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Original Article

Identification of risk factors affecting impaired glucose metabolism among the adult population of district Srinagar

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ABSTRACT

Background: The World has seen an emerging trend of diabetes among adolescents and moderately aged people over the last decade. The aim of the study was to identify the risk factors associated with impaired glucose metabolism and the prevalence of impaired glucose metabolism among the adult population of district Srinagar.

Methods: Multi-stage cluster random sampling design was used and from each household, participants were selected using a Kish grid method. Socio-demographic and clinical data were collected. The participants were then subjected to fasting venous blood glucose estimation.

Results: Age, waist circumference, hip circumference, weight, and body mass index were all statistically significant between normoglycemic participants and those with impaired glucose metabolism ($p < 0.018$). On logistic regression, subjects who had a higher BMI were more likely to develop Impaired glucose metabolism (OR = 3.52, OR 95% CI = 1.25–9.87); Moreover, consumption of carbonated drinks, (3–6 times/week OR = 4.40, OR 95% CI = 2.06–9.40; >6 times/week OR = 11.04, OR 95% CI = 0.86–140.66) was found to be a potential risk factor. Participants with a family history of diabetes were more susceptible to develop impaired glucose metabolism (OR = 6.41, OR 95% CI = 3.22–12.78). The risk effect of these factors was even stronger before adjusting for age, sex, family history of diabetes, and BMI in participants.

Conclusion: Risk factors for impaired glucose metabolism include increasing age, obesity, and higher consumption of carbonated drinks, hypertension, smoking behavior, high-calorie diet intake and positive family history of diabetes.

1. Introduction

The World has seen an emerging trend of Type 2 diabetes mellitus (T2DM) among adolescents and moderately aged people over the last decade. Despite the fact, diabetes used to be a major cause of morbidity and mortality among geriatrics but with changing lifestyles and socioeconomic status, it is now considered a potential disease among young adults and adolescents [1]. Estimates from the recent studies have reported this rise in the prevalence of diabetes among all inhabitant continents of the world [2]. Estimates from India show an alarming pattern in the rise of diabetes with 66.8 million people already diagnosed with diabetes and 35.4 million people with hidden or unknown diabetes status [3]. It is estimated that these figures will continue to grow at an alarming rate and burden of diabetes mellitus in India will rise to 101.2 million people by 2030 [4]. Studies have documented that the two most important modifiable factors for diabetes mellitus are obesity and physical inactivity [5]. Further modifications in lifestyle and behavior among the people have shown positive results in reducing the incidence of diabetes mellitus, thus making a way out for population-based policies to target individuals at high risk of developing diabetes mellitus.

In the current scenario, the burden of type 2 diabetes mellitus in the world is so immense that it would not be wrong to consider this disease as the epidemic of the 21st century. The primary reasons considered for this epidemic of diabetes includes the rapid epidemiological transition among the population and changes associated with food habits, changes in dietary patterns, decreased physical activity. The above mentioned epidemiological transitions have been found more among the urban population of the world who

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have adopted modern lifestyles resulting in obesity, lifestyles diseases and urbanization as evident from previous studies [6,7]. It has also been documented that those who consume a low fiber diet with high glycemic index have greater chance of diabetes than those who consume high fiber diet with low glycemic index [8]. A study on Indian population documented that uncontrolled hypertension, poor glycemic control, disorders of lipid metabolism and 1st hand smoking are the main risk factors responsible for diabetes mellitus [9]. However, the etiology behind the development of diabetes may vary among different population groups based on geographic and ethnic background [9].

We performed an intensive search in PubMed, Cochrane, Google Scholar and Research gate with keywords as Diabetes prevalence in Kashmir. The search uncovered scarcity of data on diabetes among Kashmiri population. We included studies reported by Zargar et al., 2008 [10] among adults population aged (20–40 years) and Zargar et al., 2000 [11] among individuals (>40 years) where they evaluated the prevalence of T2DM as 2.4% and 6% respectively. Over the years, there has been increased susceptibility to the risk factors for diabetes among Kashmir population owing to changing lifestyles and urbanization over the last decade and this forms the basis of our study. We have conducted this study with a primary objective to identify the risk factors associated with impaired glucose metabolism among the adult population of district Srinagar and to estimate the prevalence of type 2 diabetes mellitus and impaired fasting glycaemia (IFG) among adult (≥20 years) population of district Srinagar. The findings of this study will be useful to formulate policies for the control of type 2 diabetes mellitus in Kashmir and implement screening programmes for early detection and prevention of this disease among the adult population of Kashmir valley.

