Association of risk factors of type 2 diabetes mellitus and fasting blood glucose levels among residents of rural area of Delhi: a cross sectional study

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ABSTRACT

Background: Diabetes mellitus has reached epidemic proportions globally. India has largest number of diabetic population constituting major proportion worldwide. The epidemic of diabetes in India is due to the rapid epidemiological transition attributed to changes in dietary patterns and decreased physical activity apart from the role of genetic factors in the disease causation. The objectives of the study was to assess the risk factors of type 2 diabetes and to find the relation between risk factors of type 2 diabetes and fasting capillary blood glucose level among the study population.

Methods: A cross sectional community based study was carried out using a semi structured, pretested, questionnaire among 432 study subjects aged 30 years and above in a randomly selected sahoorpur village under Fatehpur Beri primary health centre. The study duration was from March 2011 to February 2012. Means and proportions were calculated. Multivariate logistic regression was applied.

Results: The mean (SD) age of the study population was 45 (±11.9) years. Positive family history of Diabetes was present in 14.4% of study population. History of smoking and alcohol was found in 37.5% and 8.3% respectively. Prevalence of overweight and obesity was 48.8% and 17.2% respectively. Regression showed age more than 60 years (OR 1.135, 95% CI 0.037 – 0.492), family history of diabetes (OR 4.181, 95% CI 1.734 – 10.083), higher waist circumference (OR 13.414, 95% CI 4.991 – 36.051), sedentary work (OR 3.133, 95% CI 0.032 – 0.592), obesity (OR 4.709, 95% CI 1.790 – 13.414) had higher odds of having higher fasting capillary blood glucose level.

Conclusions: The study found a higher prevalence of risk factors among the study population. Risk factors showed a significant relation with higher fasting capillary blood glucose. There is a mandate for health education to motivate change in lifestyle modification among the study population.

Keywords: Type 2 diabetes, Sedentary behaviour, Risk factors, Rural population

INTRODUCTION

Non communicable diseases (NCDs) are increasingly becoming a major cause of morbidity, mortality and disability in the WHO South-East Asia region.¹ Rapid urbanisation is leading to the development of risk factors of NCDs. In the year 2012, diabetes resulted in 1.5 million deaths worldwide, with more than 80% of these deaths occurring in low and middle – income countries.² There is a rising trend in the prevalence of diabetes in India over recent years, and the number of people living with diabetes in India is expected to increase from 32.7
million in the year 2000 to almost 60 million by 2025. Nearly 60 – 80% of patients with diabetes die of cardiovascular events.

There is considerable evidence that type 2 DM has a strong genetic basis, with risk of disease in offspring being almost 40% and 70% if one or both parents respectively have the disease. Also, the concordance of type 2 DM in monozygotic twins is as high as 70% while its 20 – 30% in dizygotic twins. The “Asian Indian Phenotype” makes Asian Indians more prone to diabetes and premature coronary artery disease. Moreover, while epidemiological transition has improved various health aspects like nutrition, hygiene, longevity, and control of many communicable diseases, it has also led to the rapid rise of non-communicable diseases. The lifestyle risk factors, especially unhealthy diet, physical inactivity and personal habits of substance use have complicated the disease web. Increase in the prevalence of type 2 diabetes may also result due to migration.

In India, only a few nationwide studies have been conducted on the prevalence of diabetes and its complications. Moreover, while the urban population has easier access to diabetes screening as well as health care facilities for its management, the rural areas have poor diabetes screening services, preventive and counselling facilities, and there is non-adherence to diabetic management guidelines, complicated by long distance travel to health services among several other problems. The present study was conducted in a rural community of Fatehpur Beri, which is a part of Sahoorpur, a housewife of New Delhi, the capital of India, to determine the prevalence of diabetes and to assess the diabetes risk profile of its adult population aged 30 years and more.

The study was conducted with the objective to assess the risk factors of type 2 diabetes in a rural area of Delhi and to find the relation between risk factors of type 2 diabetes and elevated fasting capillary blood glucose level among the study population.

