EUROPEAN JOURNAL OF BIOMEDICAL AND PHARMACEUTICAL SCIENCES
http://www.ejbps.com

ISSN 2349-8870
Volume: 5
Issue: 2
28-34
Year: 2018

PREDIABETES AND TYPE 2 DIABETES AMONG YEMENI ADOLESCENTS

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Article Received on 29/11/2017 **Article Revised on 19/12/2017** **Article Accepted on 09/01/2018**

ABSTRACT

Background: Diabetes is one of the most common disease in school-age children. In the USA, a national data set reported that the prevalence of T2 DM in youth aged 10–19 years had increased by 30.5% between 2001 and 2009. Type 2 diabetes usually develops slowly and insidiously in children. Obese children and adolescents affected by IGT and type 2 diabetes are characterized by severe insulin resistance, the deterioration in β-cell function in youth with type 2 diabetes is more accelerated (~15% per year) than that observed in adults. This would suggest that early intervention, even before the prediabetic conditions are established, should be implemented to prevent further decline in β-cell function. **Method:** The study based on multi stages cross-sectional study aimed to assess the prevalence of prediabetes and type 2 diabetes among adolescents students in Governmental secondary schools in Sana'a city, 16 schools & 1724 pupils were selected randomly by EPI. info system. **Results**: Out of a total of 1601 students were enrolled in the study, 841 (52.5%) were males and 760 (47.5%) females. The average body mass index (BMI) was 19.8±3.0 (≤85th centile) for males 21±3.7 (≤85th centile) for females. The study found that the prevalence of overweight and obesity among the participants was 121(7.6%) and 51 (3.2%) respectively. Also the average of waist measurement was (78.4±7.3) with marked more in female (79.1±7.7) than male (77.8±6.9). While 24(1.5%) of participants were in IFG stage, 15(62.5%) of them were females and 9 (37.5%) males. Finley we found that 4 cases (0.2%) of participants were considered as newly identified T2 DM 3 of them were females and 1 was male. Of the 1601 students interviewed 782(48.8%) have family history of diabetes. **Conclusion:** Although there was no statistically significant association between the prevalence of prediabetes /type 2 diabetes and overweight or obese students, the prevalence of IFG was non–significantly higher amongst overweight and obese subjects**.** We found that there was a significant association between the prevalence of IFG/type 2 diabetes and family history of diabetes, making a family history of diabetes very important risk factor for development of prediabetes and type2 diabetes.

KEYWORDS: Prediabetes, type 2 diabetes, Yemen, adolescents.

INTRODUCTION

Diabetes mellitus (DM) is a group of diseases characterized by high level of glucose in the blood resulting from defects in insulin production, insulin action or both. It is associated with serious complications and premature death, but timely diagnosis and treatment of diabetes can prevent or delay the onset of the long - term complications.

Diabetes is one of the most common disease in school-age children. Type 1diabetes (T1 DM) in USA children and adolescents is increasing[1] and more new cases of type 2 diabetes (T2 DM) are being reported in young people.

According to 2011 National Diabetes Fact Sheet, about 215,000 young people in the USA under the age of 20 had diabetes in 2010. This represents 0.26% of all people in this age group.[2]

Based on data from 2002 to 2005, the search for diabetes in youth study reported that approximately 15,600 US youth less than 20 years of age were diagnosed annually with type 1 diabetes, while 3,600 were newly diagnosed with type 2 diabetes.[3]

The Centers for Disease Control and Prevention recently published projections for type 2 diabetes prevalence using the SEARCH database, assuming a 2.3% annual increase. The prevalence of type 2 diabetes in those under 20 years of age will quadruple in 40 years.[4,5]

Also it was found that in the USA, a national data set reported that the prevalence of T2 DM in youth aged 10–

19 years had increased by 30.5% between 2001 and 2009.[6]

Although there is a limitation of studies, based on the type of methodology the prevalence of T2 DM among children under the age of 18 years old varies in Arab countries, it was found to be 9.04% and 1/1000 in Saudi Arabia.[7,8], 47.3/1000 in male and 26.3/1000 in female children in Kuwait[9], 8 children was reported in 2005 in UAE[10], 28 out of 210 in Egypt[11] and 38 out of 985 in Sudan.[12]

