, 74.4% had levels within the normal range, while 17% had IGT and 8.6% had blood sugar levels in the diabetic range [Table 2].

Table 3 shows an association between IGT and various sociodemographic characteristics and health-related conditions in the study participants. Age >35 years, education less than the Matric, being married, having hypertension, and waist/hip ratio >0.85 were associated with a higher risk of IGT, and this was statistically significant. No other significant associations were observed.

Women who infrequently consumed pulses (compared to daily or on alternate days) had an increased risk of IGT [odds ratio (OR) = 2.013, $P = 0.018$, Table 4]. No significant associations were found between IGT and other food items.

Table 5 shows the final logistic regression model for correlates of IGT of all women aged 15–49 years. Factors statistically significantly associated with an increased risk of IGT were husband's/father's education below the Matric (OR = 1.409, $P = 0.031$), waist/hip ratio >0.85 (OR = 5.985, $P = 0.001$), and an infrequent consumption of pulses (OR = 4.134, $P = 0.007$).

Table 6 shows the final logistic regression model for correlates of IGT of married women aged 15–49 years. Husband's/father's education below the Matric, waist/hip ratio >0.85, and infrequent consumption of pulses were associated with an increased risk of IGT.

Table 1: Sociodemographic, lifestyle, and behavioral characteristics of 15-49-year-old women living in urban slums of Lahore (*n*=394)

Characteristics	*N* (%)
Age (years)	
15-35	244 (63.2)
36-49	142 (36.8)
Education level	
Below the Matric	192 (49.9)
Matric or above	193 (50.1)
Occupation	
Housewife	326 (82.7)
Working	51 (12.9)
Student	4 (1.0)
Others	13 (3.3)
Marital status	
Married	296 (77.1)
Unmarried	88 (22.9)
Husband's/father's education	
Less than Matric	201 (53.7)
Matric or above	174 (46.4)
Husband's/father's occupation	
Laborers	12 (3.0)
Technical/business/others	382 (97.0)
Income/person/day	
Lower-lower class	251 (67.1)
Lower class	77 (20.6)
Lower-middle class	40 (10.7)
Middle-middle class	6 (1.6)
Smoking	
Yes	0
No	387 (100)
Daily walk	
Yes	96 (24.8)
No	291 (75.2)
Body weight	
Underweight (BMI <18.5)	37 (9.5)
Normal (BMI 18.25-24.9)	100 (25.6)
Overweight (BMI 25-29.9)	114 (29.2)
Obese (BMI >30)	139 (35.6)

BMI: Body mass index

Table 2: Results of glucose tolerance test among 15-49-year-old women living in slums of Lahore (*n*=401)

Blood sugar level	Frequency (%)
Fasting blood sugar	
Normal	340 (84.8)
Impaired fasting glucose	25 (6.2)
Diabetic	36 (9.0)
Blood sugar levels 2 h after glucose load	
Impaired glucose tolerance	67 (17.0)
Normal	293 (74.4)
Diabetic	34 (8.6)

Discussion

The incidence of diabetes mellitus is rising at epidemic proportions in developing countries, especially in Pakistan.[22] Present study was carried out to find the prevalence of IGT in a vulnerable group of population, females of reproductive age living in urban slums of Lahore. In our study population, 17% of females had impaired glucose tolerance (pre-diabetes); this is higher than the overall of prevalence of 14.4% (15.5% in urban areas and 13.9% in rural areas) as reported

Table 3: Association between impaired glucose tolerance and various sociodemographic characteristics and health-related conditions of 15-49-year-old women living in slums of Lahore (*n*=353)