METHODS

Study setting

A community-based, cross sectional study was carried out in a village under primary health centre (PHC) Fatehpur Beri, which is the rural field practice area of Department of Community Medicine, Vardhaman Mahavir Medical College and Safdarjung Hospital, New Delhi. The primary health centre provides health care service to eleven villages with a total population of approximately 49,330 according to the 2010 survey conducted by auxiliary nurse midwives (ANMs) of the area. Among the eleven villages under Fatehpur beri village, Sahoorpur, was selected by simple random sampling with lottery method. This village had a population of approximately 2200 as per the ANM survey of 2010.

Study population

Complete enumeration of the people in selected village was undertaken. All individuals aged 30 years and above in the study and those who were willing to participate in the study were included in the study. Those who had been diagnosed with type 2 DM, pregnant women and terminally ill patients were excluded from the study.

Data collection procedure

After obtaining written informed consent, the content of questionnaire was explained to the study participants. Interviewer administered questionnaire was given to the participants and data was collected. A pre-tested, semi-structured and validated questionnaire in the regionally spoken language (Hindi) was used. Weight was measured to the nearest 0.1 kg using a standardised electronic weighing machine, while height was measured to the nearest 0.5 cm using a stadiometer. Waist circumference was measured using a non-stretchable tape, at the level of midpoint between lower costal margin and iliac crest. Fasting capillary glucose was estimated using standardised digital glucometer by capillary finger prick method on a pre-informed date after overnight fasting. For measuring blood pressure, all the participants were made to stay calm and seated for 10 minutes before blood pressure measurement. Blood pressure was measured in the left brachial artery in sitting posture with adult size cuff was used to measure blood pressure. Two separate readings were taken at an interval of 5-13 minutes with the average of the two readings was taken as the final blood pressure.

Study instrument

The study instrument included interviewer administered questionnaire including socio-demographic profile of the study participants – age, sex, type of family, total family income, parents’ occupation, residence and religion etc., and risk factors of type 2 DM., standardised electronic weighing machine, a non-stretchable tape, standardized digital glucometer (AccuChek, Roche diagnostics, Germany) and standardized automatic blood pressure monitor (Omron: Model HEM-7111, Singapore119967). A value of 110 mg/dL or more was regarded as high fasting capillary blood glucose. JNC VII classification was followed for categorisation as normal blood pressure, pre-hypertension, and hypertension. Central obesity was defined as waist circumference of ≥ 90 cm in males and ≥ 80 cm in females.

Statistical analysis

Data were entered in Microsoft Excel and analysed using SPSS version 20 (IBM Inc., Illinois, USA). Univariate analysis was done to assess the distribution of risk factors for type 2 DM among the study participants, while multivariate logistic regression was done to assess the relation between the risk factors and high fasting
capillary blood glucose. A p value <0.05 was regarded as statistically significant. ROC curve was plotted to assess the predictive value of the model.

**Ethical consideration and confidentiality**

Institutional ethical committee approval was obtained before starting of the study. Confidentiality of study participants is maintained in all the phases of the study.

**RESULTS**

Out of total of 476 individuals aged 30 years or more in the study area, 432 were included in the study (20 excluded – 12 known cases of diabetes and 8 pregnant women; 11 refused to participate; 13 couldn’t be contacted even after 3 visits).

Table 1: Socio-demographic profile of study participants (N = 432).

| S. No. | Variable                          | N(%)     |
|--------|-----------------------------------|----------|
| 1.     | Age (in completed years)          |          |
|        | 30-39                             | 173(40)  |
|        | 40-49                             | 105(24.3)|
|        | 50-59                             | 73(16.9) |
|        | 60 and above                      | 81(18.8) |
| 2.     | Sex                               |          |
|        | Male                              | 225(52)  |
|        | Female                            | 207(48)  |
| 3.     | Religion                          |          |
|        | Hindu                             | 161(37.3)|
|        | Muslim                            | 271(62.7)|
| 4.     | Marital status                    |          |
|        | Currently married                 | 409(94.7)|
|        | Never married/ widowed            | 23(5.3)  |
| 5.     | Education                         |          |
|        | Illiterate                        | 210(48.7)|
|        | Primary school                    | 99(22.9) |
|        | Secondary school                  | 78(18.1) |
|        | Higher secondary                  | 29(6.7)  |
|        | Graduate and above                | 16(3.7)  |
| 6.     | Occupation                        |          |
|        | Unemployed/home maker             | 201(46.5)|
|        | Gainfully employed                | 212(49.1)|
|        | Retired                           | 19(4.4)  |
| 7.     | Socioeconomic status*             |          |
|        | Lower                             | 62(14.4) |
|        | Lower middle                      | 154(35.6)|
|        | Upper middle                      | 195(45.1)|
|        | Higher                            | 16(3.7)  |
|        | Upper Higher                      | 5(1.2)   |

* Modified B.G. Prasad Scale, October 2011.

