International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2022): 7.942

Preventive Screening for Diabetes Mellitus and its Associated Risk Factors Using Innovative Mobile Lab cum Labike Technology

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Abstract: ***Diabetes mellitus (DM) is one of the world's most serious public health issues. Its high morbidity and death contribute to high healthcare costs, particularly in poorer nations. This study uses the cutting - edge mobile lab Cum Labike technology to ascertain the prevalence of diabetes and the risk factors related with it in the rural community. A cross - sectional study with 859 people over the age of 18 was carried out in two rural areas of Delhi. The WHO STEPS technique was employed to gather information on additional variables and socio - demographic parameters. Measurements were made of height, weight, blood sugar, and lipid profile. The semi - automated biochemistry analyzer on the mobile lab Cum Labike was used to gather and test the blood samples. Diabetes affected 4.1% of the participants in the study. Hypercholesterolemia, age, and raised triglycerides were significantly associated with diabetes. Prevention of risk factors, management of complications of these non - communicable diseases are possible if early detection can be made but due to unavailability of diagnostic facilities at cheaper rates most of the patients diagnosed too late. Labike using semi - automated biochemistry analyzer is an innovative technology and has the capacity as a point of care device used for the preventive screening and providing diagnostic services in the remote and rural areas.***

Keywords: Non - communicable diseases, Hypercholesterolemia**,** Diabetes, Labike, Semi - automated analyzer.

1. Introduction

Diabetes is considered as a major public health problem worldwide but there are few studies which report the prevalence of these diseases or replicable screening strategies using innovative technologies. In 2011, World Health Organization (WHO) member states signed the Global Action Plan for the Prevention and Control of Non - communicable Diseases, which aimed to halt the rise of diabetes by 2025 [1] Also as a part of Sustainable Development Goal 3, the United Nations (UN) member states in 2015 set the target of reducing premature mortality from non - communicable diseases (NCDs) by one - third by 2030. However, given India's huge population, its achievements are critical to reaching these global targets [2]. Early diagnosis and treatment of chronic diseases are keys to improving health status of the community [3]. The recognition of small changes in health conditions are essential for early interventions when treatment is most effective which improve patient quality of life and save treatment cost of complications.

In India, the available data on the burden of DM suggests prevalence rates of 7.5% [4]. The major risk factors associated with NCDs are tobacco use, alcohol use, physical inactivity, obesity, and raised blood pressure [5]. It is already reported that through early diagnosis of NCDs and by controlling the risk factors, large number of cases suffering from chronic diseases can be prevented. However, due to unavailability of diagnostic facilities at cheaper rates most of the patients remain undiagnosed in rural setting. Patients need to go far for the health check - up and the diagnostic services. Keeping these facts in mind the Mobile lab cum Labike was invented for preventive health care facilities in remote and rural areas. The mobile lab is the ICMR validated portable lab which is mounted on the bike and is able to perform 23 biochemical tests. The rationale of the present study was to find out the prevalence of DM and their associated risk factors among the rural population of Delhi through mobile lab technology i. e. Labike.

2. Methodology

It was a cross - sectional prospective observational study conducted at Rural Health Training Centre (RHTC), in Nazafgarh, Delhi which is a rural field practice area of VMMC & SJH College, New Delhi. A total of 859 adult (aged above 18 years) participants attending the OPD at RHTC were included in the study.

Sample size calculation: A total number of 859 participants aged 18 years and above attending the OPD were included in the study. A sample size of 859 was calculated using current prevalence of diabetes in Delhi (NCR) (4.5%), with absolute error of 1.5% and taking 10% non - response rate [6]. Every patient attending the OPD was selected and all adults 18 years and above were approached and informed about the study. After obtaining written informed consent, the selected participants were interviewed, physically examined and tested for random blood sugar (RBS) and lipid profile.

Study tools: The WHO STEPS approach was used to study the profile of the risk factors for the NCDs in the population. STEPS approach includes three sequential phases: Collection of information on socio - demographic variables, and behavioural risk factors, i. e. tobacco use, alcohol use, physical inactivity, and dietary factors using a questionnaire (STEP - 1); obtaining physical measurements such as weight, height, waist circumference, and blood pressure using standardized protocols and instruments (STEP - 2); acquiring biochemical measurements such as blood glucose, serum total cholesterol, serum low - density lipoprotein

(LDL) and high - density lipoprotein (HDL) cholesterol, and triglycerides (TG) using fasting blood samples (STEP - 3). The standard WHO STEPS questionnaire was translated into the local language (Hindi) and had been pretested before the study. Self - reported history of tobacco use as smoking or smokeless form, alcohol consumption, physical activity, and dietary habits including consumption of fruits and vegetables as well as history of hypertension and diabetes mellitus was obtained from the participants.

Statistical analysis: Data were analyzed using the SPSS version16.0. Number of old and new cases of DM out of total studied sample was taken for calculation of prevalence with confidence intervals. Chi - square test was used to analyze the difference between proportions. $P < 0.05$ was considered to be statistically significant.