Characteristics	OR (95% CI)	*P*-value
Age (years)		
36-49	2.364 (1.37-4.071)	0.002
15-35	1.0	
Education		
Less than Matric	2.625 (1.488-4.631)	0.001
Matric or above	1.0	
Marital status		
Married	3.835 (1.593-9.231)	0.001
Unmarried	1.0	
Occupation		
Housewife	1.519 (0.651-3.547)	0.437
Other	1.0	
Husband's/father's education		
<Matric	1.019 (0.553-1.877)	0.10
Matric or above	1.0	
Income/person/day		
Lower class	2.491 (0.736-8.430)	0.163
Middle class	1.0	
Daily walk		
No	1.078 (0.558-2.084)	0.823
Yes	1.0	
History of hypertension		
Yes	2.191 (1.112-4.317)	0.029
No	1.0	
Family history of diabetes		
Yes	1.078 (0.607-1.916)	0.798
No	1.0	
Diabetes in first-degree relative		
Yes	1.253 (0.707-2.221)	0.439
No	1.0	
Body weight		
Obese (BMI ≥30.0)	1.617 (0.940-2.781)	0.081
Nonobese (BMI<30.0)	1.0	
Waist/hip ratio		
High (>0.85)	2.211 (1.176-4.157)	0.019
Normal (≤0.85)	1.0	
Serum cholesterol (mg/dL)		
High (>200)	0.809 (0.406-1.611)	0.546
Normal (≤200)	1.0	
Triglycerides (mg/dL)		
High (≥l50)	1.064 (0.532-2.131)	0.860
Normal (<150)	1.0	
LDL (mg/dL)		
High (≥l30)	0.691 (0.331-1.442)	0.323
Normal (<130)	1.0	
HDL (mg/dL)		
Low (≤40)	0.772 (0.307-1.948)	0.581
Normal (>40)	1.0	

OR=Odds ratio, CI=Confidence interval, BMI=Body mass index, LDL=Low-density lipoprotein, HDL=High-density lipoprotein

by second National Diabetes Survey 2016-2017.[9] This could be the result of multiple risk factors in areas with low neighborhood scores, e.g. lack of access to healthy food and proper recreational facilities. It has been seen that women with higher education were influenced by this neighborhood effect. Other reasons may be the stressful environment, including violence prevalent in these areas since chronic stressful conditions can lead the development of insulin resistance in residents of these areas.[18]

The recent studies in various countries have shown that low socioeconomic status and living in socially deprived areas predispose individuals to IGT and diabetes.[7,18] The psychosocial stress factors also play an important role in glycemic control. Important factors specifically affecting females include lower levels of education, gender bias in the ability to access to healthcare, stress, and poverty.[23] Being underweight or overweight can predispose one to abnormal GT.[24] A family history of diabetes was present in 42.2% of these females, which is also alarming. A review of the dietary habits shows that the diet of these females was not balanced and did not have all essential nutrients.[25] Age >35 years, education of respondent < the Matric, being married, a history of hypertension, waist/hip ratio >0.85, and an infrequent intake of pulses were shown to be risk factors for IGT. Similar results have been shown by previous studies in Pakistan and elsewhere.[26,27]

Markers of obesity, BMI, waist circumference, and waist/hip ratio have been documented as important predictors of glucose intolerance.[28] Although individuals with a higher BMI had a higher percentage of IGT, it was significant at 0, 1, which is higher than our study criteria. Studies have shown an association with IGT at a lower level of BMI in this region.[14] Furthermore, it has been seen that glucose intolerance in the lower socioeconomic groups is independent of BMI.[28]

High systolic blood pressure and age were significantly associated with IGT, and similar findings were reported earlier.[28] An increased waist/hip ratio was the second strongest predictor (OR = 5.985). This finding has been consistently found in almost all known studies carried out to find out the predictors of diabetes and prediabetes.[29,30]

Infrequent intake of pulses was also a highly significant predictor (OR = 4.134), and this finding is also consistent with other studies carried out elsewhere on the effect of intake of pulses on IGT.[26] Increased intake of pulses has also been shown to reduce metabolic risk factors. This effect is suggested to be due to the low energy density of pulses.[27] Further studies to observe the effect of diet on IGT are needed in Pakistan to confirm this important association.

A lower level of husband's/father's education was found to be associated with IGT. In previous studies, glucose intolerance was associated with respondent's own education, but an association with husband's/father's education was not tested. This was found to be a significant predictor of IGT in this study,[7] because it influenced the level of healthcare the females in these households were provided with. It means the education of the whole population is necessary for the achievement of preventive goals.