Mean (SD) age of study participants was (45±11.9) years (minimum age =30 years, maximum age =73 years). Almost equal number of males and females were recruited in the study. Majority of the participants were Muslims (62.7%) as shown in Table 1.

Table 2: Risk factor profile of study participants (N= 432).

| S. No. | Risk factors                          | N(%)     |
|--------|---------------------------------------|----------|
| 1.     | Family history of diabetes            |          |
|        | No history                            | 370(85.6)|
|        | Single parent                         | 45(10.4) |
|        | Both parents                          | 13(3.1)  |
|        | Sibling                               | 4(0.9)   |
| 2.     | Ever smoker                           |          |
|        | Yes                                   | 162(37.5)|
|        | No                                    | 270(62.5)|
| 3.     | Ever consumer of alcohol              |          |
|        | Yes                                   | 36(8.3)  |
|        | No                                    | 396(91.7)|
| 4.     | Work related physical activity        |          |
|        | Moderate/ vigorous                    | 372(86.1)|
|        | Sedentary                             | 60(13.9) |
| 5.     | Leisure time physical activity        |          |
|        | Moderate/ vigorous                    | 337(78)  |
|        | Sedentary                             | 95(22)   |
| 6.     | Daily fruits and vegetables consumption|         |
|        | ≤ 5 servings                          | 346(80.1)|
|        | ≥ 5 servings                          | 86(19.9) |
| 7.     | Body mass index                       |          |
|        | <18.5                                 | 9(2.1)   |
|        | 18.5 to 24.9                          | 138(31.9)|
|        | 25 to 29.9                            | 211(48.9)|
|        | ≥30                                   | 74(17.1) |
| 8.     | Waist circumference (in cm)           |          |
|        | Males                                 |          |
|        | <90                                   | 99(44)   |
|        | ≥ 90                                  | 126(56)  |
|        | Females                               |          |
|        | <80                                   | 64(30.9) |
|        | ≥ 80                                  | 143(30.9)|
| 9.     | Blood pressure (JNC VII criteria)     |          |
|        | Normotension                          | 155(35.8)|
|        | Pre hypertension                      | 183(42.4)|
|        | Hypertension                          | 94 (21.8)|

Positive family history was present in 14.4% of study participants, 10.4% had history in single parent and 3.1% had history in both parents. Smoking and alcohol consumption was present in 37.5% and 8.3% participants respectively. Regarding work related physical activity, 13.9% were sedentary workers. Also, about 22% of the participants did not perform any leisure time physical exercise. About 80.1% of the participants consumed less than 5 servings of fruits and vegetables per day. The mean (SD) BMI of the participants was 24.39 (± 3.07) kg/ square metres, with almost half (48.8%) being overweight. Central obesity was present in almost 44% of
Applying multivariate logistic regression as shown in Table 3 among the factors, age of the study subjects more than 60 years (OR 1.135, 95% CI: 0.037 – 0.492), family history of diabetes (OR 4.181, 95% CI: 1.734 – 10.083), waist circumference more than cut off value for Indian (OR 13.414, 95% CI: 4.991 – 36.051), sedentary worker (OR 3.133, 95% CI: 0.032 – 0.592), participants without leisure time physical exercise (OR 12.394, 95% CI: 1.790 – 12.394), pre hypertension (OR 88.769, 95% CI: 20.397 – 386.330) and hypertension (OR 806.186, 95% CI: 130.189 – 4999.252) had higher odds of having higher fasting capillary blood glucose level.

The area under the ROC curve in the present study for the predictive ability model is 0.86 which is considered to be “good” as it showed that almost 88% variability of high fasting capillary blood glucose can be explained by above mentioned logistic model as shown in Figure 1.

