Original Article

Obesity and its Link to Undiagnosed Diabetes Mellitus and Hypertension in Rural Parts of Western India

Meenakshi Kalyan, Prasanna Dhore[1], Vedavati Purandare, Shailesh Deshpande[1], A. G. Unnikrishnan

Departments of Endocrinology and Diabetes and [1]Education and outreach, Chellaram Diabetes Institute, Pune, Maharashtra, India

Abstract

Background: Obesity and overweight are becoming major health concerns worldwide. Hence, we studied the association between overweight and obesity with new-onset diabetes and hypertension in a selected rural population. **Methodology:** Community health workers made house-to-house visits, inviting adults >20 years of age who were at a higher risk of diabetes, from a predefined rural area of Maharashtra, to visit a mobile diabetes clinic operating in a hub and spoke manner. Sociodemographic data and anthropometric measurements were recorded. BMI and waist circumference was classified according to the WHO recommended cutoffs for Asians. Subjects with capillary blood fasting glucose of ≥126 mg/dL or random glucose of ≥200 mg/dL by glucometer were diagnosed as diabetes and blood pressure of ≥140/90 mmHg by sphygmomanometer were diagnosed as hypertension. Subjects with a known history of diabetes mellitus and hypertension were excluded. **Results:** Out of 29,324 total population, 16.5% of subjects were overweight and 26.4% were obese. Mean ± SD of BMI of the participants was 22.9 ± 4.1 kg/m^2 in males and 22.4 ± 4.2 kg/m^2 in females. Around 35% of males and 30.5% of females had a high waist circumference of ≥90 cm and ≥80 cm, respectively, 20.5% of subjects had newly diagnosed hypertension, and 11.4% of subjects had newly diagnosed diabetes mellitus. The occurrence of newly diagnosed hypertension and diabetes showed an increasing trend with increasing BMI. **Conclusion:** Our community-based screening suggested a high prevalence of overweight and obesity in rural India. There was a high prevalence of newly diagnosed hypertension and diabetes in this population.

Keywords: Diabetes, hypertension, India, obesity, rural

Introduction

The global epidemic of overweight and obesity is increasingly becoming a major public health problem in the world.[1] Being a complex condition, obesity, and overweight contribute to the burden of chronic diseases including diabetes, hypertension, dyslipidemia, cardiovascular disease, and even some cancers and affects virtually all ages and socioeconomic groups.[2] An epidemiological study conducted on the Indian rural population showed that 25.8% of people were overweight and 38.2% were obese.[3,4] There is a higher risk for the development of obesity-related noncommunicable diseases at lower body mass index levels in Asian Indians when compared to their western counterparts.[5] Due to the increased risk of morbidity and mortality, obesity is now being recognized as a disease in its own right. A lack of awareness, limited access to healthcare and unaffordability are the problems likely to be encountered by overweight and obese subjects in rural areas. The study aimed to assess the impact of Asia specific guidelines on the prevalence of overweight and obesity in a large rural population and its association with undiagnosed diabetes mellitus and hypertension.

Methodology

This was a cross-sectional study conducted in the villages of Maharashtra state in western India over 5 years, comprising a sample size of 29, 324 rural populations in the age group of 20–80 years by simple random sampling were representative of the rural area. Data was collected from a mobile diabetes clinic program, the design of which has been published

Access this article online

Quick Response Code:

Website: www.ijem.in

DOI: 10.4103/ijem.IJEM_582_19

Address for correspondence: Dr. A.G. Unnikrishnan, CEO, Chellaram Diabetes Institute, Pune, Maharashtra, India. E-mail: ceo@cdi.org.in

Submitted: 01-Nov-2019 **Revised:** 26-Dec-2019
Accepted: 06-Feb-2020 **Published**: 30-Apr-2020

How to cite this article: Kalyan M, Dhore P, Purandare V, Deshpande S, Unnikrishnan AG. Obesity and its link to undiagnosed diabetes mellitus and hypertension in rural parts of Western India. Indian J Endocr Metab 2020;24:155-9.

