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Original Research Article

A cross-sectional study of impaired glucose tolerance amongst undergraduate medical students

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ABSTRACT

Background: Diabetes is an important chronic disease both in terms of prevalence and associated morbidity and early mortality. Mortality rates in diabetics are two- to threefold higher than those without diabetes. Type 2 Diabetes Mellitus is preceded by a period of abnormal glucose homeostasis and hence early diagnosis is important in decreasing this morbidity and mortality. The oral glucose tolerance test (OGTT) is currently the gold standard for the diagnosis of diabetes.
Methods: This cross sectional single observer study was conducted amongst all the undergraduate students and interns of a municipal medical college to assess the point prevalence of impaired glucose tolerance and the factors predisposing to the same. After necessary permissions, participants giving written informed consent were interviewed and participants were subjected to an oral glucose tolerance test (OGTT) and their heights, weights were measured.
Results: None of the participants had an increased fasting blood glucose but 30 min, 60 min and 90 min post OGTT blood glucose levels were increased in 9 (11.84%) participants and 120 min post OGTT blood glucose was increased in 15 (19.73%) participants. Increase in Body Mass Index (BMI) shows a positive correlation with fasting (r=0.155) and 120 min post OGTT blood glucose (r=0.042). Increase in weekly junk food servings shows a positive correlation with fasting (r=0.014), 90 min (r=0.004) and 120 min post OGTT blood glucose (r=0.009).
Conclusions: Impaired glucose tolerance was present in a substantial number of non-diabetic students and had a correlation with BMI, exercise and junk food intake.

Keywords: Impaired glucose tolerance, Latent diabetes, Medical Students

INTRODUCTION

Diabetes is an important chronic disease both in terms of the number of persons affected and the considerable associated morbidity and early mortality.[1] According to the International Diabetes Federation, the current load of diabetes in the world is around 415 million and expected to rise to 642 million by 2040. The south East Asian countries, especially India, the current burden are 78.3 million and expected to rise to 140 million by 2040.[2,3]

Mortality rates for people with diabetes are two- to threefold higher than those without diabetes; with cardiovascular disease as the leading cause of death.[1] Diabetic renal disease is a major cause of morbidity and mortality among those with diabetes. Although the prevalence of both type 1 and type 2 Diabetes Mellitus is increasing worldwide, the prevalence of type 2 Diabetes Mellitus is rising much more rapidly, presumably because of increasing obesity, reduced activity levels as countries become more industrialized, and the aging of the population.[4] Also there is a growing trend towards developing Type 2 Diabetes mellitus at a much before earlier age than before.[5] Type 2 Diabetes Mellitus is preceded by a period of abnormal glucose homeostasis classified as impaired fasting glucose (IFG) or impaired glucose tolerance (IGT). A number of lifestyle modifications and pharmacologic agents prevent or delay the onset of DM.[4]

Early diagnosis and preventive treatment then logically becomes important in decreasing morbidity and mortality due to type 2 Diabetes Mellitus. Screening by a health care professional or within the health care setting for pre-diabetes and diabetes should be considered in those ≥45 years of age, particularly in those with a BMI> 25 kg/m^2.[1] The oral glucose tolerance test (OGTT) is currently the gold standard for the diagnosis of diabetes.[2]

METHODS

This cross sectional single observer study was conducted amongst all the undergraduate students and interns of a Municipal Medical College in Kalwa, Thane, located about 30 kilometres from Mumbai city in the state of Maharashtra in Western India to assess the point prevalence of impaired glucose tolerance amongst medical students and interns and the factors predisposing to the same amongst them. After obtaining permissions from the Institutional Ethics Committee (IEC) and authorities for conducting the study, participants giving written informed consent (n=76) were interviewed with the help of a semi structured proforma.

Height of each participant was measured by a standard measuring tape vertically hoisted on a vertical wall and weight was measured by a spring type pre-calibrated balance. Participants were subjected to an Oral Glucose Tolerance Test consisting of ingestion of 75 gm of glucose in 100ml of water and blood glucose was measured using a pre-calibrated hand held glucometer device before the glucose challenge i.e., 8 hours fasting and after the glucose challenge at 30 min, 60 min, 90 min and 120 min intervals.