Figure 1: ROC Curve showing predictive ability of model.
ROC area: 0.879, 95% CI: 0.847-0.910, P value = 0.00, Hosmer-Lemeshow goodness of fit statistic p value = 0.527.

Table 3: Multivariate logistic regression showing association of risk factors for diabetes and fasting blood sugar levels among study participants (N = 432).

| S. No. | Variable                          | Fasting blood sugar | Adjusted OR | 95% CI | P value |
|--------|----------------------------------|---------------------|-------------|--------|---------|
|        |                                   | Normal n (%) | High** n (%) |         |         |
| 1.     | Age group                         | 40-49 years        | 74 (23.6)  | 31 (26.3) | 0.07    | 0.02 – 0.23 | 0.000* |
|        |                                   | 50 - 59            | 43(13.7)   | 30(25.4) | 0.15    | 0.04 – 0.53 | 0.003  |
|        |                                   | ≥ 60               | 45 (14.3)  | 36 (30.5) | 1.13    | 0.03 – 0.49 | 0.002* |
|        |                                   | 30 – 39            | 152 (48.4) | 21 (17.8) | Reference |
| 2.     | Sex                               | Female             | 147 (46.8) | 60 (50.8) | 0.28    | 0.10 – 0.76 | 0.013* |
|        |                                   | Male               | 167 (53.2) | 58 (49.2) | Reference |
| 3.     | Socio economic status             | Middle             | 148 (47.1) | 47 (39.8) | 0.13    | 0.05 – 0.32 | 0.000  |
|        |                                   | Upper#             | 12 (3.8)   | 9 (7.6)   | 0.31    | 0.06 – 1.53 | 0.154  |
|        |                                   | Lower^             | 154 (49.0) | 62 (52.5) | Reference |
| 4.     | Family history of diabetes        | Present            | 33 (10.5)  | 29 (24.6) | 4.18    | 1.73 – 10.08 | 0.001  |
|        |                                   | Absent             | 281 (89.5) | 89 (75.4) | Reference |
| 5.     | Smoking                           | Present            | 123 (39.2) | 39 (33.1) | 0.18    | 0.05 – 0.58 | 0.005  |
|        |                                   | Absent             | 191 (60.8) | 79 (66.9) | Reference |
| 6.     | Work related physical activity    | Moderate           | 222 (70.7) | 83 (70.3) | 0.12    | 0.03 – 0.47 | 0.002  |
|        |                                   | Sedentary          | 33 (10.5)  | 27 (22.9) | 3.13    | 0.03 – 0.54 | 0.005  |
|        |                                   | Vigorous           | 59 (18.8)  | 8 (6.8)   | Reference |
| 7.     | Leisure time physical exercise    | No                 | 55 (17.5)  | 40 (33.9) | 6.39    | 2.53 – 16.12 | 0.000  |
|        |                                   | Yes                | 259 (82.5) | 78 (66.1) | Reference |
| 8.     | Waist circumference               | Above the normal cut off value | 160 (51.0)   | 108 (91.5) | 13.41   | 4.99 – 36.05 | 0.00   |
|        |                                   | Within the cut off value | 154 (49.0)   | 10 (8.5) | Reference |
| 9.     | BMI                               | Pre obese          | 154 (49.0) | 57 (48.3) | 2.37    | 0.93 – 6.04 | 0.069  |
|        |                                   | Obese              | 31 (9.9)   | 43 (36.4) | 4.70    | 1.79 – 12.39 | 0.002  |
|        |                                   | Normal             | 129 (41.1) | 18 (15.3) | Reference |
| 10.    | BP                                | Pre-hypertensive   | 129 (41.1) | 54 (45.8) | 88.76   | 20.39 – 386.33 | 0.000  |
|        |                                   | Hypertensive       | 34 (10.8)  | 60 (50.8) | 806.18  | 130.18 – 4999.25 | 0.000  |
|        |                                   | Normal             | 151 (48.1) | 4 (3.4)   | Reference |

p-value <0.05 is significant. ** High FBS = Fasting capillary blood sugar level ≥ 110 mg/dl (IFG + Hyperglycaemia).
DISCUSSION

