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Evaluate the Impact of Age, Sex, Level of Education, Body Weight and Occupation on Diabetes Mellitus in Among Individual of Khanna, Punjab, India

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Abstract: Diabetes mellitus is a one type of disease which comes under metabolic disorders and also produces different defects like resulting from a defect either in insulin secretion, insulin action or both. Insulin deficiency in turn leads to chronic hyperglycemia with disturbances of metabolism of carbohydrate, fat, and protein. It is a one type of condition which is defined as the level of increase in glucose giving rise to risk of microvascular damage. It is associated with reduced life expectancy, significant morbidity due to specific diabetes related to microvascular complications, increased risk of macrovascular complications (ischaemia heart disease, stroke and peripheral vascular disease). Polyuria, polydipsia, polyphagia, unexplained weight loss, and presence of ketones in the urine are the major symptoms of diabetes mellitus. According to the International Diabetes Federation (IDF), around 415 million people had DM in 2015 and this number is expected to rise to 642 million by 2040. Prevalence of type 2 diabetes mellitus (T2DM) among adult individuals is more than 95%. India has the second highest number of diabetic people with 69.1 million people after China.

The aim of the study is the impact of age, sex, level of education, body weight and occupation on Diabetes Mellitus in among individual of Khanna, Punjab.

The study was conducted in Khanna City, Ludhiana District, and the State of Punjab, India. The sample source was individuals aged 20 years and above permanently living in the city. The sample size was calculated using the single population proportion formula by considering 5.1% prevalence of DM, 0.03 desired precision, 95% confidence interval (CI), and a design effect of 2. Thus, the minimum sample size (n) calculated was found to be 300.

In present study total 300 number participants with response rate of 100% successfully participated . Age is one of the main factors for the study which is ranging from 20 years and above with a mean of 31 (SD=±6.5). The majority out of 147/300 (48%.1) of the study participants were diabetic, while 22.9% (69/300) of the respondents were pre-diabetic (Table -3).

In conclusion, the present study provides reliable and recent epidemiological information regarding the high burden of diabetes mellitus among the adult population in Khanna, Punjab, India. Around 15% of the general adult population has diabetes or pre-diabetes, calling for urgent attention. This study also highlights a significant burden of undiagnosed cases of DM in the community; most of them are poorly controlled. There is a need to identify the large pool of undiagnosed cases of DM and offer early treatment in order to avoid complications.

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Introduction

Diabetes mellitus is a group of metabolic disorders or diseases resulting from a defect either in insulin secretion, insulin action or both. Insulin deficiency in turn leads to chronic hyperglycemia with disturbances of carbohydrate, fat, and protein metabolism [1]. It is a condition primarily defined by the level of hyperglycemia giving rise to risk of microvascular damage (retinopathy, nephropathy and neuropathy). It is associated with reduced life expectancy, significant morbidity due to specific diabetes related to microvascular complications, increased risk of macrovascular complications (ischaemia heart disease, stroke and peripheral vascular disease) [2]. Polyuria, polydipsia, polyphagia, unexplained weight loss, and presence of ketones in the urine are the major symptoms of diabetes mellitus [3]. According to the International Diabetes Federation (IDF), around 415 million people had DM in 2015 and this number is expected to rise to 642 million by 2040 [4]. Prevalence of type 2 diabetes mellitus (T2DM) among adult individuals is more than 95% [5]. India has the second highest number of diabetic people with 69.1 million people after China estimated in 2015 [4]. The prevalence of DM in India ranges from 5-17% with higher levels found in the southern part of the country and urban areas [6-12]. The risk factors are due to increase in individuals' age, moving from rural to urban areas, and consumption of unhealthy food, reduced-physical activity and obesity [13]. A couple of studies related to the prevalence of DM and its risk factors have been done in North of India, specifically, in the state of Punjab [6, 12], but their attention has been more to the city of Chandigarh. This study assesses the prevalence and risk factors of type 2 diabetes mellitus (T2DM) in the city of Khanna, Punjab, India.