2. Methods

This cross-sectional analytical study was conducted in district Srinagar, the summer capital of Jammu & Kashmir state from August 2016 to July 2017. Adult population >20 years of age and permanent residents of district Srinagar who have been residing in the district from last few decades were included in the study. Pregnant females and patients with known Type 1 diabetes mellitus were excluded from the study. In this study, the sample size was calculated using estimated previous prevalence of 6.1% reported by Zargar et al. [11], absolute precision at 2.5%, a design effect of 1.5, non-response rate of 10% and confidence level at 95%, the sample size came out to be 580. A three-stage cluster random sampling design was used for the study.

In the first stage, 29 clusters were selected from a total of 90 clusters using probability proportionate to size sampling (PPS). As district Srinagar has 90 census enumeration wards, each ward was designated as a single cluster. Then from each cluster, 20 households were selected using systematic random sampling. In case the household was locked, the adjacent household was included in the study. Then only one individual was selected from each household using the Kish Grid method [12] after explaining the objectives of the study and written informed consent. A validated questionnaire was used to collect socio-demographic data and clinical data. Flowchart of the sampling method is illustrated in Fig. 1.

The participants were asked to fast overnight at least for 8 h before blood collection scheduled for the next morning. The samples were then sent to a certified biochemical laboratory using the fastest available transport in a cold box within 2 h of sample collection. A total of 580 subjects were examined and blood reports obtained. One hundred eighty-six subjects (129 with IFG, and 57 with DM) had fasting serum glucose levels of more than 100 mg%, namely IFG/DM and were taken as cases. Participants with self-reported diabetes mellitus or being under treatment were also included as diabetic patients. Three hundred ninety-four subjects having fasting serum glucose levels less than 100 mg% were taken as controls. Finally, 580 subjects (including 394 control and 186 impaired glucose metabolism subjects) were included in the data analysis.

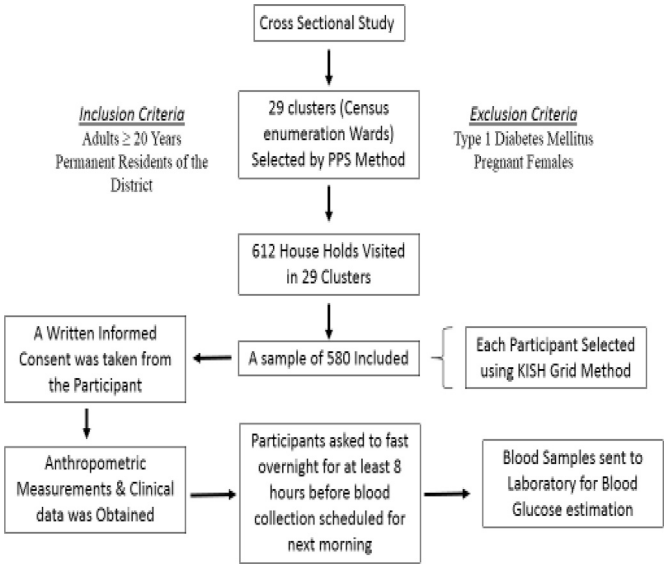

Fig. 1. Flowchart showing sample methods adopted during the study.

The study was approved by the Ethical Committee of Government Medical College, Srinagar.

2.1. Statistical analysis

Data were entered in Microsoft Excel 2007 spreadsheet and was analyzed using SPSS v.20.0 statistical software. The continuous variables were described as measures of central tendency (mean ± SD) if they were in normal distributions. One way analysis of variance (ANOVA) was used to compare the means of three groups of measurements. To analyze the influence of potential risk factors on impaired glucose metabolism with normoglycemic individuals as the reference group, we used binary logistic regression analysis, with adjustment for age, family history of diabetes, physical activity, smoking behavior, consumption of carbonated drinks and BMI. A p-value < 0.05 was considered to be statistically significant.

3. Results

A total of 580 participants (including 289 males and 291 females), aged 21–79 years were included in the present study. Age, waist circumference, hip circumference, weight, and body mass index were all statistically significant between normoglycemic participants and those with impaired glucose metabolism ($p < 0.018$). There was no significant difference in height in-between the groups as shown in Table 1.

A binary logistic regression analysis was conducted to analyze the effect of various factors on susceptibility to IFG or T2DM compared with normoglycemic individuals as the reference group and age, family history of diabetes, smoking behavior, and history of hypertension, consumption of carbonated drinks, physical activity, calorie intake, and BMI as covariates. As shown in Table 2, when other factors were constant, subjects who had a

Table 1
Characteristics of participants with normal/impaired fasting glucose Levels or diabetes.

