Original Research Article

DOI: http://dx.doi.org/10.18203/2394-6040.ijcmph20171315

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

Mrinmoy Adhikary¹, Vinoth Gnana Chellaiyan²*, Ranadip Chowdhury³, Shailaja Daral⁴, Neha Taneja⁵, Timiresh Kumar Das⁴

Department of Community Medicine, ¹Murshidabad Medical College and Hospital, West Bengal, India; ²Chettinad Hospital & Research Institute, Kelambakkam, Chennai, TamilNadu, India; ³RG Kar Medical College, Kolkata, West Bengal, India; ⁴VMMC & Safdarjung Hospital, NewDelhi, India; ⁵St. Stephens Hospital, NewDelhi, India

Received: 17 January 2017 Accepted: 07 March 2017

*Correspondence:

Dr. Vinoth Gnana Chellaiyan, E-mail: drchellaiyan@gmail.com

Copyright: © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

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 – 12.394) 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. 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 2025.³ Nearly 60 – 80% of patients with diabetes die of cardiovascular events.⁴

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. 5-7 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. 9,10 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. 11 Increase in the prevalence of type 2 diabetes may also result due to migration.¹²

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 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, Vardhman 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, semistructured 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. capillary glucose was estimated using standardized 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)
	Education	
	Illiterate	210(48.7)
5.	Primary school	99(22.9)
5.	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)
	Socioeconomic status*	`
	Lower	62(14.4)
_	Lower middle	154(35.6)
7.	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(%)			
	Family history of diabetes				
1.	No history	370(85.6)			
	Single parent	45(10.4)			
	Both parents	13(3.1)			
	Sibling	4(0.9)			
	Ever smoker				
2.	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)			
	Leisure time physical activity				
5.	Moderate/ vigorous	337(78)			
	Sedentary	95(22)			
	Daily fruits and vegetables consumption				
6.	< 5 servings	346(80.1)			
	≥ 5 servings	86(19.9)			
	Body mass index				
	<18.5	9(2.1)			
7.	18.5 to 24.9	138(31.9)			
	25 to 29.9	211(48.9)			
	≥30	74(17.1)			
	Waist circumference (in cm)				
	Males				
	<90	99 (44)			
8.	≥ 90	126 (56)			
	Females				
	<80	64(30.9)			
	≥ 80	143(30.9)			
	Blood pressure (JNC VII criteria)				
9.	Normotension	155(35.8)			
<i>J</i> .	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

the males and 70% of females. Pre-hypertension was seen in 42.4% and hypertension in 21.8% of participants as shown in Table 2.

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 6.394, 95% CI: 2.535 – 16.127), Obesity (OR 4.709, 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.

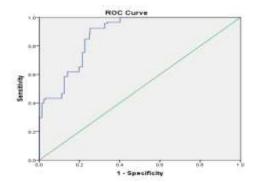


Figure 1: ROC Curve showing predictive ability of model.

ROC area: 0.879, 95% CI: 0.847-.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.	Variable		Fasting blood sugar		Adjuste	ed 95% CI	P value
No.			Normal n (%)	High** n (%)	OR	93 /0 C1	r value
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	
	Family history of diabetes	Present	33 (10.5)	29(24.6)	4.18	1.73 – 10.08	0.001
4.		Absent	281 (89.5)	89(75.4)		Reference	
_	Smoking	Present	123 (39.2)	39(33.1)	0.18	0.05 - 0.58	0.005
5.		Absent	191 (60.8)	79(66.9)		Reference	
	Work related physical activity	Moderate	222 (70.7)	83(70.3)	0.12	0.03 - 0.47	0.002
6.		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 Pudduchery 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 \geq 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. 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. Another study conducted by Vijayakumar 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. Alochol 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.