The obtained data was statistically analysed using percentage distribution, and correlation between two variables was measured by Pearson's product moment correlation coefficient. Statistical significance of difference (taken as p-value<0.05) was calculated using standard error of difference between two means.

RESULTS

Age and gender

The distribution of participants according to age and gender shows that 55.56% of the participants were females, while 44.74% were males. 52.63% of the participants were between 21-22 years of age while 38.16% were between 18-20 years of age. Mean age of females was 20.59 years with a Standard Deviation of 1.19 years while mean age of males was 21.35 years with a Standard Deviation of 1.2 years. Demographic profile of the participants is depicted in Table 1.

Table 1: Age and gender distribution.

Age	Female	(%)	Male	(%)
18-20	20	26.32	9	11.84
21-22	20	26.32	20	26.32
23-24	2	2.63	5	6.58

Family History of DM

2 female students (2.64%) had history of Diabetes Mellitus in both their parents. Table 2 gives the details of Family history of Diabetes Mellitus among the participants.

The difference in the means of fasting blood glucose levels between those who had a history of diabetes mellitus in their father or mother and those who did not was statistically significant (p<0.05) but the difference in their 120 min post OGTT blood glucose was statistically insignificant (p>0.05). Family history details of the participants are depicted in Table 2 and 6.

Table 2: Family history of (H/O) diabetes mellitus.

		Female	(%)	Male	(%)
H/O DM in Father	No	36	47.37	29	38.16
	Yes	6	7.89	5	6.58
H/O DM in Mother	No	37	48.68	33	43.42
	Yes	5	6.58	1	1.32
H/O DM in other family member	No	36	47.37	30	39.47
	Yes	6	7.89	4	5.26

Table 3: Other factors.

		Female	(%)	Male	(%)
Addictions	Yes	0	0	0	0
	No	42	55.26	34	44.74
Exercise	No exercise	27	35.53	19	25
	2-4 hours	8	10.53	8	10.53
	5-7 hours	7	9.21	7	9.21
H/O trauma or surgery	No	34	44.74	30	39.47
	Yes	8	10.53	4	5.26
Fruit servings per week	0 - 10	26	34.21	22	28.95
	11 - 20	10	13.16	6	7.89
	21 - 30	6	7.89	2	2.63
	31 - 40	0	0	4	5.26
Junk food servings per week	0 - 5	28	36.84	23	30.26
	6 - 10	10	13.16	9	11.84
	11 - 15	3	3.95	1	1.32
	16 - 20	0	0	1	1.32
	> 20	1	1.32	0	0

Anthropometry

The details of height, weight and Body Mass Index of participants is given in Table 5. Increase in BMI shows a positive correlation with fasting (r=0.155) and 120 min post OGTT blood glucose (r=0.042).

Family income

Mean family income was Rs.62217.11 with a standard deviation of Rs.52641.89. 36.84% of participants had family incomes between Rs.26000 and Rs.50000 while only 13.16% participants had family incomes above Rs.100000/- Increase in family income shows a positive correlation with 60 min (r=0.15), 90 min (r=0.015) and 120 min post OGTT blood glucose (r=0.08).

Occupation of parents

34.21% of the fathers were service class people with 21.05% professionals and 27.63% self-employed. 78.95% of the mothers were homemakers with 9.21% professionals and 6.58% teachers.

Table 4: Oral glucose tolerance test (Blood glucose levels).