Variable	Normoglycemic Levels (394)	Impaired Fasting Glucose Levels(IFG) (129)	Diabetes(T2DM) (57)
Age (Years)	42.94 ± 13.42	46.66 ± 12.06 *	54.00 ± 8.67 *
Height (cm)	170.38 ± 6.09	169.46 ± 7.01	167.03 ± 8.83
Weight (Kgs)	64.76 ± 6.56	67.78 ± 7.76 *	68.61 ± 6.14 *
Waist (cm)	82.24 ± 3.16	84.22 ± 3.23 *	85.70 ± 4.78 *
Hip (cm)	84.74 ± 3.19	86.93 ± 3.37 *	88.70 ± 5.21*
BMI (Kg/m^2)	23.21 ± 2.51	24.55 ± 3.45 *	25.66 ± 2.64

*P < 0.017, Comparisons between IFG/T2DM and normoglycemic individuals; there was no significant difference between of all variables between T2DM and IFG subjects; p < 0.017: Statistically significant. Values were mean ± SD.

Table 2
Binary logistic regression analysis of factors influencing impaired glucose metabolism.

Independent Variables	p-Value	OR	95% C.I.	
			Lower	Upper
Age of the Participants	0.05*	1.02	0.99	1.04
Family History of Diabetes Mellitus	<0.001*	6.41	3.22	12.78
Physical Activity/week	<0.001*	2.66	1.36	5.17
Calorie Intake/Week	<0.001*	3.69	2.25	6.06
History of Hypertension	<0.001*	7.88	4.02	15.46
Smoking Behavior	<0.001*	3.69	2.25	6.06
Consumption of Carbonated Drinks				
Never	1	–	–	–
1-3 times/week	0.436	0.76	0.38	1.50
3-6 times/week	<0.001*	4.40	2.06	9.40
>6 times/week	0.064	11.04	0.86	140.66
Body Mass Index (Kg/m^2)				
Normal/Underweight	1	–	–	–
Overweight	0.463	1.23	0.69	2.19
Preobese	0.019*	2.17	1.13	4.15
Type 1 Obesity	0.017*	3.52	1.25	9.87

OR: odds ratio, CI: confidence interval, p values less than 0.05 are marked with *.

higher BMI were more likely to develop IFG or T2DM (OR = 3.52, OR 95% CI = 1.25–9.87); Moreover, consumption of carbonated drinks was a risk factor for IFG or T2DM (3–6 times/week OR = 4.40, OR 95% CI = 2.06–9.40; >6 times/week OR = 11.04, OR 95% CI = 0.86–140.66). Participants with a family history of T2DM were more susceptible to develop T2DM (T2DM history: OR = 6.41, OR 95% CI = 3.22–12.78). The risk effect of these factors was even stronger before adjusting for age, sex, family history of diabetes, and BMI in participants. Those having smoking behavior and excessive calorie intake per week were also at a higher risk of getting IFG or T2DM. In our study, we did not find any association of gender, occupation and socioeconomic status with impaired glucose metabolism among participants.

Prevalence of impaired glucose metabolism (IFG and T2DM) among study participants is shown in Fig. 2, 129 [22.24%, CI = 18.8–25.5]] of study participants had fasting blood glucose levels between 100 and 125 mg/dl (IFG) while 57 [9.8%, CI = 7.4–12.0] had fasting blood sugar levels more than 126 mg/dl (T2DM).

4. Discussion

This was a community-based cross-sectional analytical study to identify the risk factors for impaired glucose metabolism (IFG & T2DM) and to estimate the prevalence of impaired glucose metabolism (IFG & T2DM) among adults (≥20 years) in district Srinagar. In this study, we determined the influence of potential risk factors on impaired glucose metabolism.

In this study, a total of 580 participants (including 289 males and 291 females), and aged 21–79 years were included. The participants were grouped into grouped into normoglycemic, impaired fasting glycaemia and diabetic group based on their fasting blood glucose levels. The mean of factors like age, waist circumference, hip circumference, weight, and body mass index was analyzed and was found to be statistically significant between normoglycemic participants and those with impaired glucose metabolism ($p < 0.018$). The results are in accordance with the results published by Kirkman et al. [13], Y Yin et al. [14] and Suastika K et al. [15] who