earlier.[6] Briefly, community health workers called accredited social health workers (ASHAs) visited from house-to-house, identifying subjects for diabetes screening. The subjects found to be at high risk based on the questionnaire were then invited to a mobile base clinic that operated in a hub and spoke pattern. The "hub" was a larger village where the mobile base clinic was stationed and the surrounding "spoke" were the smaller villages where the team visited each day. Study questionnaires were prepared to record the sociodemographic data of participants.[6] A general physical examination was carried out in all subjects. Weight was measured with a weighing scale, height with a stadiometer and BMI was calculated. BMI according to the WHO recommendations for Asians was considered as follows: BMI of 18.0–22.9 kg/m^2 as normal, BMI of 23–24.9 kg/m^2 as overweight, and ≥25 kg/m^2 as "obese" and these standards were applied in this study.[7] The blood pressure was measured using a standardized sphygmomanometer with appropriate cuff sizes. Hypertension was defined as ≥140/90 mmHg according to JNC VIII.[8] A capillary blood sample was taken and a glucometer was used to measure the fasting/random blood glucose. Diabetes mellitus was defined as fasting glucose of ≥126 mg/dL or random glucose of ≥200 mg/dL.[9] Data analysis was done by SPSS, 95% CI and *P* value <0.05 was considered significant.

Exclusion criteria

Subjects with a known history of diabetes mellitus, hypertension, tuberculosis, renal and liver diseases, and malignancy were excluded.

Results

Out of the total population of 37,203 subjects, 29,324 subjects were included in the study after excluding the subjects with either diabetes or hypertension or both, as shown in Figure 1. Among the participants, 12, 500 were males and 16,824 were females. The mean age was 54.1 ± 16.8 years. On assessing risk factors, 42.9% were tobacco chewers, 0.1% were smokers, and 0.1% were consuming alcohol daily. About exercise, 5.2% of subjects were performing regular exercises 150 min/week. Professionally, 39.5% were farmers, 15.7% were housewives, 30.9% were laborers, 3% in service jobs, and 10.9% were unemployed. Out of the total population, 16.5% of subjects were overweight and 26.4% were obese [Table 1]. Mean ± SD of BMI of the participants was 22.8 ± 4.1 in males and 22.40 ± 4.22 in females. About 35% of males had a high waist circumference of ≥90 cm and 30.5% of females had a high waist circumference of ≥80 cm. The prevalence of overweight and obesity differs significantly across all age groups as shown in Figure 2. A total of 5997 (20.5%) patients had newly diagnosed hypertension. The distribution of the mean ± SD of systolic BP and diastolic BP in the group of cases with newly diagnosed hypertension was 148.2 ± 6.3 mmHg and 96.4 ± 3.2 mmHg, respectively. The distribution of the prevalence of newly diagnosed hypertension differed across all age groups showed an increasing trend with age [Figure 3]. A total of 3332 patients (11.4%) had newly diagnosed diabetes mellitus. The distribution of prevalence of newly diagnosed diabetes mellitus differed across all age groups showed an increasing trend with age [Figure 3]. The distribution of the mean ± SD of random glucose in the group of newly diagnosed diabetes mellitus patients was 295.4 ± 98.0 mg/dL. The distribution of prevalence of newly diagnosed hypertension and diabetes differs significantly across various BMI groups and increasing trend with higher BMI [Table 2]. Out of the total population, 950 subjects (3.2%) had both new-onset diabetes and hypertension.

Discussion

The present study shows the high cumulative prevalence of cardiovascular risk factors-overweight, obesity, hypertension,

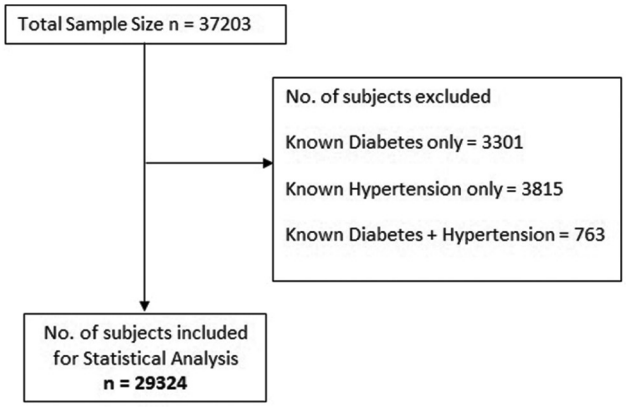

Figure 1: The flow diagram showing the number of subjects included for statistical analysis