The increased prevalence of T2 DM in the pediatric population is affected by obesity worldwide. Ethnicity and genetic susceptibility related to a positive family history have been recognized as predisposing risk factors for T2 DM.[13]

The progression from normal glucose tolerance (NGT) to type 2 diabetes involves intermediate stages of impaired fasting glucose (IFG) and impaired glucose tolerance (IGT), also known as prediabetes. The pathophysiology underlying the development of these glucose metabolic alterations is multifactorial; however an alteration in the balance between insulin sensitivity and insulin secretion represents the most important player in the development of type 2 diabetes. Obese children and adolescents affected by IGT and type 2 diabetes are characterized by severe insulin resistance which is associated with an increased lipid accumulation in visceral compartments, liver and muscle tissue and by reduced sensitivity of β-cell of first and second-phase insulin secretion.[14] Type 1 diabetes is an autoimmune disease accounts for approximately 5% of all diagnosed cases of diabetes, but is the leading cause of diabetes in children of all ages.[15] The American Diabetes Association (ADA) criteria for diagnosis of diabetes are the same for children, adolescents, and adults. Classification of the type of diabetes is generally more difficult than establishing a diagnosis of diabetes. In many cases, classification is based on observation of clinical features and course, or it may be accomplished with the aid of data from additional testing (e.g., C-peptide test, detection of autoantibodies and determination of fasting insulin level).[16] Neither C-peptide nor fasting insulin levels has been standardized for distinguishing a diagnosis of type 2 from type 1 diabetes in children.[5] However, it is probable that there are many patients who have clinical and bio-chemical features of both type 1 and type 2 diabetes.[17,18] For example, excessive weight is common in children with type 1 diabetes.[14] Furthermore, diabetes associated autoantibodies and ketosis may be present in patients with features of type 2 diabetes (including obesity and acanthosis nigricans).[19] Type 2 diabetes usually develops slowly and insidiously in children, the first stage in the development of it is often insulin resistance. Youth with hybrid or mixed diabetes are likely to have both insulin resistance that is associated with obesity and type 2 diabetes and antibodies against the pancreatic islet cells that are associated with autoimmunity and type 1 diabetes. The transition from prediabetes to type 2 diabetes in adults is usually a gradual phenomenon that occurs over 5–10 years.[20] Therefore, the early presentation of type 2 diabetes in youth raises the possibility of an accelerated process in pediatric age compared with adults. In fact, an interesting report by Gungor and Arslanian[21] suggested that despite a relatively robust initial insulin secretion, the deterioration in β-cell function in youth with type 2 diabetes is more accelerated (~15% per year) than that observed in adults.

The observed rapid progression of the glucose homeostasis alterations in pediatric age underlines the importance of focusing the attention on the earliest stages of the disease before the onset of any alterations in glucose tolerance. In addition, the rapid tempo of the development of type 2 diabetes, which is driven by the rapid failure of β-cell function, would suggest a rather more aggressive course in the development of the disease than what is usually seen in adulthood. This would suggest that early intervention, even before the prediabetic conditions are established, should be implemented to prevent further decline in β-cell function.

For this reason we decided to visit the youth in their schools to educate them and their teachers about diabetes and to increase their awareness about the prevention of the disease and finally to study the prevalence of prediabetes and diabetes among Yemeni adolescents since there is no previous study of diabetes among Yemeni adolescents.

OBJECTIVES

This study was undertaken to assess the prevalence of prediabetes and type 2 diabetes among adolescents students of Governmental secondary schools in the Sana'a capital.

METHODS

The study based on multi stages cross- sectional study of students in Governmental secondary schools in Sana'a city, 16 schools & 1724 pupils were selected randomly by EPI. info system.

A letter of invitation describing the study, informed consent and assent forms, and Arabic questionnaire were sent to the ministry of education and then to the schools principles, who were asked to sign the informed consent and together with the student complete a questionnaire including the child's demographics (age, gender) reported family history of diabetes mellitus, and physical activities, such as walking or active play.