History

A disease characterized by the 'too great emptying of urine' finds its place in antiquity through Egyptian manuscripts dating back to 1500 B.C. [14]. Indian physicians called it *madhumeha* ('honey urine') because it attracted ants. The ancient Indian physician, Sushruta, and the surgeon Charaka (400-500 A.D.) were able to identify the two types, later to be named Type 1 and Type 2 diabetes [15]. In obese persons, cells of fat tissues have to process more nutrients than they can manage. The stress in these cells triggers an inflammation that releases a protein known as cytokines. Cytokines then block the signals of insulin receptors, thus gradually causing the cells to become resistant to insulin.

Insulin allows your cells to use glucose (sugar) for energy. When you are resistant to insulin, your body is unable to convert the glucose into energy and you end up with a persistently high blood glucose level.

Besides suppressing normal responses to insulin, the stress also triggers inflammation in cells that can lead to heart disease.

Compared to people without diabetes, people who have diabetes are at higher risk for severe heart disease, such as coronary heart disease heart failure or diabetic cardiomyopathy (heart muscle disorder).

This is because over time, high blood glucose from diabetes damages blood vessels and the nerves that control the heart and blood vessels. Additionally, people with diabetes also have other conditions such as high blood pressure and obesity that further raise their risk of developing heart disease.

However, there are steps that can be taken to reduce the risk of developing heart disease if you have diabetes. These include keeping your blood glucose, normal blood pressure, and cholesterol under control, Quit smoking, Follow a healthy eating plan, Engage physical activity regularly, Maintain a healthy weight and get enough sleep.

Methodology

Study Setting. The study was conducted in Khanna City, Ludhiana District, and the State of Punjab, India. According to the 2011 national census, the total population of Khanna city was 128, 137 out of which males were 67,811 and females were 60,319. The literacy rate was 84.43 percent [16].

Study Design, Period and Sample Size. A community based- laboratory study was conducted from January 01 to December 31, 2020. The sample source was individuals aged 20 years and above permanently living in the city. The sample size was calculated using the single population proportion formula by considering 5.1% prevalence of DM [156], 0.03 desired precision, 95% confidence interval (CI), and a design effect of 2. Thus, the minimum sample size (n) calculated was found to be 300.

Sampling Technique. Multistage sampling technique was employed to select study participants. Of the five villages nearby the city, three of them were selected randomly. Then, the sample was allocated to the selected villages in proportion to the total number of households in each village. Accordingly, 121, 120, and 65 study participants were sampled from Payal, Ikolahi, and Issru, respectively. Households in each village were selected by the systematic sampling technique by using the list of households as a sampling frame. Finally, if more than one eligible individual were found in a household, a study participant was selected randomly from that particular house.

Exclusion Criteria

(i) Individuals who were taking any drug with possible impact on glucose metabolism (e.g., steroids, B-blockers, and thiazide diuretics) other than ant diabetes mellitus drugs were excluded to avoid false positive prediabetes or diabetes mellitus.
(ii) Pregnant women were excluded from the study to avoid the possible impact of pregnancy on anthropometric and laboratory parameters.

Data Collection and Measurement.

Data on demographic and behavioral characteristics were collected by trained personnel through a face-to-face interview using a semi structured questionnaire. The field study team was composed of enumerators, laboratory technicians, nurses, and supervisors.

Step 1: Demographic and Behavioral Characteristic Data. In this step, demographic and behavioral risk factors were collected through face-to-face interviews using an interviewer-administered questionnaire. Each participant was questioned for age, sex, educational status, marital status, occupation type, physical activity, history of raised blood pressure and diabetes, fruit and vegetable intake, alcohol consumption, and smoking habit.