		Female	(%)	Male	(%)
Fasting Plasma Glucose	< 70 mg%	0	0	0	0
	71-100 mg%	42	55.26	30	39.47
	101-120 mg%	0	0	4	5.26
	>120 mg%	0	0	0	0
30 Min Post OGTT Plasma Glucose	Less than 100	0	0	1	1.32
	101-140	3	3.95	9	11.84
	141-200	38	50	22	28.95
	201-250	1	1.32	2	2.63
60 Min Post OGTT Plasma Glucose	Less than 100	1	1.32	2	2.63
	101-140	17	22.37	18	23.68
	141-200	22	28.95	11	14.47
	201-250	1	1.32	3	3.95
	251-300	1	1.32	0	0
90 Min Post OGTT Plasma Glucose	Less than 100	3	3.95	5	6.58
	101-140	22	28.95	19	25
	141-200	16	21.05	10	13.16
	201-250	1	1.32	0	0
120 Min Post OGTT Plasma Glucose	<140 mg/dl	33	43.42	28	36.84
	>140 mg/dl	9	11.84	6	7.89

Addictions

None of the male and female participants had any addictions according to their responses.

Exercise

Mean duration of exercise in male participants was 1.97 hours with a standard deviation of 2.48 hours while the mean duration of exercise in female participants was 1.57 hours with a standard deviation of 2.31 hours. 60.53% of all participants did not exercise at all.

H/O Surgery/trauma

Only 15.79% participants had a history of trauma or surgery (Table 3). Abdominal trauma or surgical trauma to the tail of pancreas can predispose to early diabetes mellitus.

Diet

Mean servings of fruits consumed by female participants were 9.36 servings per week with a standard deviation of 8.27 servings per week while mean servings of fruits consumed by male participants were 10.8 servings per week with a standard deviation of 10.75 servings per week. Increase in weekly fruit servings shows a positive correlation with fasting (r=0.16) and 30 min post OGTT blood glucose (r=0.06) but a negative correlation with 60 min (r= - 0.01), 90 min (r= - 0.13) and 120 min post OGTT blood glucose (r= - 0.08).

Junk food

Mean junk food servings consumed by female participants were 4.26 per week with a standard deviation of 4.61 servings per week while mean junk food servings consumed by male participants were 3.82 per week with a standard deviation of 4.27 servings per week. Only 2.64% participants had 16 or more servings of junk food per week. Increase in weekly junk food servings shows a positive correlation with fasting (r=0.014), 90 min (r=0.004) and 120 min post OGTT blood glucose (r=0.009). The details of junk food intake of participants are given in Table 3.

Table 5: Anthropometry and family income.

		Female	Male	Total
Height (m)	Mean	1.60	1.69	1.64
	SD	0.06	0.06	0.08
Weight (kg)	Mean	54.92	66.74	60.20
	SD	8.82	9.55	10.85
Body Mass Index	Mean	21.47	23.40	22.33
	SD	3.09	3.34	3.33
Family Income (Rs)	Mean	74142.86	47485.29	62217.11
	SD	60288.97	37115.81	52641.89

Table 6: Factors influencing blood glucose levels.

H/O Diabetes mellitus in mother or father				
Fasting blood glucose	**NO (n=61)**	**YES (n=15)**	**Z Value#**	**p value**
Mean	86.83	91.72	2.27	0.0116*
SD	7.75	5.76		
Gender				
Post 120 min OGTT blood glucose	**Male (n=34)**	**Female (n=42)**	**Z Value#**	**p value**
Mean	114.65	125.45	2.18	0.0143*
SD	23.47	18.62		

*Statistically significant #Standard Error of Difference between 2 means

Blood glucose (Fasting)

Mean fasting blood glucose in females was 87.29 mg/dl with a standard deviation of 6 mg/dl while mean fasting blood glucose in males was 88.17 mg/dl with a standard deviation of 9.04 mg/dl. Only 4 male participants (5.26%) had fasting blood glucose between 101 and 120 mg/dl which is an indicator of a pre-diabetic state. None of the participants had a fasting blood glucose level of more than 120 mg/dl. The difference in the means of fasting blood glucose levels between male and female participants is statistically insignificant (p>0.05). The details of blood glucose levels of participants during the OGTT are given in Table 4.