All participants underwent physical examination including height (HT), body weight (BW) and blood pressure (BP). Height and weight were measured in the standard ways on which the participant stand wearing light clothes and no shoes. Height was expressed in centimeters and weight was expressed in kilograms.

Body Mass Index (BMI) was calculated as weight in kilograms divided by the square of height in meters. Children with a BMI ≥ 85th percentiles but ≤ 94.99th percentile, for age and sex, were classified as overweight and those with a BMI > 95th percentile were classified as obese.[14,22]

Blood Pressure (BP) was measured after the child rested for at least 5 minutes in a sitting position, using sphygmomanometer with the adult cuff standard technique. An average of two readings was used for final records. All measurements were taken between 8:30 AM and 11:00 AM at each participating school.

Data collection by questionnaire prepared by the team and measuring blood glucose by Glucometer. According to (WHO) criteria, fasting Fasting glucose (FPG) is normal if the level is <110 mg/dL (<6.1 mmol/L) and is considered impaired plasma glucose (IFG) if the level is 110-125 mg/dL (6.1-6.9 mmol/L), while diabetes is considered when FPG is ≥126 mg/dL (7.0 mmol/L).[23] Data analysis was carried out using Software Package for Social Sciences (SPSS) V.20.0.,(Chicago 11), the significance level was determined by Pearson chi-square (with a significance level (0.05).

RESULTS

Out of a total of 1724 participants, we found that there were 3 (0.17%) cases of a known Type 1 DM who were separated from the study. A total of 1601 cases for which they completed the information and included in the analysis, all the participants were aged between 16-18 years with a mean age of 16.6 years and so we excluded the cases who their ages more than 18 or less than 16 years.

Out of a total of 1601 students were enrolled in the study 841(52.5%) were males and 760 (47.5%) females. The average body mass index (BMI) among males was 19.8±3.0 (≤85th centile) while it was 21.3±3.7 (≤85th centile) among females. Regarding the height, body weight and waist circumference we found that the averages were 164.1±9.3 cm, 53.4±9.7 kg and 77.8±6.9 cm respectively among males while they were 156.2±6.6 cm, 51.9±9.9 kg and 79.1±7.7 cm among females. (table1).

Table 1: Average of General characters of the participants.

Variable	Sex					
	males		females		Total	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Age(years)	16.6	0.6	16.6	0.6	16.6	0.6
B.W(kg)	53.4	9.7	51.9	9.9	52.7	9.8
HT(cm)	164.1	9.3	156.2	6.6	160.4	9.0
BMI	19.8	3.0	21.3	3.7	20.5	3.4
wais.c(cm)	77.8	6.9	79.1	7.7	78.4	7.3
FPG(mg/dl)	81.7	11.5	84.2	11.8	82.9	11.7
SBP(mmHg)	107.6	11.6	116.1	49.8	111.6	35.6
DBP(mmHg)	73.1	8.9	77.1	7.5	75.0	8.5

B.W=body weight, HT=height, BMI=body mass index, wais.c.=waist circumference, FPG= fasting plasma glucose, SBP=systolic blood pressure, DBP= diastolic blood pressure.

In our study we found that the prevalence of overweight those which their BMI ≥85% to ≤ 95% and obesity with BMI ≥ 95% among the participants were 121(7.6%) and 51 (3.2%) respectively. Also the average of waist measurement was (78.4±7.3) with marked more in females (79.1±7.7) than male (77.8±6.9). A number of our participants 659 (41.2%) recognized acceptable range of physical activities with higher prevalence among males 444 (52.8%) than females 215 (28.3%).

Regarding the level of FPG we found that 1573(98.3%) participants have normal FPG (less than 110 mg /dl), 824(52.4%) of them were males and 749(47.6%) females. While 24(1.5%) of participants were in IFG stage, 15(62.5%) of them were females and 9 (37.5%) males. Finley we found that 4 cases (0.2%) of participants were considered as newly identified T2DM (FPG>126mg/dl) 3 of them were females and 1 was male. Of the 1601 students interviewed782 (48.8%) have family history of diabetes, 387 of them (46.0%), males and395 (52.0%) females.