Present study showed 14.4% of the study population had a positive family history of diabetes as shown in Table 2 which is comparable with reported prevalence of 9.3% in a study conducted by Majgi et al in the year 2007 in rural Puduchery and 37% in another study conducted by Vijaykumar et al in rural Kerala respectively.14,15 More than one third of the population 37.5% were smoker (Table 2) which is much more than a study conducted by the WHO–ICMR on non-communicable disease risk factors surveillance study in the year 2003–2006, where prevalence of smoking was in rural India was 26.7%.16

Regarding physical activity 13.9% were sedentary workers and 22% of the study subjects were not involved in any kind of leisure time physical exercise (Table 2). This findings coincides with other studies conducted by Majgi et al in rural Puduchery and Vijaykumar et al in rural area of central Kerala found the prevalence of sedentary behaviour was 21.2% and 14.5% respectively and in another study by Mohan et al in the year 2003 in rural Tamil Nadu observed that leisure time physical activity was absent in 32% cases.14,15,17

Only 19.9% of the study subjects took 5 or more servings of fruits and vegetables per day (Table 2) which was much more than a study conducted by Anand et al in the year 2003 where they reported only 7.9% and 5.4% of men and women respectively consumed ≥5 servings of fruits and vegetables in Faridabad.18

Prevalence of overweight 48.9% and obesity 17.1% (Table 2) was very high. Similar result observed by Ahmed et al in 2011 in Kashmir valley and Nazil et al in the year 2007 in rural Wardha where they reported prevalence of obesity was 36.82% and 24.1% respectively.19,20 More than half of the male study subjects 56% and more than two third 69.1% of the female study subjects were centrally obese (Table 2). In the year 2010, a community based survey from Urban city of Orissa in Eastern India was carried out by Prasad et al prevalence of central obesity using same criteria as in the present study was reported as 48.9%.21

Hypertension was present in 21.8% of the population which is comparable with a study conducted by WHO–ICMR study on risk factors surveillance for Non communicable disease during the period between 2003–2006, where prevalence of hypertension in rural area was 24.6% which was very close to the present study.22 Another study conducted by Vijaykumar et al in the year 2007 in rural central Kerala found the prevalence of pre hypertension and hypertension as 34.9% and 36.1% respectively.15

In logistic regression analysis as in Table 3 age of the study subjects more than 60 years, family history of diabetes, waist circumference more than cut off value for Indian, sedentary worker and participants without leisure time physical exercise, obesity, pre hypertension and hypertension were significantly associated with higher odds of having higher fasting capillary blood glucose level.

The similar results were reflected by a study by Prabakaran et al (2007) in North Indian population, Ajay et al (2006) on central Indian population, where age, sex, low-education level, family history of DM, hypertension and overweight/obesity came out to be significant risk factors of diabetes.22,23 Duc Son et al (2001) in Vietnam and Lee et al (2009) in Korea observed a positive association between diabetes and age, history of delivering large for gestational age baby, family history of diabetes, sedentary activity, and obesity.24,25

The present study showed that almost 88% variability of high fasting capillary blood glucose can be explained by above mentioned logistic model. Alcohol consumption and ≥5 servings of fruits and vegetables could not be included in the model as there was no study subjects in normoglycemic group, this explained a comparatively low predictability of the model considering all the probable risk factors for high FBS.

Limitations

The study is not without the compromise of external validity of the study as the proportion of Muslim population is very much higher compared to national average.

CONCLUSION

Diabetes mellitus is reaching potentially epidemic proportions in India. The present study showed that burden of risk factors for Type 2 diabetes mellitus, mainly obesity, pre-hypertension, hypertension, central obesity, tobacco smoking and positive family history of diabetes were highly prevalent in this study population. The level of morbidity and mortality due to diabetes and its potential complications are enormous, and pose significant healthcare burdens on both families and society.

In India, the steady migration of people from rural to urban areas, the economic boom, and corresponding change in life-style are all affecting the level of diabetes. Yet despite the increase in diabetes there remains a paucity of studies investigating the precise status of the disease because of the geographical, socio-economic, and ethnic nature of such a large and diverse country. Given the disease is now highly visible across all sections of society within India, there is now the demand for urgent research and intervention - at regional and national levels - to try to mitigate the potentially catastrophic increase in diabetes that is predicted for the upcoming years. The
present study demands increasing awareness among the study participants.

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