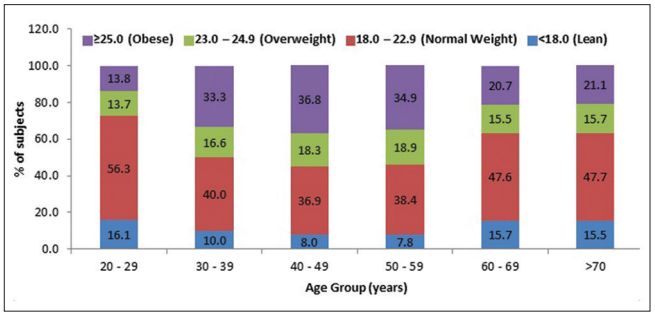

Figure 2: Age distribution of prevalence of overweight and obesity

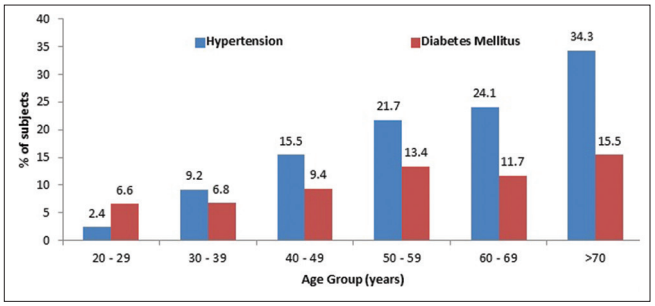

Figure 3: Age distribution of the prevalence of newly diagnosed hypertension and diabetes

Table 1: Distribution of overall prevalence of overweight and obesity (based on BMI and waist circumference)

BMI Groups (kg/m²)	No. of subjects	% of subjects (Prevalence)	95% CI of Prevalence
<18.0 (Lean)	3692	12.6	11.5-13.1
18.0-22.9 (Normal weight)	13069	44.6	43.7-45.0
23.0-24.9 (Overweight)	4835	16.5	15.4-17.0
≥25.0 (Obese)	7728	26.4	25.4-26.9
Total	29324	100.0	
Waist circumference (WC)	**No. of subjects**	**% of subjects (Prevalence)**	**95% CI of Prevalence**
Normal	19871	67.8	67.1-68.1
High WC (≥90 cm) (Males)	4371	35.0	33.6-35.7
High WC (≥80 cm) (Females)	5082	30.2	28.9-30.8
WC(≥90 cm Male/≥80 cm Female) (Overall)	9453	32.2	31.2-32.7
Total	29324	100.0	

Table 2: Distribution of prevalence of newly diagnosed hypertension and Diabetes mellitus according to BMI

BMI Groups (kg/m²)	Newly diagnosed Hypertension		Newly diagnosed Diabetes		Total	
	n	%	*n*	%	*n*	%
<18.0 (Lean)	469	12.7	302	8.2	3692	100.0
18.0-22.9 (Normal weight)	2233	17.1	1412	10.8	13069	100.0
23.0-24.9 (Overweight)	1117	23.1	616	12.7	4835	100.0
≥25.0 (Obese)	2178	28.2	1002	13.0	7728	100.0
Total	5997	20.5	3332	11.4	29324	100.0

The distribution of prevalence of newly diagnosed hypertension and diabetes mellitus showed a significantly increasing trend with higher BMI (P<0.001 for linearity trend)

and diabetes which portends high rates of cardiovascular disease-related morbidity and premature mortality in the future.

To our knowledge, this is the largest systematic study of the relationship between overweight/obesity and the risk of new-onset diabetes and hypertension in rural India. The role of BMI in Indians and its link to cardiovascular and diabetes risk has been described in various studies.[10-13]

Our study confirms that there is indeed a link between higher levels of BMI and the increasing prevalence of new-onset diabetes and hypertension in rural India.

The large sample size (n = 29324) and the systematic inclusion of study subjects via a house-to-house visit-based approach by community health workers and their evaluation at a mobile diabetes clinic near their doorstep makes the study unique, and the results are important.

Our findings on obesity and overweight raise an important public health concern. Even more worrisome is the findings that about one in ten subjects had undiagnosed diabetes and that one out of five subjects had undiagnosed hypertension; the prevalence of these conditions increased with increasing BMI.