Table 4: Association between impaired glucose tolerance and various food items in 15-49-year-old women living in slums of Lahore

Food items	OR (95% CI)	*P-value*
Protein (meat and eggs)		
Seldom (weekly, fortnightly, monthly, or never)	1.371 (0.766-2.453)	0.311
Frequent (daily/alternate days)	1.0	
Pulses		
Seldom (weekly, fortnightly, monthly, or never)	2.013 (1.12-3.165)	0.018
Frequent (daily/alternate days)	1.0	
Bakery products		
Seldom (weekly, fortnightly, monthly, or never)	0.978 (0.461-2.0740	0.953
Frequent (daily/alternate days)	1.0	
Carbohydrate		
Seldom (weekly, fortnightly, monthly, or never)	1.212 (1.154-1.274)	0.10
Frequent (daily/alternate days)	1.0	
Fried food		
Seldom (weekly, fortnightly, monthly, or never)	0.507 (0.191-1.346)	0.166
Frequent (daily/alternate days)	1.0	
Milk category		
Seldom (weekly, fortnightly, monthly, or never)	1.3689 (0.770-2.431)	0.355
Frequent (daily/alternate days)	1.0	
Daily fat intake		
Seldom (weekly, fortnightly, monthly, or never)	1.53 (0.730-3.190)	0.435
Frequent (daily/alternate days)	1.0	
Vegetables		
Seldom (weekly, fortnightly, monthly, or never)	0.595 (0.173-2.053)	0.407
Frequent (daily/alternate days)	1.0	
Fruits		
Seldom (weekly, fortnightly, monthly, or never)	0.969 (0.548-1.710)	0.912
Frequent (daily/alternate days)	1.0	

OR=Odds ratio, CI=Confidence interval

The strength of this study lies in the fact that the data were collected from different slum areas of three different towns. The study participants were selected by systematic random sampling. A vast number of predictors including sociodemographic factors, history, and anthropometric measures were recorded and analyzed for association with IGT. The limitations of this study are that it was carried out in selected areas of the city owing to the constraints of logistics and workforce. It is suggested that similar studies covering a larger area should be carried out to produce more conclusive results to plan and implement prevention. This study stresses the need for preventive strategies in urban slum areas, especially for females vulnerable to complications of abnormal glucose intolerance (diabetes and prediabetes).[22]

To achieve success in the prevention of diabetes, it is imperative to launch population-based preventive strategies. These should aim at awareness campaigns, provision of healthy food, and opportunities for physical activity at institutions. Moderate-intensity physical activity can prevent the progression of IGT to type 2 diabetes and improve the cardiovascular risk profile.[6] It has been shown that improvement in maternal and child health practices also plays a very important role in the prevention of type 2 diabetes. It has also been recommended that foods should be strictly labeled with their sugar content; there should be restrictions on the sale of sugar-containing beverages to children and adolescents, increased taxes on these items, and facilitation and incentives for farmers to grow healthy food crops. These recommendations have been implemented in certain countries with very good results.[4] The involvement of women in these prevention programs will help in disseminating the message of a healthy lifestyle in the communities and have a great impact on women's lives.[31]

Conclusion

This study highlights the increased frequency of IGT in a vulnerable group of the population, i.e. females of the reproductive age group living in urban slums, and identifies important risk factors. There is a need for targeted health promotion and educational activities. Preventive strategies should be initiated at the primary care level where weighing machines and measuring tapes are available. Health and social conditions should be improved in slum areas.

Table 5: Correlates of impaired glucose tolerance in women aged 15-49 years: Logistic regression analysis final model (all study participants)

Variable	Unadjusted OR	*P*-value	Adjusted OR	*P*-value
Age	2.364 (1.37-4.071)	0.002	2.504 (0.962-6.515)	0.06
Husband's/father's education<Matric	1.019 (0.553-1.877)	1.0	1.409 (1.032-1.925)	0.031
Waist/hip ratio >0.85	2.211 (1.176-4.157)	0.019	5.985 (2.104-17.027)	0.001
Seldom intake of pulses (weekly, fortnightly, monthly, or never)	2.013 (1.12-3.165)	0.018	4.134 (1.464-11.672)	0.007
Seldom intake of meat/eggs (weekly, fortnightly, monthly, or never)	1.371 (0.766-2.453)	0.311	0.430 (0.167-1.106)	0.08

OR=Odds ratio

Table 6: Correlates of impaired glucose tolerance in women aged 15-49 years: Logistic regression analysis final model (married women only)

Variable	Un-Adjusted OR	*P*-value	Adjusted OR	*P*-value
Husband's/father 's education < Matric	1.019 (0.553-1.877)	1.0	1.347 (0.990-1.832)	0.058
Waist/hip ratio >0.85	2.211 (1.176-4.157)	0.019	6.54 (2.343-18.261)	0.001
Consuming pulses frequently (daily or on alternate days)	2.013 (1.12-3.165)	0.018	3.353 (1.163-9.666)	0.025

OR=Odds ratio

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Conflicts of interest

There are no conflicts of interest.

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