From the participants sample we did not register any hypertensive. Table (2).

Table (2) Details of General Characters among Males and Females.

Variable		males		females		Total	
		No.	%	No.	%	No.	%
B.W.(kg)	Less than normal	327	38.9%	136	17.9%	463	28.9%
	normal	509	60.5%	609	80.1%	1118	69.8%
	more than normal	5	.6%	15	2.0%	20	1.2%
	Total	841	100.0%	760	100.0%	1601	100.0%
HT. (Cm)	Short	289	34.4%	212	27.9%	501	31.3%
	normal	548	65.2%	536	70.5%	1084	67.7%
	Tall	4	.5%	12	1.6%	16	1.0%
	Total	841	100.0%	760	100.0%	1601	100.0%
BMI. Chart.	underweight	201	23.9%	69	9.1%	270	16.9%
	healthy	575	68.4%	584	76.8%	1159	72.4%
	overweight	50	5.9%	71	9.3%	121	7.6%
	Obese	15	1.8%	36	4.7%	51	3.2%
	Total	841	100.0%	760	100.0%	1601	100.0%
Waist Circum.	normal	815	96.9%	641	84.3%	1456	90.9%
	more than normal	26	3.1%	119	15.7%	145	9.1%
	Total	841	100.0%	760	100.0%	1601	100.0%
Family History	Yes	387	46.0%	395	52.0%	782	48.8%
	No	454	54.0%	365	48.0%	819	51.2%
	Total	841	100.0%	760	100.0%	1601	100.0%
Physical Activity	yes	444	52.8%	215	28.3%	659	41.2%
	sometimes	342	40.7%	457	60.1%	799	49.9%
	No	55	6.5%	88	11.6%	143	8.9%
	Total	841	100.0%	760	100.0%	1601	100.0%
FPG. Level	<110	831	98.6%	742	98.0%	1573	98.3%
	110-126	9	1.3%	15	1.7%	24	1.5%
	>126	1	0.1%	3	0.3%	4	0.2%
	Total	841	100.0%	760	100.0%	1601	100.0%

Regarding the correlations between the levels of IFG / T2DM and risk factors among participants, we found that there was a significant association between the level of IFG/T2DM among participants and family history with P. Value (0.016) while there were non-significant associations between the prevalence of IFG/Type 2 DM and overweight, waits circumference and physical activity with P. value (0.832, 0.722, 0.409) respectively. Table (3).

Table (3) Correlations between Fasting Plasma Glucose and Risk Factors.

Variable.	Level of blood glucose					Chi -square	P-value
		<110		>110			
		No.	%	No.	%		
B.W.(cm)	less than normal	455	28.9%	8	28.6%	0.368	0.832
	normal	1098	69.8%	20	71.4%		
	more than normal	20	1.3%	0	0.0%		
	Total	1573	100.0%	28	100.0%		
Waist Circ.(cm)	normal	1430	90.9%	26	92.9%	0.128	0.722
	more than normal	143	9.1%	2	7.1%		
	Total	1573	100.0%	28	100.0%		
F.H	yes	762	48.4%	20	71.4%	5.817	0.016*
	no	811	51.6%	8	28.6%		
	Total	1573	100.0%	28	100.0%		
Physical Activity	yes	649	41.3%	10	35.7%	1.789	0.409
	sometimes	782	49.7%	17	60.7%		
	no	142	9.0%	1	3.6%		
	Total	1573	100.0%	28	100.0%		

*. The Chi-square statistic is significant at the 0.05 level.