Blood glucose (30 min post OGTT)

Mean blood glucose in females 30 min post OGTT was 166.19 mg/dl with a standard deviation of 19.42 mg/dl while mean blood glucose in males 30 min post OGTT was 158.41 mg/dl with a standard deviation of 29.32 mg/dl. 3 participants (3.93%) had 30 min post OGTT blood glucose between 201 and 250 mg/dl which is an indicator of an impaired glucose tolerance. The difference in the means of 30 min post OGTT blood glucose levels between male and female participants is statistically insignificant (p>0.05).

Blood glucose (60 min post OGTT)

Mean blood glucose in females 60 min post OGTT was 152.3 mg/dl with a standard deviation of 32.25 mg/dl while mean blood glucose in males 60 min post OGTT was 144.06 mg/dl with a standard deviation of 32 mg/dl. 4 participants (5.27%) had 60 min post OGTT blood glucose between 201 and 250 mg/dl. 1 female student (1.32%) had 60 min post OGTT blood glucose between 251 and 300 mg/dl which is an indicator of an impaired glucose tolerance. The difference in the means of 60 min post OGTT blood glucose levels between male and female participants is statistically insignificant (p>0.05).

Blood glucose (90 min post OGTT)

Mean blood glucose in females 90 min post OGTT was 135.38 mg/dl with a standard deviation of 30.13 mg/dl while mean blood glucose in males 90 min post OGTT was 128.11 mg/dl with a standard deviation of 26.69 mg/dl. 26 participants (34.21%) had 90 min post OGTT blood glucose between 141 and 200 mg/dl.

1 female participant (1.32%) had 90 min post OGTT blood glucose between 201 and 250 mg/dl which is an indicator of an impaired glucose tolerance. The difference in the means of 90 min post OGTT blood glucose levels between male and female participants is statistically insignificant (p>0.05).

Blood glucose (120 min post OGTT)

Mean blood glucose in females 120 min post OGTT was 125.45 mg/dl with a standard deviation of 18.62 mg/dl while mean blood glucose in males 120 min post OGTT was 114.64 mg/dl with a standard deviation of 23.47 mg/dl. 15 participants (19.73%) had 120 min post OGTT blood glucose more than 140 mg/dl which is an indicator of an impaired glucose tolerance. The difference in the means of 120 min post OGTT blood glucose levels between male and female participants is statistically significant (p<0.05).

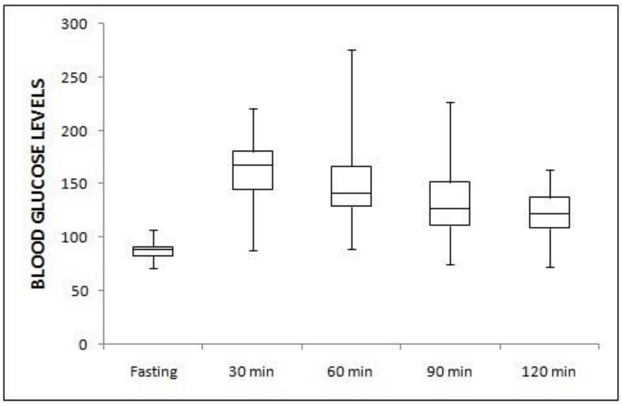

Figure 1: Blood glucose values after oral glucose tolerance test.

DISCUSSION

Age and gender

Majority of the participants in this study were between 18-22 years of age. Similarly in a study by Sinha R et al impaired glucose tolerance was detected in 25% of the 55 obese children (4 to 10 years of age) and 21% of the 112 obese adolescents (11 to 18 years of age); silent type 2 diabetes was identified in 4% of the obese adolescents.[6]

Family history

In this study a statistically significant difference in the fasting blood glucose levels among those who had a history of diabetes in their parents and those who did not highlights the presence of a non-modifiable risk factor and consequently the importance of regular monitoring and screening of progress of impaired glucose tolerance to frank diabetes. A study by Valdez R et al, Yoon P, et al, also provides evidence of the independence and significance of the association between family history and the prevalence of diabetes.[7]

