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BODY MASS INDEX AND ITS ASSOCIATION WITH SELECTED RISK FACTORS FOR NON-COMMUNICABLE DISEASES IN A RURAL AREA IN KARNATAKA, INDIA

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ABSTRACT

Background: Body Mass Index (BMI) has been shown to be an important predictor of risk of non- communicable diseases (NCDs) and associated with risk factors for NCDs This study was conducted to determine the association of BMI with sociodemographic, biochemical (fasting glucose, lipid profile), blood pressure and anthropometric (waist hip measurements) risk factors for NCDs in a rural area.

Methods: This cross sectional study was conducted in a village in Karnataka, through a house-to-house survey of persons ≥ 18 years of age, employing a questionnaire and laboratory investigations. Anthropometric measurements, blood pressure, fasting blood glucose and lipid profile was measured.

Findings: Of the 585 subjects, 45%, 25.3%, 29.7% were in normal, underweight and pre-obese/obese BMI categories respectively. Prevalence of hypertriglyceridemia, abnormal HDL, systolic hypertension (≥ 140mmHg), diastolic hypertension (≥ 90mmHg) was 17.7%, 72.6%, 7.5% and 10.3% respectively In the pre-obese/obese category, 72.5% had abnormal waist circumference and WHR (41%) respectively. Association of BMI with gender, age, waist-hip ratio, systolic and diastolic blood pressure, fasting triglycerides (all P = 0.001) and HDL (P = 0.038) was observed.

Conclusion: BMI was associated with increased waist circumference, dyslipidemia, increased fasting blood glucose and hypertension and are serious health problems in rural India also.

Key words: Body Mass Index, laboratory investigations, non-communicable diseases, risk factors, rural

INTRODUCTION

Body Mass Index (BMI) has been shown to be an important predictor of risk of non communicable diseases (NCDs). Further, BMI has been associated with several risk factors for NCDs such as fasting blood glucose, dyslipidemia, hypertension, and abnormal waist circumference.[1]Besides increasing the life expectancy of the Indian population, greater connectivity to urban areas allows rural populations to adopt urban lifestyles without migration to urban areas.

Prevalence of risk factors for NCDs and its association with BMI from rural population has public health importance, as two thirds of India's population live in rural areas.[2] It is well known that rural populations have limited access to health care and limited ability to bear the high cost of treatment. In 1993, a WHO expert committee meeting[3], proposed BMI cut off points of 25·0-29·9 kg/M^2 for overweight grade 1, 30·0-39·9 kg/M^2 for overweight grade 2 and ≥ 40·0 kg/M^2 for overweight grade 3. Since Asians are at a higher risk of developing atherosclerosis and related complications, the cut off limit for overweight has been accepted at a BMI of 23·0 Kg/m^{2}for Asians.[4]

Most studies on BMI as a risk factor for NCDs were carried out in urban areas of India where the prevalence of NCDs is high.[5,6] Hence, this cross sectional study was planned in a rural area with the objective of determining the association of BMI categories of underweight, normal weight as well as pre-obese /obese, with sociodemographic, biochemical, physiological, and anthropometric risk factors for NCD such as fasting glucose, lipid profile, blood pressure, and waist hip measurements.

METHODS

A cross sectional survey was carried out in a rural area of Kaiwara Primary Health Centre (PHC), Chintamani Taluk of Karnataka State, India. Ethical clearance was obtained from the institutional ethics committee. One village (Jangamsheegehally) was selected randomly from a list of 36 villages covered by the Kaiwara PHC which serves as the rural field practice area of the Department of Community Medicine of a Medical College. All adults ≥ 18 years of age in 218 households in the village with a population of 722 were included. After establishment of a rapport with the villagers, an awareness programme (through meeting with village leaders, posters, and announcements) regarding the purpose of the study was carried out. Written informed consent of the participants was obtained.

A pretested semi-structured questionnaire which included questions relating to socio demographic details and risk factors for NCDs was used. A training manual which provided information on the questionnaire and methodology for recording of blood pressure and anthropometric measurements was developed based on the manual of the MONICA study.[7]The manual contained definitions used in the study, details of method of data collection, drawing of blood sample, centrifugation, storage, and transportation of blood samples to the tertiary laboratory for analysis. One-day training was conducted for all the medical personnel, field workers, and technicians involved in data collection.