Mechanization of manual farm labor, urbanized lifestyle, increasing access to high calorie, refined energy-dense food, and economic growth may explain the clustering of obesity into new-onset diabetes and hypertension in rural populations. Other studies have reported similar trends.[14-16]

The present study demonstrated that a high prevalence of obesity was associated with middle age and physical inactivity which is similar to a study conducted in a rural area of Japan[17] with only 5% subjects performing regular exercise per week. The prevalence of newly detected hypertension was 20.5%which is similar to a study conducted in a rural community in central India[18] and SITE study.[19] The present study shows the overall prevalence of diabetes to be 11.4% which is in agreement with a study by Vaz *et al*.[20] The prevalence of undiagnosed hypertension and diabetes was 23.1% and 12.7% in overweight subjects, respectively which is similar to other studies.[21,22] The prevalence of undiagnosed hypertension and diabetes in obese subjects were 28.2% and 13%, respectively. Our study showed an increased prevalence of hypertension than diabetes in obese subjects which is somewhat different from another study[23] showing 22.2% hypertension and 20.2% of diabetes. Most hypertension and diabetes remained undetected, more notably in the rural setting, similarly observed in sub-Saharan Africa[24] and patterns in treatment and control varied by area of residence, age, and sex.

Random capillary blood glucose (RCBG) is the most convenient way to reach large numbers of people.[25] In a study conducted in Asian Indians, RCBG cut points of 140 and 143 mg/dL maximized the sensitivity and specificity for diabetes and Asian Indians with RCBG >110 mg/dL at screening are recommended to undergo definitive testing.[26]

We have reported in a previous publication that a high-risk screening program, which combines community health worker

based enrollment and a mobile clinic-based screening is cost-effective.[6] Our study confirms the benefit of a systematic screening program for the detection of overweight and obesity-related chronic disease.

In addition to screening, public health experts need to lay down strategies to prevent the impending epidemic of obesity-related noncommunicable diseases worldwide. Health education, enlisting the help of community health workers, strengthening existing healthcare infrastructure, and even setting up a new specialty on noncommunicable disease management are all important.

Our study has important limitations. The high-risk screening approach by community health workers could have resulted in a selection bias. Selecting subjects using a high-risk-for-diabetes questionnaire could have preselected subjects at higher risk of obesity, diabetes, and hypertension. Secondly, nutritional and educational status was not assessed, though employment status and physical activity status was assessed. Thirdly the diagnosis of hypertension and diabetes was made by a single measurement, this is another limitation of the study. Nevertheless, the large sample size strengthens the relevance of our results.

In the ICMR-INDIAB study (Nov 2008 to Apr 2010) prevalence of obesity was 16.6% and overweight was 11.3%. Among residents of Maharashtra state.[2] In our study (2012–2017) 26.4% were obese and 16.5% of subjects were overweight. Further research and policy need to focus on strategies to tackle the occurrence of obesity/overweight related comorbidities in the rural population. To summarize, the present study shows a high prevalence of obesity/overweight in rural India, which is, in turn, linked to undiagnosed diabetes and hypertension.