Anthropometry

In the present study male participants had a mean body mass index of 23.4 with a standard deviation of 3.34 while female participants had a mean body mass index of 21.47 with a standard deviation of 3.09. Increase in BMI shows a positive correlation with fasting (r=0.155) and 120 min post OGTT blood glucose (r=0.042). Similarly a study by Ganz M, et al found a positive association between BMI and a risk of type-2 diabetes mellitus.[8] In a study by Hopper M, et al significantly higher blood glucose levels were also found in women, high BMI, low fitness, and rapid weight gain groups.[9] But in a study by Higaki Y et al body mass index, the percentage of body fat, and waist-to-hip ratio in the borderline glucose tolerance group did not differ from those in normal glucose tolerance group.[10]

Exercise

The difference in the number of participants who exercised and did not exercise between males and females was not significant ($\chi 2$=0.0038, p=0.95). Increase in weekly exercise frequency showed a weak correlation with fasting (r=0.16) and 120 min post OGTT blood glucose (r=0.01). In a study by Manson J et al women who engaged in physical exercise at least once per week had an age-adjusted relative risk (RR) of NIDDM of 0.67 (p<0.0001) compared with women who did not exercise weekly indicating that physical activity may be a promising approach to the prevention of diabetes mellitus.[11]

Diet

In the present study an increase in weekly junk food servings showed a positive correlation with fasting (r=0.014), 90 min (r=0.004) and 120 min post OGTT blood glucose (r=0.009). In a study by Ramchandani N et al commonly reported barriers to diabetes control included diet and irregular schedules.[12] This highlights the importance of diet control right from the stage of impaired glucose tolerance which is a risk factor in the occurrence and progress of diabetes.

Plasma glucose levels

Median plasma glucose levels were 88.5 mg% for fasting, 167 mg% for 30 min post OGTT, 141 mg% for 60 min post OGTT, 127 mg% for 90 min post OGTT and 122 mg% for 120 min post OGTT status which are within normal limits. But the 3rd quartile levels show fasting plasma glucose levels at 91.25 mg% and 120 min post OGTT plasma glucose levels at 137 mg% which are within normal limits but the plasma glucose levels for 30 min, 60 min and 90 min post OGTT are 180.25 mg%, 166.5 mg% and 151.25 mg% respectively which is above normal levels. These constitute the impaired glucose tolerance group which escape detection by routine fasting and post prandial plasma glucose estimation. Xianghai

Zhou X et al concluded that as a screening tool for newly diagnosed diabetes and pre-diabetes, the fasting capillary glucose measurement performed better than A1C in the general population.[13]

The maximum levels for plasma glucose were 107 mg% for fasting, 221 mg% for 30 min post OGTT, 276 mg% for 60 min post OGTT, 227 mg% for 90 min post OGTT and 164 mg% for 120 min post OGTT status which can be detected on post prandial plasma glucose examination but are missed on routine fasting or random plasma glucose estimation. But Davidson M, et al have recommended that the 2-hour glucose concentration criterion on an oral glucose tolerance test for the diagnosis of diabetes should be raised from ≥11.1 mmol/L (200 mg/dL) to ≥13.3 mmol/L (240 mg/dL) for diagnostic concentrations of glucose to predict the subsequent development of specific diabetic complications (e.g., retinopathy).[14] Still in a study among three hundred students with no prior diagnosis of illness from the University of Kansas, Lawrence, prevalence was high for impaired fasting glucose (9%), and fasting insulin was useful in capturing at risk individuals.[15] This again indicates the importance of more intensive tests for early detection of risk of developing diabetes in future.

CONCLUSION

Impaired glucose tolerance was present in a substantial number of non-diabetic students who had normal fasting and post-prandial blood glucose levels and hence could easily escape routine screening procedures and may not be useful in early identification of potential future diabetics. Impaired glucose had a positive correlation with BMI, exercise and junk food intake hence lifestyle modification with emphasis on physical activity should be advocated in young population.

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