The study was conducted between Septembers to November 2010. A house-to-house survey was done, during which each eligible subject (≥ 18 years of age) identified in the house was given a unique identification number in serial order. Each of the eligible subjects was interviewed with the questionnaire. Following the interview, blood pressure and anthropometric measurements were recorded with standardized instruments (MONICA study manual).[7]These instruments were subjected to appropriate quality control checks. Height was measured without footwear with a non-stretchable standardized measuring scale with an accuracy of up to 0·5 cm. Weight was measured with a standard 'Indian Standards Organization' certified weighing scale with minimum clothes and without footwear with an accuracy of up to 100 gms. The weighing scale was set to zero and checked with a known weight every day. Waist and hip measurements were taken with a non-stretchable plastic tape and rounded off to the nearest 0·5 cms. Waist and hip measurements of female subjects was done by female investigators. After 5 minutes of rest, blood pressure was measured in a sitting position on the right arm with a mercury sphygmomanometer to the nearest 2mm Hg. Blood pressure, waist, and hip measurements were taken twice with a five minute interval and the average of the two measurements was recorded as the final measurement.

Sample size estimation: Studies on chronic illness carried out in rural areas in India have reported that the prevalence of select chronic diseases was nearly 30%.[5] With an absolute precision of 5% and a confidence level of 99%, the estimated sample size was 559. However, all the persons in the village ≥ 18 years of age were included in the study so that full co-operation of the villagers would be obtained. Due to cost constraints, laboratory investigations were done on a random sample of the respondents. Hence, sample size for laboratory investigations was estimated based on the prevalence of dyslipidemia among normotensives in a rural area, as 48%;[8] a relative precision of 15% with alpha error of 5%, the required sample size was 185. However, 10% more subjects were included to allow for non response.

At the end of the survey (2 months), 204 randomly selected subjects were asked to come for laboratory investigations. Subjects were informed orally as well as with an information pamphlet in the local language, about blood collection for estimation of glucose and lipid profile and the importance to remain fasting for 12 hours. The investigations were done in the village school where a trained technician collected 5ml of venous blood samples and processed them. Samples were centrifuged and the serum was taken within three hours in an icebox to the biochemistry laboratory of the medical college hospital for analysis.

Definitions used in the study were as follows:

Blood pressure measurements were classified according to The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure.[9]

Body mass index, was classified using cut offs of BMI for Asians.[10]Waist and HC were classified according toa joint Interim Statement of international organizations.[1,11]Blood glucose levels were classified according to the WHO recommendations of 1999.[12]Blood lipid levels were classified according to the recommendations of the Adult Treatment Panel III.[13]

Statistical analysis: Data was analyzed using the SPSS Version 18·0. Descriptive statistics such as proportions /mean, standard deviations were calculated. Chi square test was employed to test for differences in the various parameters. Prevalence rates of risk factors/diseases were estimated. Considering BMI of 18·5-22·9 as reference category, univariate odd's ratios were estimated along with 95% confidence intervals separately for underweight and pre-obese/obese categories. Multinomial logistic regression was done to identify independent factors associated with underweight and preobese/obese categories as compared to normal BMI after adjusting for other factors.

RESULTS

A total of 218 households (the whole village) were included, in which there were 722 persons ≥ 18 years of age. However, even after repeated visits, 585 persons (81·0%) were covered for the study. Of the 585 persons studied, 263 (45%) were in the normal BMI category of 18·5-22·9. The rest of the subjects were underweight- BMI <18·5 (n=148, 25·3%) or pre-obese/obese-BMI ≥23 (n=174, 29·7%). Only 16 (2·7%) subjects had a BMI of>30 and hence they were combined with the pre-obese category.

Association of BMI with socio-demographic characteristics (Table 1 & 3): A higher proportion of females were found to be underweight (35%) as compared to males (14·7%, OR = 2·59, 95% CI 1·64-4·10) while the reverse was true in pre-obese/ obese category. The association between BMI categories and gender was found to be statistically significant (P=0·001). A lower proportion of subjects who were underweight were found in the 40-49 and 50-59 year age groups as compared to normal BMI category (OR =0·29, CI 0·10-0·81; 0·27, CI 0·09-0·81). However, among obese subjects a greater proportion was found in the age group of 30-59 years. The association between BMI and age groups was statistically significant (P=0·010).

A higher proportion of literate persons were pre-obese /obese as compared to not literate persons. Except for the high school category, the odds ratios were found to be statistically significant in all other categories. Among the occupational groups, clerical workers and semi-professionals were found to be more underweight as compared to the other two categories; however the differences were not statistically significant.

Association of BMI with anthropometric measurements and blood pressure (Table 2 & 3): In the substantially increased risk based on waist-hip ratio (WHR) category, 41 %(95% C I: 35.5-46.5)of subjects were pre-obese/obese as compared to 15.6% (95% C I: 11.1-20.1)in the no risk category.