Acknowledgments

We are thankful to accredit social health workers (ASHAs) from our institute who has contributed effectively to mobile clinic and outreach programs in the remote villages of Maharashtra in Western India. We are thankful to all the team members of the outreach program who have contributed to compiling the data in the software to enable the statistical analysis. Chellaram Foundation was the funding source. A significant contribution to the conception, design, execution, and interpretation of the reported study is equally done by Meenakshi Kalyan and Prasanna B. Dhore and can be considered as joint first authors.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. World Health Organization. Obesity: Preventing and managing the global epidemic. Report of a WHO consultation. World Health Organ Tech Rep Ser 2000;894:1-253.
2. Pradeepa R, Anjana RM, Joshi SR, Bhansali A, Deepa M, Joshi PP, *et al*. Prevalence of generalized and abdominal obesity in urban and rural India-ICMR-INDIAB study (Phase I) [ICMR-INDIAB-3]. Indian J Med Res 2015;142:139-50.
3. Misra A, Shrivastava U. Obesity and dyslipidemia in South Asians. Nutrients 2013;7:2708-33.
4. Kowsalya T, Parimalavalli R. Prevalence of overweight/obesity among adolescents in urban and rural areas of Salem, India. J Obes Metab Res 2014;1:152-5.
5. World Health Organization. Appropriate body mass index for Asian populations and its implications for policy and intervention strategies. Lancet 2004;363:157-63.
6. Dhore PB, Tiwari S, Mandal MK, Purandare VB, Sayyad MG, Pratyush DD, *et al.* Design, implementation and results of a mobile clinic based diabetes screening program from India. J Diabetes 2016;4:590-3.
7. World Health Organization. The Asia Pacific Perspective: Redefining Obesity and Its Treatment. Melbourne: Health Communications Australia; 2000.
8. James PA, Oparil S, Carter BL, Cushman WC, Dennison-Himmelfarb C, Handler J, *et al*. 2014 Evidence based guideline for the management of high BP in adults. JAMA 2014;311:507-20.
9. Classification and diagnosis of diabetes standards of medical care in diabetes. Diabetes Care 2018;41(Suppl 1):S13-27.
10. Misra A, Vikram N, Gupta R, Pandey R, Wasir J, Gupta V. Waist circumference cutoff points and action levels for Asian Indians for identification of abdominal obesity. Int J Obes (Lond) 2005;30:106-11.
11. Jafar TH, Chaturvedi N, Pappas G. Prevalence of overweight and obesity and their association with hypertension and diabetes mellitus in an Indo-Asian population. CMAJ 2006;175:1071-7.
12. Katulanda P, Jayawardena MA, Sheriff MH, Matthews DR. Derivation of anthropometric cut-off levels to define CVD risk in Sri Lankan adults. Br J Nutr 2011;105:1084-90.
13. Bhowmik B, Munir SB, Diep LM, Siddiquee T, Habib SH, Samad MA, *et al*. Anthropometric indicators of obesity for identifying cardiometabolic risk factors in a rural Bangladeshi population. J Diabetes Invest 2013;4:361-8.
14. Siddiquee T, Bhownik B, Da Vale Moreira NC, Mujumder A, Mahtab H, Khan AK, *et al*. Prevalence of obesity in rural Asian Indian Population and its determinants. BMC Public Health 2015;15:860.
15. Zhang X, Sun Z, Zhang X, Zheng L, Liu S, Xu C, *et al*. Prevalence and associated factors of overweight and obesity in a Chinese rural population. Obesity 2008;16:168-71.
16. Panagiotakos DB, Pitsavos C, Chrysohoou C, Risvas G, Kontogianni MD, Zampelas A, *et al*. Epidemiology of overweight and obesity in a Greek adult population: The ATTICA study. Obes Res 2004;12:1914-20.
17. Aoyagi K, Kusano Y, Takamura N, Abe Y, Osaki M, Une H. Obesity and cardiovascular risk factors among men and women aged 40 years and older in a rural area of Japan. J Physiol Anthropol 2006;25:371-5.
18. Kokiwar PR, Gupta SS, Durge PM. Prevalence of hypertension in a rural community of central India. J Assoc Physicians India 2012;60:26-9.
19. Joshi SR, Saboo B, Vadivale M, Dani SI, Mithal A, Kaul U, *et al*. Prevalence of diagnosed and undiagnosed diabetes and hypertension in India-Results from the screening India's twin epidemic (SITE) study. Diabetes Technol Ther 2012;14:8-15.
20. Vaz NC, Ferraria AM, Kulkarni MS, Vaz FS. Prevalence of diabetes mellitus in rural population of Goa, India. Natl Med J India 2011;24:16.
21. Rahman M, Williams G, Mamun A. Hypertension and Diabetes prevalence among adults with moderately increased BMI: Findings from nationwide survey in Bangladesh. Public Health Nutr 2017;20:1343-50.
22. Stevens J, Truesdale KP, Katz EG, Cai J. Impact of bodymass index on incident hypertension and diabetes in Chinese Asians, American whites and American blacks. Am J Epidemiol 2008;167:1365-74.
23. Mandal A. Study of prevalence of Type 2 Diabetes mellitus and Hypertension in overweight and obese people. J Family Med Prim Care 2014;3:25-8.
24. Atalkte F, Erquou S, Kaptoge S, Taye B, E. Choufflo-Tcheugui JB, Kengue AP. Burden of undiagnosed hypertension in Sub Saharan Africa: A systemic review and meta analysis. Hypertension 2015;65:291-8.
25. Zhang P, Engelgau MM, Valdez R, Cadwell B, Benjamun SM, Venkat Narayan KM. Efficinet cut off points for three screening tests for

detecting undiagnosed diabetes and pre diabetes. An economic analysis. Diabetes Care 2005;28:1321-5.
26. Somannavar S, Ganesan A, Deepa M, Datta M, Mohan V. Random capillary blood glucose cut points for diabetes and pre diabetes derived from community based opportunistic screening in India. Diabetes Care 2009;32:641-3.