DISCUSSION

Type 2 diabetes is progressive, and one main factor responsible for this is a continued decline in β-cell function.[24] Several studies[24] have demonstrated that diabetes and prediabetes do not develop until the β-cell fails to compensate appropriately to the peripheral insulin resistance state. Type 2 diabetes occurs in youth more often during the second decade of life, coinciding with the physiological occurrence of pubertal insulin resistance.[25]

It is found that obese adolescents with type 2 diabetes have a marked reduction in both first- and second-phase insulin secretion. Thus at diagnosis, just as in the adults[24], ~80% of their β-cell function is reduced or lost.[26]

In our study we found that out of the total studied sample, 3 participants (0.17%) were found to be a known cases with type 1 diabetes, of which 2 (0.38%) were males and 1 (0.07%) was female. But we excluded them from our study.

In this study we found that the prevalence of newly identified type 2 diabetes was 4 (0.2%) depending only on (FPG) and not confirmed by another investigations as (GTT) or (HBA1c). This results is less than that found in Saudi Arabia National Surveillance for adolescents aged 12-18 years 4.56%[27], US 1.0%[28,29] and Canadian 3.5%.[30] Prevalence of of prediabetes using IFG was 24(1.5%) from the study sample, this is less than that found in Saudi Arabia National Surveillance 6.62%[27] and more less than that found in studies in Saudi Arabia 26.3%[31], Egypt 16%[32], Jordan 23%[33], Nigeria 17%[34] and Mexico 18.3%.[35] While the prevalence amongst USA adolescents aged 12 to 19 years, was 13% using IFG and 3% when IGT was used.[29] The prevalence of prediabetes using IGT amongst adolescents is lower than prevalence using IFG in most studies.[29,23,36]

The prevalence of prediabetes has been found to be high among adolescents with obesity.[37,38] The two fold increase in prevalence of IFG over a five year period in the NHANES study between 1999 to 2006 was attributed to the rapid rise in the prevalence of obesity amongst adolescents.[29] In our study, although there was no statistically significant association between the prevalence of prediabetes /type 2 diabetes and overweight or obese students, the prevalence of IFG was non–significantly higher amongst overweight and obese subjects. This finding could be explained by the less prevalence of obesity/overweight among Yemeni adolescents students since we found that the prevalence of overweight and obesity were 121(7.6%) and 51 (3.2%) respectively. Also the average of waist circumference measurement was (78.4±7.3) with marked more in female (79.1±7.7) than male (77.8±6.9). Our finding was less than that has been found in other studies[37,38,39] and that has been reported by D'Narayanappa and colleagues[39] in Indian prepubertal children and Aboulella and colleagues.[32] In the study on 'STOPP' type 2 diabetes, conducted amongst 8th grade students with a mean age of 14 years, 40% had IFG. In those with a BMI ≥ 95th percentile, the prevalence of IFG increased to 47%, while it was 36% in students with normal BMI (95th percentile.[40]

Although previous studies showed a lower prevalence of type 2 diabetes and IGT in Italian youths (0.5% and 5%, respectively)[41], a recent study conducted in Italy[43] on a large sample of overweight/obese children and adolescents reported a prevalence of glucose metabolism alterations of 12.4%. IGT was the most frequent alteration, accounting for 11.2%, with a higher prevalence in adolescents (14.8%) than in children (4.1%).[42]

The greater average of overweight and waist measurement among females than males in our study could explain the greater prevalence of IFG and Type2 diabetes among females 15(1.7%) and 3 (0.3%) respectively rather than males 9(1.3%) and 1(0.1%) respectively.

A major number of our participants 659 (41.2%) recognized acceptable range of physical activities with higher prevalence among males 444 (52.8%) than females 215 (28.3%). This phenomenon could be considered as additive reason for the less prevalence of IFG /Type 2 diabetes among males than females in our study.

In the other hand we found that there was a significant association between the prevalence of IFG/type 2 diabetes and family history of diabetes, since we found that 782 (48.8%) of participants have either first or second degree of family history of diabetes.

This finding came in consistent with that found in Mexico[43] when they found that IFG was identified in 88% of those children and adolescents aged 7-15 years with a family history, compared to 2% of those without. Similarly, among obese children from Germany[44] a history of parental diabetes was associated with a 9.5 fold increased risk for prediabetes. Making a family history of diabetes very important risk factor for development of prediabetes and type 2 diabetes.

From the participants sample we did not register any hypertensive.

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