Step 2: Biochemical Measurements. Fasting blood glucose, triglyceride (TG), and total cholesterol level measurements were taken. The Accu-Chek Active system uses a capillary blood sample which is set to plasma serum standard, showing results in plasma glucose values. This measurement was immediately performed for all participants, and the results were recorded in the questionnaire. Fasting capillary blood samples were collected three times at different occasions (for three consecutive days) from a single study participant, and glucose measurement was carried out within fractions of seconds after sample collection. Then, their average was taken for analysis, and this might have minimized the appearance of abnormal results. The diagnosis of DM was based on the American Diabetes Association diabetes mellitus classification criteria with fasting blood glucose of ≥126 mg/dl being considered as positive for DM; impaired fasting glucose, FBG: ≤110 mg/dl to normoglycemic, FBG: ≤61 mg/dl to. Moreover, three ml of fasting venous blood was collected from each participant, using EDTA tubes (after an overnight fasting, i.e., ≥8 h) for biochemical measurements. The sample of every participant was taken to Mizan Tepi University Clinical Laboratory for plasma separation. Plasma samples were transferred into 2 ml Eppendorf tubes and stored at −20° C. Finally, all plasma samples were taken to Jimma University Specialized Hospital for total cholesterol (TC) and triglyceride (TG) level determination, using the HumaStar 80 chemistry analyzer (Human Diagnostic, Germany) as previously described.

Data Quality Assurance

Data collectors were refreshed on proper measurement and sample collection. Regular field supervisions were carried out to monitor the field work, and data was collected during the actual field data collection period. After blood samples were collected, plasma was separated and placed at −20° C prior to analysis. The

instrument, HumaStar 80 chemistry analyzer, was calibrated using a calibrator (AutoCal), and quality control samples normal (HumaTrol N) and pathological (HumaTrol P) were run each day before running samples for tests. The manufacturer's instructions of the machine and the reagents were strictly followed. 2.10. Data Analysis. The data was entered, cleaned, and analyzed using the SPSS version 20.0 software package. Descriptive statistics were used to summarize the characteristics of study participants. Bivariate and multivariate analyses were used to assess the association between explanatory variables and the outcome variable. All explanatory variables with p-value of ≤0.2 in the bivariate analysis were inserted in the multivariate binary logistic regression model to see the independent effect of each variable on diabetes. The magnitude of the association was measured using the adjusted odds ratio (AOR) and 95% confidence interval (CI). A p-value < 0.05 was considered as statistically significant.

Data Analysis

The data was entered and analyzed using the SPSS version 20.0 software package. Descriptive statistics were used to summarize the characteristics of study participants. Bivariate and multivariate analyses were used to assess the association between explanatory variables and the outcome variable. All explanatory variables with p-value of ≤0.2 in the bivariate analysis were inserted in the multivariate binary logistic regression model to see the independent effect of each variable on diabetes. The magnitude of the association was measured using the adjusted odds ratio (AOR) and 95% confidence interval (CI). A p-value < 0.05 was considered as statistically significant.

Result

Socio demographic Variables. A total of 305 participants with a response rate of 100% successfully participated in the study. The age of the participants ranged from 20 years and above with a mean of 31 (SD = ±6.5). The socio demographic characteristics of the variables were summarized in Table 1

Table 1: Socio demographic characteristics of the study population aged 20 and above in Khanna, Punjab, India, 2021

Variable	Frequency	Percentage
Sex	150	49.2
Male		
Female	155	50.8
Age group (years)	26	8.5
20–30		
30–40	42	13.7
40–50	51	16.7
50–60	80	26.2
60–70	70	23
≥70	37	12
Level of education	57	18.6
Illiterate		
Able to read and write	70	23
Elementary school	97	31.8
High school	63	20.6
Diploma and above	18	5.9
Occupation	60	19.6
Government employee		
Nongovernment employee	70	23
Merchant	34	11.1
Daily laborer	86	28.1
Student	11	3.6
Housewife	20	6.5
House servant	3	0.9

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Retired	10	3.2
Other	14	4.5
Family monthly income in <100	17	5.5
100–300	114	37.3
400–600	96	31.4
700–1000	59	19.3
>1000	19	6.2
Family history of diabetes mellitus Yes	119	39.1
No	186	60.9
Family history of hypertension Yes	84	27.5
No	221	72.5

Behavioral Characteristics. About one third (32.1%) of the total (305) participants said that they were frequent alcohol drinkers, whereas 1% (4/305) of them reported that they were ex- drinkers. Other behavioral characteristics of the study subjects are presented in Table 2.