Table 1: Distribution (%) of BMI and its association with sociodemographic characteristics

Variables	BMI categories [11]			P value@	Univariate Odds Ratios	
	Normal (18·5-22·99) n=263	Underweight (<18·5) n=148	Pre and obese (23·0+) n=174		OR 95%CI*	OR 95%CI#
Sex (%)						
Male (n=279)	47·0	14·7	38·4	0·001	1·0	1·0
Female (n=306)	43·1	35·0	21·9		2·59(1·64-4·10)	0·24 (0·15-0·39)
Age group (years) (%)						
<20 (n=34)	35·3	44·1	20·6	0·010	1·0	1·0
20-29 (n=138)	52·2	25·4	22·5		0·39 (0·15-1·00)	0·74 (0·24-1·19)
30-39 (n=136)	39·0	25·0	36·0		0·51 (0·19-1·34)	1·58 (0·52-5·14)
40-49 (n=107)	46·7	16·8	36·4		0·29 (0·10-0·81)	1·33 (0·44-4·39)
50-59 (n=68)	52·9	17·6	29·4		0·27(0·09-0·81)	0·95 (0·29-3·34)
60-69 (n=66)	37·9	30·3	31·8		0·64(0·22-1·85)	1·44 (0·43-5·13)
≥70 (n=36)	41·7	38·9	19·4		0·75(0·23-2·42)	0·80 (0·18-3·54)
Education (%)						
Not literate (n=248)	49·6	29·4	21·0	0·001	1·0	1·0
Up to Middle school (n=176)	35·8	25·6	38·6		1·20(0·72-1·20)	2·55 (1·55-4·21)
High school (n=84)	50·0	21·4	28·6		0·72(0·36-1·40)	1·36 (0·71-2·55)
Above high school (n=77)	45·5	15·6	39·0		0·58(0·26-1·23)	2·03 (1·08-3·87)
Occupation (%)						
Cat 1 (n=233)	40·8	27·0	32·2	0·056	1·0`	1·0
Cat 2 (n=231)	49·8	19·9	30·3		0·60 (0·37-0·99)	0·77 (0·49-1·21)
Cat 3 (n=121)	43·8	32·2	24·0		1·11 (0·64-1·93)	0·69 (0·39-1·23)

Cat 1: Unskilled worker, semi skilled, Skilled worker; Cat 2: Clerical, Semi professional, Professional; Cat 3: Unemployed
*Normal BMI versus underweight; #Normal BMI versus Obese; @adjusted for all other factors

Table 2: Distribution (%) of BMI and its association with anthropometric measurements and with blood pressure

Variables	BMI categories				Univariate Odds ratios	
	Normal (18·5-22·99) n=263	Underweight (<18·5) n=148	Pre and obese (23·0+) n=174	P@ value	OR 95%CI*	OR 95%CI#
Waist/Hip ratio (cms) (%)						
No risk (<0·9 (M); <0·85 (F)) (n=257)	45·1	39·3	15·6	·001	1·0	1·0
Substantially Increased risk (≥0·90 (M); ≥ 0·85(F)) (n=315)	44·1	14·9	41·0		0·39 (0·25-0·61)	2·69 (1·71-4·26)
Waist circumference (cms) (%)						
Normal (<90(M); < 80 (F)) (n=452)	50·0	31·9	18·1	·001	1·0	1·0
Abnormal (≥90 (M); ≥80 (F)) (n=120)	24·2	3·3	72·5		0·22 (0·05-0·64)	8·27 (4·94-13·99)
Systolic blood pressure (mm Hg) (%)						
Normal (n=259)	49·0	34·4	16·6	·0001	1·0	1·0
Prehypertension (n=282)	44·7	17·0	38·3		0·54(0·34-0·85)	2·53 (1·61-3·99)
Hypertension (n=44)	22·7	25·0	52·3		1·57(0·57-4·30)	6·79 (2·81-17·16)
Diastolic blood pressure (mm Hg) (%)						
Normal (n=326)	46·0	30·7	23·3	·0001	1·0	1·0
Prehypertension (n=199)	48·2	18·6	33·2		0·58 (0·36-0·93)	1·36 (0·87-2·10)
Hypertension (n=60)	28·3	18·3	53·3		0·97 (0·39-2·30)	3·71-1·86-7·58)

*Normal versus underweight, #Normal versus pre-obese/obese, @adjusted for all other factors