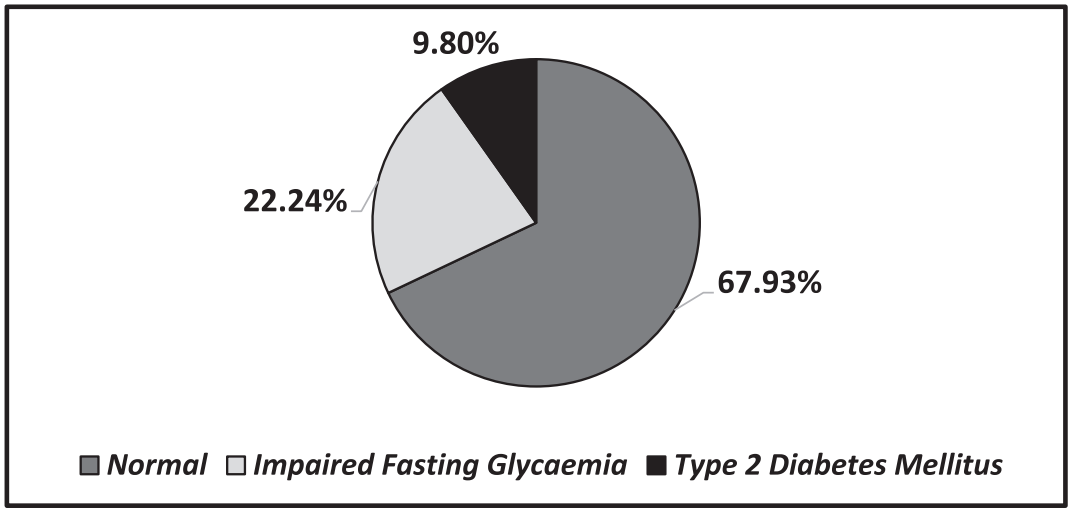

Fig. 2. Diabetic status of Study Participants. IFG= Impaired fasting glycaemia; T2DM = Type 2 Diabetes Mellitus.

reported a significant association of age, waist-hip ratio, weight, and BMI with impaired glucose metabolism. Generalized obesity/high BMI and abdominal obesity were independently associated with impaired glucose metabolism which is similar to the results in most other studies [16–18]. However, we did not find any association of height in-between the groups which are in accordance with the studies published earlier by Kirkman et al. [13] and Kautzky Willer et al. [19].

A binary logistic regression analysis we found that with an increase in age, the risk of impaired glucose metabolism increased significantly ($p < 0.05$), with the likelihood of 1.02 for each additional year of life. These findings are consistent with other studies [17–18]. Furthermore, consumption of carbonated drinks >3 times/week and >6 times/week increased the likelihood of impaired glucose metabolism to 4.40 and 11.04 times respectively. These findings are in accordance with the published literature [20]. The consumption of carbonated drinks raises blood glucose levels which eventually over continuous consumption over a period of time causes weight gain and Insulin insensitivity leading to the development of IFG and T2DM. It was also found that participants who are physically inactive have a likelihood of developing impaired glucose metabolism 2.66 times than those who are physically active. The same is published by other earlier studies [21,22]. Generalized obesity/high BMI and abdominal obesity were independently associated with T2DM and IFG which is similar to the results in most other studies [23–25]. In this study, there was a positive association of family history of diabetes mellitus with IFG and T2DM. The family history of T2DM was found to be a strong predictor of the disease which is supported by most other studies [16,26,27]. Further, hypertension among study subjects was more likely to increase the risk of impaired glucose metabolism to 7.88 times. Similar findings were reported by earlier studies [28–30].

This study estimated the overall prevalence of diabetes in district Srinagar to be 9.8% [95% CI 7.4–12.0] and the prevalence of prediabetes to be 22.2% [95% CI 18.8–25.5] (ADA criteria). Zargar et al. (2001 & 2008) [11,12] reported a prevalence of T2DM and IFG (6.1% & 8.09% in 2001 & 2.4% and 11.1% in 2008) among adults > 40 years and 20–40 years respectively. National Urban Diabetes Survey showed the prevalence of 12.1% for diabetes and 14% for impaired glucose tolerance in six large metropolitan cities of India [8]. The above estimates indicate that there is the difference in the prevalence of T2DM and IFG between different regions of the Indian states and might be explained by factors such as the difference in socioeconomic status, obesity prevalence, physical activity, dietary pattern and possibly genetic variations. Our study adds to the growing body of evidence suggesting that the prevalence of T2DM has increased since 2001 from 6.1% to 9.8% [ADA Criteria] and IFG from 8.1% to 12.1% [WHO Criteria] in the present scenario. This can be explained by several factors including the adoption of new lifestyles in parallel with the strong economic growth our state has experienced in the past 20 years.

5. Conclusion

Our analysis suggests an increase in the prevalence of diabetes in district Srinagar. Risk factors for impaired glucose metabolism include increasing age, obesity, and higher consumption of carbonated drinks, hypertension, smoking behavior, high-calorie diet intake and positive family history of diabetes. People should meet with professional dieticians to plan an individualized diet within the general guidelines that takes into consideration their own health needs. Consumption of carbonated drinks and smoking in any form should be avoided. People should try to achieve a healthy weight, control of blood pressure and normal blood glucose levels.

Conflicts of interest

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.dsx.2019.01.023.

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