Table 2: Behavioral characteristics of study population aged 15 years and above at Khanna, Punjab, India, 2021.

Variables	Frequency	Percentage
Alcohol consumption		
Nondrinker	269	88.1
Frequent drinker	15	4.9
Ex-drinker	21	7
Smoking habit		
Nonsmoker	256	83.9
Smoker	30	9.8
Ex-smoker	19	6.3
Physical activity		
Sedentary	78	25.5
Moderate	205	67.2
Vigorous	22	7.2
Oil consumption		
Liquid oil	290	95
Cruddy oil	2	0.6
No oil used	13	4.4
Frequency of eating any fruit		
Every day	104	34
Every three day	160	52.4
Once a week	27	8.8
Once a month	14	4.5
Not eating	0	0
Frequency of eating any vegetables		
Every day	177	58
Every three day	106	34.7
Once a week	18	5.9
Once a month	4	1.3
Not eating	0	0

Frequency of eating fatty meat		
Every day		
	0	0
Every three day	2	0.6
Once a week	6	1.9
Once a month	17	5.5
Not eating	280	91.9

4.3. Physical and Biochemical Measurements

Out of the total study participants, 19.6% of them had ≥126 mg/dl fasting blood glucose level. The different types of physical and biochemical measurements are summarized in Table 3.

Table 3: Physical and biochemical measurement characteristics of study population aged 20 years and above in Khanna, Punjab, India, 2021.

Variables	Frequency	Percentage
Hypertension		
Yes	73	24 (14.39–21.92)
No	232	76 (78.07–85.60)
Waist circumference		
Normal	113	37.1 (30.35–32.13)
High	192	62.9 (70.86–77.64)
Body mass index		
Underweight	58	15.4 (10.99–17.86)
Normal	98	30.9 (56.43–65.95)
Overweight	104	43.4 (16.45–24.33)
Obese	45	13.2 (2.26–6.19)
Fasting blood glucose		
Diabetic	147	48.1 (70.01–81.87)
Pre-diabetic	69	22.9 (14.34–18.49)
Normo-glycemic	87	28.5 (19.00–22.22)
Hypoglycemic	2	0.5 (−0.19–1.18)
Total cholesterol		
<200 mg/dl	140	45.5 (44.1–47.93)
≥200 mg/dl	165	54.09(52.69–55.27)
Triglyceride		
<150 mg/dl	123	40.1 (43.00–46.10)
≥150 mg/dl	182	59.9 (57.89–60.99)

Prevalence of Diabetes Mellitus. The majority, 48.1% (147/305), of the study participants were diabetic, whilst 22.9% (69/305) of the respondents were pre-diabetics (Table 3). The prevalence of DM was found to be 48.1% (147 out of 305). Out of individuals who were found to be diabetic, the proportion of previously undiagnosed DM was 79.5% (117/147) .

Factors Associated with Diabetes Mellitus. Study participants with high waist circumference were 4.1 times more likely to be DM positive compared to those whose waist circumference was normal (AOR =4.107, 95% CI: 1.108, 15.231). Regarding body mass index, being overweight was also independently associated with the prevalence of DM. Respondents who were overweight were 4.1 times at more risk of being DM positive than those with normal body mass index (AOR= 4.163, 95% CI: 1.516, 11.435). Similarly, individuals with smoking habits were about 27 times more likely to be DM positive when compared to participants who never smoked in their lifetime (AOR =26.946, 95% CI: 3.146, 230.819) .