Funding: No funding sources Conflict of interest: None declared

Ethical approval: The study was approved by the

Institutional Ethics Committee

REFERENCES

- Non-communicable Diseases Risk Factor Surveillance in South-East Asia Region Report of a Workshop Bali, Indonesia 10- 13 June 2003.
- World Health Organisation. Global Health estimates: Deaths by cause, age, sex and country, 2000-12. Geneva, WHO, 2014. Available from: www.who.int/mediacentre/factsheets/fs312/en/. Accessed on 5th June 2016.
- 3. International Diabetes Federation. Diabetes atlas 2000. Brussels: IDF, 2000.
- 4. Huxley R, Barzi F, Woodward M. Excess risk of fatal coronary heart disease associated with diabetes in men and women: meta-analysis of 37 prospective studies. BMJ. 2006;332:73–8.
- Groop L, Forsblom C, Lehtovirta M, Tuomi T, Karanko S, Nissén M, et al. Metabolic consequences of a family history of NIDDM (the Botnia study): evidence for sex-specific parental effects. Diabetes. 1996;45:1585–93.
- Lyssenko V, Jonsson A, Almgren P, Pulizzi N, Isomaa B, Tuomi T, et al. Clinical risk factors, DNA variants, and the development of type 2 diabetes. N Engl J Med. 2008;359:2220–32.
- Lyssenko V, Almgren P, Anevski D, Perfekt R, Lahti K, Nissén M, et al. Botnia study group. Predictors of and longitudinal changes in insulin sensitivity and secretion preceding onset of type 2 diabetes. Diabetes 2005;54:166–174pmid:15616025
- Kaprio J, Tuomilehto J, Koskenvuo M, Romanov K, Reunanen A, Eriksson J, et al. Concordance for type 1 (insulin-dependent) and type 2 (non-insulindependent) diabetes mellitus in a population-based cohort of twins in Finland. Diabetologia 1992;35:1060–7.
- 9. Joshi R. Metabolic syndrome Emerging clusters of the Indian phenotype. J Assoc Physicians India. 2003;51:445-6.
- Deepa R, Sandeep S, Mohan V. Abdominal obesity, visceral fat and type 2 diabetes- "Asian Indian phenotype. In: Mohan V, Rao GHR, editors. Type 2 diabetes in South Asians: Epidemiology, risk factors and prevention. New Delhi: Jaypee Brothers Medical Publishers (P) Ltd; 2006: 138-52.
- 11. The global burden of disease: 2004 update. Geneva, World Health Organization, 2008.
- 12. Misra A, Pandey RM, Devi JR, Sharma R, Vikram NK, Khanna N. High prevalence of diabetes, obesity and dyslipidaemia in urban slum population in northern India. Int J Obes Relat Metab Disord. 2001;25:1722-9.
- 13. Anjana RM, Ali MK, Pradeepa R, Deepa M, Datta M, Unnikrishnan R, et al. The need for obtaining

- accurate nationwide estimates of diabetes prevalence in India rationale for a national study on diabetes. Indian J Med Res. 2011;133:369–80.
- 14. Majgi SM, Soudarssanane BM, Roy G, Das AK. Risk Factors of Diabetes Mellitus in Rural Puducherry. J Health Allied Sc. 2012;11(1):4.
- 15. Vijayakumar G, Arun R, Kutty VR. High prevalence of type 2 diabetes mellitus and other metabolic disorders in rural central Kerala. J Assoc Physicians India. 2009;57:2-4.
- 16. Prabhakaran D, Chaturvedi V, Ramakrishnan L, Jeemon P, Shah P, Snehi U, et al. Risk factors related to the development of diabetes in men working in a north Indian industry. Natl Med J India. 2007;20(1):4–10.
- Mohan V, Deepa R, Deepa M, Somannavar S, Datta M. A Simplified Indian Diabetes Risk Score for Screening for Undiagnosed Diabetic Subjects. J Assoc Physicians India. 2005;53:12-3.
- 18. Anand K, Shah B, Yadav K, Singh R, Mathur P, Paul E, et al. Are the urban poor vulnerable to non-communicable diseases? A survey of risk factors for non-communicable diseases in urban slums of Faridabad. Natl Med J India. 2007;20:115–20.
- 19. Ahmad J, Ahmad M, Ashraf M, Rashid R, Ahmad R, et al. Prevalence of Diabetes Mellitus and Its Associated Risk Factors in Age Group of 20 Years and Above in Kashmir, India. Al Ameen J Med Sci. 2011;4(1):3–4.
- 20. Nazil M, Quazi ZS, Gaidhane AM, Waghmare TS, Goyal RC. Risk factors of type-2 diabetes mellitus in rural Wardha: A community based study. Int J Diabetes Dev Ctries. 2008;28(3):79–82.
- 21. Prasad DS, Kabir Z, Dash AK, Das BC. Prevalence and risk factors for diabetes and impared glucose tolerance in Asian Indians: a community survey from urban Eastern India. Diabetes Metab Syndr. 2012;6(2):96–101.
- Risk factors surveillance for non-communicable diseases (NCDs): the multisite ICMR-WHO collaborative initiative. http://www.globalforum health.org/-filesapld/forum 9. Accessed on 23rd November 2006
- 23. Ajay VS, Prabhakaran D, Jeemon P. Prevalence and determinants of diabetes mellitus in the Indian industrial population. Diabet Med. 2008;25(10):1187-94.
- 24. DucSon LN, Kusama K, Hung NT, Loan TT, Chuyen NV, Kunii D, et al. Prevalence and risk factors for diabetes in Ho Chi Minh City, Vietnam. Diabet Med. 2004;21(4):371-6.
- 25. Leeal HY, Kim JH, Kim BO, Byun YS, Cho S, Goh CW, et al. Urban rural difference in the prevalence and associated risk factors of Type 2 Diabetes mellitus in Korean adults. Intenl J Cardiology. 2012;32:22-9.

Cite this article as: Adhikary M, Chellaiyan VG, Chowdhury R, Daral S, Taneja N, Das TK. 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. Int J Community Med Public Health 2017;4:1005-10.