Ethical consideration: The study participants were explained the purpose of the study and informed consent was taken. The study was approved by the Institutional Ethics Committee.

3. Results

Characteristics of the Sample

The study included 859 subjects of which 306 (35.6%) were males and 553 (54.4 %) were females. Of the total study subjects, 94.5% were Hindus, 4.8% were Muslims, and 0.6% were Christians. The proportion of literate was 81.8% and majority of them were married (73.7%). Unemployment among the study subject was 68.8% and majority (50.6%) of them have monthly income between Rs.10000 - 50000.

Prevalence of diabetes:

Among the study participants the prevalence rate of diabetes was 4.1% (CI 5.4% - 2.8%) of which, a higher prevalence was noted among males (5.2%) as compared to females (3.6%). Diabetes was significantly higher in individuals more than 56 years than those who were less than 56 years of age (χ^2=43.8; 0.001). There was a no significant difference in proportion of diabetes in different groups based on monthly per capita income, education, marital status, occupation and in professional categories (*Table - 1).*

Table 1: Socio - demographic characteristics vs Diabetes of the study participants

Characteristics	Total n=859 (%)	n (%)		χ^2 (P value)
		Diabetic n=36 (%)	Non - Diabetic n=823 (%)	
Sex				
Male	306 (35.6)	16 (5.2)	290 (94.8)	1.27, (0.17)
Female	553 (64.4)	20 (3.6)	533 (96.4)	
Age				
18 - 25	246 (28.6)	1 (0.4)	245 (99.6)	43.8, (0.001*)
26 - 35	145 (16.9)	0	145 (100)	
36 - 45	176 (20.5)	6 (3.4)	170 (96.6)	
46 - 55	120 (14.0)	9 (7.5)	111 (92.5)	
56 - 65	107 (12.5)	14 (13.1)	93 (86.9)	
66 & above	65 (7.6)	6 (9.2)	59 (90.8)	
Education				
Illiterate	156 (18.2)	9 (5.8)	147 (94.2)	1.18, (0.19)
Literate	703 (81.8)	27 (3.8)	676 (96.2)	
Religion				
Hindu	812 (94.5)	35 (4.3)	777 (95.7)	4.97, (0.17)
Muslim	41 (4.8)	0	41 (100)	
Others	6 (0.7)	1 (16.6)	5 (83.3)	
Marital Status				
Married	633 (73.7)	33 (5.2)	600 (94.8)	8.49, (0.03*)
Unmarried	216 (25.1)	2 (0.9)	214 (99.1)	
Separated	10 (1.0)	0	9 (100)	
Occupation				
Professional	18 (2.1)	0	18 (100)	1.82, (0.93)
Semi - prof.	20 (2.3)	1 (5.0)	19 (95.0)	
Shop - owner	36 (4.2)	2 (5.6)	34 (94.4)	
Skilled	47 (5.5)	3 (6.4)	44 (93.6)	
Semi - skilled	67 (7.8)	3 (4.5)	64 (95.5)	
Unskilled	80 (9.3)	4 (5.0)	76 (95.0)	
Unemployed	591 (68.8)	23 (3.9)	568 (96.1)	
Income				
0 - 5000	103 (12.0)	5 (4.9)	98 (95.1)	0.27, (0.96)
5001 - 10000	293 (34.1)	13 (4.4)	280 (95.6)	
10001 - 50000	435 (50.6)	17 (3.9)	418 (96.1)	
50001 & above	28 (3.3)	1 (3.6)	27 (96.4)	

Table - 2, shows that, there was no significant difference in prevalence of diabetes among smokers and alcohol users than in the non - users. However, tobacco use was more in diabetes as compared to non - diabetes participants (χ^2=6.51, 0.04). Out of 36 diabetic subjects, 10 (5.9%) were overweight and 10 (8.0%) were obese, although there were no significant differences related to BMI categories. Overweight and obese were significantly associated with

diabetes (χ^2=9.46, 0.02). There was also no significant difference in prevalence of diabetes with physical activities and consumption of fruits and vegetables per week (*Table - 2).*

Table 2: Distribution of modifiable risk factors for Diabetes in the study participants

Behavioural risk factors	Total n=859 (%)	n (%)		χ^2, (P value)
		Diabetic n=36 (%)	Non - Diabetic n=823 (%)	
Smoking				
Yes	63 (7.3)	1 (2.8)	62 (7.5)	1.148 (0.242)
No	796 (92.7)	35 (97.2)	761 (92.5)	
Tobacco				
Yes	19 (2.2)	3 (15.8)	16 (84.2)	6.51, (0.04*)
No	840 (97.8)	33 (3.9)	807 (96.1)	
Alcohol use				
Yes	36 (4.3)	1 (2.8)	35 (97.2)	0.17, (0.55)
No	807 (95.7)	34 (4.2)	773 (95.8)	
Fruits consumed				
0 - 2 times /week	419 (48.8)	23 (5.5)	396 (94.5)	3.47, (0.17)
3 - 4 times	223 (26.0)	7 (3.1)	216 (96.9)	
≥ 5 times	217 (25.3)	6 (2.8)	211 (97.2)	
Vegetables consumed				
0 - 2 times	12 (1.4)	1 (8.3)	11 (91.7)	0.82, (0.66)
3 - 4 times	7 (0.8)	0	7 (100)	
≥ 5 times	840 (97.8)	35 (4.2)	805 (95.8)	
Physical activity				
Yes	436 (50.8)	6 (4.5)	128 (95.5)	0.03, (0.50)
No	423 (49.2)	30 (4.1)	695 (95.9)	
BMI				
Underweight	106 (12.3)	1 (0.9)	105 (99.1)	9.46, (0.02)
Normal	458 (53.3)	15 (3.3)	443 (96.7)	
Overweight	170 (19.8)	10 (5.9)	160 (94.1)	
Obese	125 (14.6)	10 (8.0)	115 (92.0)	