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Discussion

Overall prevalence of DM and prediabetes among the study participants was 48.1 and 22.9% respectively. Only 20.5% of all cases of DM were already known in case or on treatment, among whom only about one-third had controlled blood glucose status reported high prevalence of diabetes and prediabetes i.e. 11.1 and 13.2% respectively [17].

Barik *et al*. in a large cross-sectional survey in rural West Bengal, which is situated in the eastern region of the country, found that the prevalence of diabetes and pre-diabetes among adults >18 years was 2.95 and 3.34% respectively (18). This state-wide study was done in one of the most prosperous states in India. There have been few large community based studies looking at prevalence of diabetes in India. The National Urban Diabetes Survey showed an age-standardized prevalence of 12.1% for diabetes and 14% for IGT in six large metropolitan cities [163]. The Prevalence of Diabetes in India Study (PODIS) reported lower diabetes prevalence of 5.9 and 2.7% in urban and rural areas respectively with an overall prevalence of 4.3% [19]. Two studies in Chandigarh, a very prosperous city in North India, showed high prevalence of diabetes. In the INDIAB study, the city was found to have the highest prevalence of diabetes (13.6%) [20]. The Chandigarh Urban Diabetes Survey (CUDS) also]. In another study, Little et al. reported a high prevalence of type 2 diabetes (10.8%) among adults population (>19 years) in rural parts of South India [21]. These figures imply that though the prevalence of DM varies in different settings, it is certainly quite high and warrants immediate attention.

Our study adds to the limited but growing body of evidence suggesting that diabetes is no longer confined to urban areas of India and is a matter of concern in rural areas as well [20]. Considering the fact that over 70% of the population of India are rural and often faced with issues like poverty, poor access to health care, this is quite a worrisome finding. The present study reported no gender difference in the prevalence of DM which is supported by evidence from other studies in India], although a few studies have shown a male preponderance.

Generalized obesity/high BMI and abdominal obesity were independently associated with diabetes which is similar to the results in most other studies [22]. Indians have a lower BMI than those of European descent. However, the risk of diabetes increases at very low levels of BMI for Indians [166]. Poor physical activity was also associated with diabetes as supported by earlier studies .The protective effects of physical activity against obesity, cardiovascular disease, and metabolic syndrome have already been proven [19]. The associations remained even after controlling for anthropometric measures, indicating that physical activity may have a direct impact on risk of diabetes apart from its association through obesity .Efforts that focus on healthy diet and promoting physical activity have the potential to reduce the risk of obesity, the single most important risk factor for type 2 diabetes [6]. Family history of DM is a strong predictor of the disease which is supported by most other studies [23]. The study results indicate that elderly individuals, hypertensive, obese (general/abdominal) or those with a family history of DM constitute an important group for screening.

Nearly 80% of individuals with diabetes were previously undiagnosed. The ratio of undiagnosed to total patients with DM was much higher compared to another study in rural Tamil Nadu conducted by Anjana *et al*. (48% undiagnosed) [23]. In another study in Delhi, only one-third of the diabetic patients were aware of their condition [24] thereby indicating the need for aggressive screening programs. Despite screening for NCDs including diabetes being a major component of the National Programme for Control of Cancer, Diabetes, Cardiovascular Diseases and Stroke (NPCDCS) in India, implementation is dismal [25]. The government of India has taken certain initiatives at national level which is appreciable, but there is a need to implement it at grass root level before the disease takes the shape of a pandemic in India. The pool of undiagnosed cases of DM left untreated is more prone to microvascular as well as macrovascular complications. Hence, it is necessary to identify and offer early therapy to these individuals and ensure regular follow up. The study results show that among persons with known DM on treatment, nearly two-third had uncontrolled blood glucose levels. Further studies are required to understand the reasons for the same.

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