RESEARCH ARTICLE

Prediabetes in adolescents — an emerging epidemic — a cross-sectional survey of medical students at a public university, Quetta, Pakistan

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Abstract

Objectives: To determine the prevalence and determinants of prediabetes among adolescents.

Method: The cross-sectional study was conducted at a public-sector medical university in Quetta, Pakistan, from December 2019 to February 2020, and comprised students aged 16-19 years. A self-administered questionnaire was used to gather socio-demographic data. Fasting blood sample was taken to measure the fasting plasma glucose level, lipid profile and glycated haemoglobin levels. Height, weight, neck circumference and waist circumference were also measured. Data was analysed using SPSS 21.

Results: Of the 351 subjects, 158(45%) were males and 193(55%) were females. The overall mean age was 18.81±0.41 years. Of the total, 81(23.1%) participants were found to have prediabetes. Neck circumference was identified as the strongest predictor for prediabetes, followed by high level of triglycerides, high systolic blood pressure, low levels of high-density lipoproteins, high levels of low-density lipoproteins, high diastolic blood pressure, waist circumference and body mass index ($p<0.05$). There was no significant difference in the prevalence of prediabetes among male and female students ($p>0.05$).

Conclusion: There was no significant difference in the prevalence of prediabetes among male and female medical students. Neck circumference, Waist circumference, Body mass index, systolic blood pressure, Diastolic blood pressure, Triglyceride and High density Lipoprotein were strong predictors of prediabetes in adolescent population.

Keywords: Prediabetes, Adolescents, Prevalence, Fasting plasma glucose. (JPMA 71: 1438; 2021)

DOI: https://doi.org/10.47391/JPMA.2178

Introduction

Prediabetes is the precursor of diabetes mellitus (DM) in which blood glucose tolerance is impaired due to either decreased insulin sensitivity, increased insulin resistance or both. Patients with prediabetes fall in a grey area as they do not fulfill the criteria for DM diagnosis.[1] The prevalence of prediabetes is increasing globally, affecting all age groups including children and adolescents.[2]

A 10-year study showed a prevalence of prediabetes up to 17.4% in the adolescent age group.[3] The second National Diabetes Survey of Pakistan (NDSP), in 2018, reported prevalence of prediabetes in Pakistani adult population to be 14.4%.[4] Limited data from Pakistani adolescent population is available. A study on 130 medical students from Pakistan reported 11.5% to be prediabetic.[5]

It is important to nip the problem of prediabetes in the bud because prediabetics have four times greater risk of developing diabetes compared to those who have normal glucose tolerance.[6,7] This raises the need of picking up the problem as soon as possible so that appropriate interventions can be made and future development of diabetes can be prevented. Now the question arises when should this screening begin. According to the American Diabetes Association (ADA), prediabetes is linked with an increased risk of developing diabetes and cardiovascular disease in adults, but this risk increases dramatically if the onset of prediabetes is in adolescence.[3]

Diagnosing prediabetes at an early age will help prevent the risk of developing type 2 DM (T2DM). Lifestyle interventions during childhood and adolescence, like maintaining a healthy weight, taking balanced nutrition, and regular physical activity, can help prevent the development of diabetes in the future.[8] Screening the paediatric population for early recognition of prediabetes will prevent progression to T2DM, hence decreasing the diabetes-associated chronic health conditions, like cardiovascular diseases, stroke etc., in adulthood.

The current study was planned to determine the prevalence and determinants of prediabetes in Pakistani adolescents.

Subjects and Methods

The cross-sectional study was conducted at a public-sector medical university in Quetta, Pakistan, from December 2019 to February 2020. After approval from the ethics review committee of the University of Balochistan, Quetta, sample size was calculated using then Daniel's formula of

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response estimate[9] while keeping confidence interval (CI) at 95%, margin of error at 5% and estimated response distribution at 50%. The sample was raised using non-probability convenience sampling method, and comprised students of either gender aged 16-19 years.

Those excluded were individuals not willing to participate, having co-morbid conditions, like hypothyroidism and diabetes, or prolonged corticosteroids therapy.

After taking consent from the subjects, data was collected using a self-administered questionnaire addressing demographics, diet and physical activity patterns, and smoking status. Anthropometric measurements of all the participants, including weight, height, waist circumference (WC) and neck circumference (NC), were recorded. Height was measured without shoes, on a flat surface to the nearest 0.1cm using wall-mounted stadiometer. Weight was measured with clothes only, using a bathroom scale to the nearest 0.1kg. BMI for age ' growth charts were used for the classification of body mass index (BMI).[10,11] WC was measured with a measuring tape and cutoffs for male and females were taken in accordance with criteria for South Asian males and females.[12] NC was measured by positioning the adolescent in the standing position with the head positioned in the Frankfurt horizontal plane. The measurement was taken by placing the top edge of the measuring tape below the laryngeal prominence at the level of the thyroid cartilage to the nearest value of 0.1cm.[13] NC range was categorised in line with literature.[14] Blood pressure (BP) was measured using mercurial sphygmomanometer.