Table 3, shows that among those who had raised cholesterol levels, 8.3% were found to be diabetic as compared to diabetes among normal cholesterol (χ^2=11.28, 0.001). Similarly, those who have abnormal TG, 8.6% of them have diabetes as compared to diabetes among normal triglyceride (χ^2=21.3; p=0.001). However, HDL, LDL and Hypertension were not statistically related to diabetes (*Table 3).*

Table 3: Distribution of biochemical risk factors among the study participants

Biochemical risk factors	Total n=859 (%)	n (%)		χ^2, (P value)
		Diabetic n=36 (%)	Non - Diabetic n=823 (%)	
Raised Total Cholesterol (mg/dl)				
< 200	654 (76.1)	19 (2.9)	635 (97.1)	11.28, (0.001*)
≥ 200	205 (23.9)	17 (8.3)	183 (91.7)	
Raised Triglycerides (mg/dl)				
< 150	569 (66.2)	11 (1.9)	558 (98.1)	21.3, (0.001*)
≥ 150	290 (33.8)	25 (8.6)	265 (91.4)	
Serum HDL (mg/dl)				
< 40	439 (51.1)	15 (3.8)	376 (96.2)	0.22, (0.38)
≥ 40	420 (48.9)	21 (4.5)	447 (95.5)	
Serum LDL (mg/dl)				
<130	688 (80.1)	25 (69.4)	663 (80.6)	2.67, (0.08)
>130	171 (19.9)	11 (30.6)	160 (19.4)	

4. Discussion

In the present study, the overall prevalence of diabetes among the study participants was 4.1%, which is slightly higher than the prevalence of diabetes in India Study (PODIS) which reported, lower diabetes prevalence 2.7% in rural areas [7]. 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 [8]. 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 [9]. These figures imply that though the prevalence of diabetes varies in different settings, it is certainly quite high and needs immediate attention. It is also realized that the diabetes is no longer confined to urban areas of India and is a matter of concern in rural areas as well [10]. where over 70% of the population of India residing and often faced with problems like poverty and poor access to health care. The present study reported no gender difference in the

prevalence of diabetes which is supported by evidence from other studies in India, although a few studies have shown a male preponderance [11] Primarily, the risk of diabetes is associated with age, obesity, smoking, diet, and physical inactivity. In the present study, the diabetes was associated with tobacco use and BMI. Association of increased age with diabetes has also been reported by Dasappa H et. al [12]. In our study it was observed that married participants were more diabetes than unmarried which could be possibly because of confounding effect of age or they faced stress or responsibilities as compared to unmarried people, however, further studies are required to conclude these possibilities. Dietary habits played a vital role in enhancing the diabetes risk and more attention is required regarding this aspect [13]. The present study did not find any association between the alcohol and diabetes [14]. Findings of tobacco and diabetes were similar to a previous study [15]. Highest proportion of diabetes subjects was seen among obese subjects. This has been reported by Khambalia. A et. al [16]. Reducing weight with diet and exercise has been found to cause significant risk reduction in progression to overt diabetes [17] which could be acceptable suggestions to the participants of present study.

5. Limitations

The study had few limitations. Firstly, this being a cross - sectional study, prevents us from drawing causal inferences. Secondly, measurement of the blood glucose and other lipid parameters were done by a mobile lab using semi - automated analyzer instead of fully automated or glucometer. However, regular quality control check on analyzer was done in a reference laboratory. Lastly, only random blood glucose was used to diagnose diabetes.

6. Conclusion

The advancement in healthcare technologies and networking infrastructure have spurred the availability of low - cost, commercially available diagnosis systems that have the potential to connect patients with their healthcare providers in a timely and efficient manner. It has impacted the ability to increase healthcare access, improve accuracy in medical treatments, and in some cases, reduce costs while achieving better health outcomes, among others. Both researchers and practitioners have started to look for opportunities in using existing technology to support medical decision to improve care and reduce healthcare costs. In this context mobile lab cum Labike technology is designed and commercially available which is of accessible in rural areas, low cost and affordable, and may be utilized in provision of universal healthcare.

Acknowledgment: The author would like to acknowledge the funding from the ICMR for this study.

Conflict of interest: There were no conflicts of interest.

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