Analysis of fasting blood samples for fasting plasma glucose (FPG), low-density lipoprotein (LDL), high-density lipoprotein (HDL) and triglycerides (TG) was done using an automated biochemistry analyser. Cutoffs for biochemical parameters were taken as per literature, and participants were labelled prediabetic if they had glycated haemoglobin (HbA1c) 5.7-6.4% and FPG >100-125mg/dl.[15]

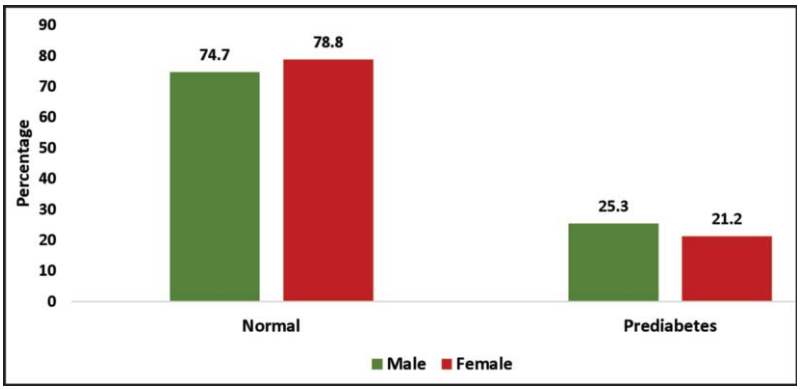
Data was analysed using SPSS 21. Mean and standard deviation (SD) were calculated for continuous variables, while frequencies and percentages were calculated to determine the prevalence of prediabetes. Chi-square test was applied to determine the association of prediabetes with gender, anthropometric measures, and BMI status. Logistic regression was applied to determine likelihood of predictors for prediabetes. Normality assessment was carried out by using the Kolmogorov-Smirnov test. Since the data had non-normal distribution, therefore non-parametric tests were used. For dichotomous variables, Man Whitney U test was applied for mean comparison. Mean ranks were used for statistical interpretation where applicable. P<0.05 was considered statistically significant.

Result

Of the 377 individuals approached, 351(93.1%) participated in the study; 158(45%) males and 193(55%) females. The overall mean age was 18.81±0.41 years. Among the participants, 106(30.2%) were Pathan, 94(26.8%) Baloch, 62(17.7%) Urdu-speaking, 35(10%) Punjabi and 23(6.6%) Sindhi (Table-1). Based on positive

Table-1: Socio-demographic characteristics of the study participants.

Demographic Characteristic	Frequency (N)	Percentage (%)
Gender		
◆ Male	158	45
◆ Female	193	55
Maternal Education		
◆ <12 years education	217	61.8
◆ >12 years education	134	38.2
Paternal Education		
◆ <12 years education	96	27.3
◆ >12 years education	255	72.7
Employment status		
Employed		
◆ Father	300	85.5
◆ Mother	81	23.1
Ethnicity		
◆ Balochi	94	26.8
◆ Pathan	106	30.2
◆ Sindhi	23	6.6
◆ Punjabi	35	10
◆ Urdu speaking	62	17.7
◆ Others		8.8
Smoking status		
◆ Smoker	27	7.7
◆ Non-smoker	324	92.3



*(p-value= 0.368)

Figure: Prevalence of prediabetes according to gender.

Table-2: Comparison of means of anthropometric and biochemical values between males and females.

Parameter	Males N=158	Females N=193	p-value*
Neck circumference (cm)	37.79±2.49	34.21±1.94	<0.001
Waist circumference (cm)	81.48±10.37	72.15±8.94	<0.001
Systolic blood pressure (BP) (mmHG)	119.27±11.17	110.56.23±13.54	<0.001
Diastolic blood pressure (BP) (mmHG)	81.34±8.08	74.95±8.81	<0.001
Fasting plasma glucose (mg/dl)	94.07±11.08	91.32±11.24	0.22
Fasting cholesterol (mg/dl)	161.78±35.75	156.66±33.96	0.171
Haemoglobin A1c (%)	5.28±0.47	5.19±0.42	0.72
Triglycerides (mg/dl)	162.19±51.32	132.81±47.78	<0.001
High-density lipoprotein (HDL) (mg/dl)	44.49±8.49	50.03±10.96	<0.001
Low-density lipoprotein (LDL) (mg/dl)	84.85±4.23	80.06±35.62	0.211
Body mass index	22.12±4.23	21.32±3.84	0.066

Table-3: Predictors of prediabetes in adolescents.

Predictors of Prediabetes	Odds Ratio (OR)	95% confidence interval (CI) for OR		p-value
		Lower limit of OR	Upper limit of OR	
Female gender	0.79	0.48	1.30	0.368
BMI	2.05	1.22	3.43	0.006
Neck Circumference (NC)	52.8	24.74	112.68	<0.001
Central obesity (WC)	2.32	1.15	4.69	0.016
SBP	2.82	1.55	5.12	<0.001
DBP	2.65	1.53	4.58	<0.001
High LDL	2.67	1.17	6.07	0.16
TG	3.87	2.21	6.77	<0.001
HDL	2.74	1.64	4.57	<0.001

BMI: Body mass index, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, HDL: High-density lipoprotein, LDL: Low-density lipoprotein, TG: Triglycerides.

findings on both HbA1c and FPG, 81(23.1%) participants were found to be prediabetic; 40 (25.3%) among the males and 41(21.2%) among the females (p=0.368) (Figure).

Mean values between the two genders for NC, WC, SBP, DBP, fasting TG, HDL showed significant difference between males and females (Table-2).

Among the 81 prediabetics, 15(18.5%) had high-risk WC, while 71(87.7%) had increased NC, indicating that NC was a better predictor of prediabetes (p<0.001) compared to WC.

High NC was the strongest predictor of prediabetes in adolescents (Odds ratio [OR]: 52.80), followed by high TG levels (OR: 3.87). None of the genders was found to be protective against the development of prediabetes (p>0.05). Other variables that were predictive of prediabetes in ascending order were high SBP, low HDL, high LDL, high DBP, WC and BMI of overweight and obese categories (Table-3).

Discussion

Prediabetes is the cause behind many chronic illnesses, like DM and cardiovascular diseases. Early diagnosis of prediabetes may help us in preventing its conversion into DM, and, hence, morbidity and mortality related to it. The current study was conducted with 351 individuals which makes it the largest study sample to date from Pakistan in this age group.

In our study, 23.1% students suffered with prediabetes which was higher compared to earlier studies.[5,16,17] A study in Malaysia reported the prevalence of prediabetes as 22.1% and another study revealed a frequency of 21.7%.[18,19] The current results revealed no significant difference in the frequency of prediabetes among males and females. The finding is in contrast with literature which showed male preponderance.[20,21] The current study used HbA1c and FPG levels as indicators for the diagnosis of prediabetes. Similar indicators were used in earlier studies.[20,22,23] In the current study, males differed significantly from females with respect to NC, WC, SBP, DBP, fasting TG and HDL levels. Earlier studies found that cholesterol level and SBP was different in males compared to females.[23,24] A Saudi Arabian study concluded that the higher the WC, the stronger was its association with prediabetes in males.[20] The current study reported NC as the strongest predictor of prediabetes. There has been evidence that there is an independent association between NC and different glycaemic parameters.[25] On the contrary, there are studies reporting no association of NC with FPF, insulin resistance (IR).[26,27] Since most of such data related to adult population, therefore we need more studies involving adolescent and paediatric populations to establish an association of NC with FPG and HbA1c.

The current study also found that BMI, SBP, DBP, TG and HDL were strong predictors of prediabetes among adolescents. Studies have earlier reported BMI, TG and SBP as strong predictors of prediabetes in this age group.[23,28-30] DBP and HDL, however, have not been previously reported to have significant association with prediabetes among adolescents.

The strength of the current study is that it has identified NC, which is a very low-cost parameter, as a screening tool for prediabetes. The study has some limitations too. Due to financial constraints, the study could only focus on the late adolescence age group. The results could have been more generalisable had it included early and middle adolescent age groups too. Further large-scale studies are needed in the general population to validate the findings of the current study.

Conclusion

BMI, SBP, DBP, TG and HDL were found to be strong predictors of prediabetes in the adolescent population. Not only medical students, but other students with risk factors, should be examined earlier for prediabetes.

Community health programmes are needed for awareness among non-medical adults.

Acknowledgement: We are grateful to Dr. Gulshan Himani and Dr. Mehwsih Mehmood of the Indus Hospital, Karachi, and Zubair Ishaque of Ziauddin University, Karachi, for their assistance in literature search, questionnaire-designing and data entry.

Disclaimer: None.

Conflict of Interest: None.

Source of Funding: None.

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