Table 3: Multivariate ananlysis of BMI with sociodemographic characteristics, anthropometric measurements and blood pressure

Variables	Multivariate Odds ratios (without lab investigations(n=572)		Multivariate Odds ratios (with lab investigations) (n=178@	
	OR 95%CI*	OR 95%CI#	OR 95%CI*	OR 95%CI#
Sex (%)				
Male (n=279)	1·0	1·0	1·0	1·0
Female (n=306)	2·25 (1·31-3·86)	0·48 (0·27-0·86)	6·46 (1·74-24·06)	0·42 (0·11-1·68)
Age group (years) (%)				
<20 (n=34)	1·0	1·0	1·0	1·0
20-29 (n=138)	0·39 (0·15-1·03)	0·62 (0·19-2·06)	0·52 (0·05-5·73)	0·46 (0·05-4·86)
30-39 (n=136)	0·38 (0·13-1·06)	1·84 (0·53-6·34)	0·12 (0·01-1·79)	1·64 (0·14-19·17)
40-49 (n=107)	0·25 (0·08-0·79)	1·34 (0·38-5·17)	0·04 (0·00-0·87)	0·67 (0·05-9·99)
50-59 (n=68)	0·18 (0·05-0·61)	1·28 (0·33-5·08)	0·09 (0·00-1·75)	4·61 (0·30-70·03)
60-69 (n=66)	0·62 (0·19-2·04)	1·38 (0·34-5·63)	0·29 (0·01-5·92)	0·44 (0·02-8·57)
≥70 (n=36)	0·66 (0·18-2·44)	0·63 (0·11-3·55)	0·27 (0·01-4·90)	0·06 (0·00-4·51)
Education (%)				
Not literate (n=248)	1·0	1·0	1·0	1·0
Primary school or Middle school (n=176)	1·34 (0·78-2·46)	3·46 (1·86-6·44)	0·74 (0·20-2·73)	1·61 (0·40-6·55)
High school (n=84)	0·61 (0·27-1·39)	2·29 (1·00-5·23)	0·47 (0·08-3·01)	2·62 (0·47-14·45)
Above high school, Graduate or PG (n=77)	0·52 (0·20-1·33)	4·87 (2·03-11·70)	0·33 (0·03-3·28)	10·95(1·22-96·3)
Occupation (%)				
Unskilled worker, semi skilled, Skilled worker (n=233)	1·0	1·0	1·0	1·0
Clerical, Semi professional, Professional (n=231)	0·75 (0·44-1·27)	0·79 (0·46-1·36)	0·79 (0·26-2·41)	0·57 (0·18-1·86)
Unemployed (n=121)	0·72 (0·39-1·33)	1·33 (0·63-2·82)	0·56 (0·14-2·27)	1·24 (0·25-6·14)
W/H ratio (cms) (%)				
No risk (<0·9 (M); <0·85 (F)) (n=257)	1·0	1·0	1·0	1·0
Substantially Increased risk (≥0·90 (M); ≥ 0·85(F)) (n=315)	0·42 (0·26-0·67)	1·23 (0·73-2·09)	0·54 (0·20-1·47)	0·47 (0·15-1·51)
Waist circumference (cms) (%)				
Normal (<90(M); < 80 (F)) (n=452)	1·0	1·0	1·0	1·0
Abnormal (≥90 (M); ≥80 (F)) (n=120)	0·20 (0·07-0·62)	12·22 (6·45-23·17)	1·18 (0·17-8·26)	116·5(18·5-733·7)
Systolic blood pressure (mm Hg) (%)				
Normal (n=259)	1·0	1·0	1·0	1·0
Prehypertension (n=282)	0·63 (0·37-1·08)	3·99 (2·18-7·34)	0·37 (0·11-1·23)	3·55 (1·03-12·22)
Hypertension (n=44)	2·90 (0·61-13·73)	3·29(0·72-15·04)	0·40 (0·02-10·18)	6·06(0·10-380·3)
Diastolic blood pressure (mm Hg) (%)				
Normal (n=326)	1·0	1·0	1·0	1·0
Prehypertension (n=199)	0·85 (0·48-1·52)	0·78 (0·44-1·34)	2·02 (0·55-7·43)	1·10 (0·34-3·58)
Hypertension (n=60)	0·66 (0·16-2·64)	1·67 (0·52-5·40)	5·60 (0·24-128·95)	4·57 (0·1-188·6)

*Normal versus underweight, #Normal versus pre-obese/obese, @adjusted for all other factors

The association of BMI and WHR was also found to be statistically significant (P=0·001OR: Normal versus Underweight 0.39 95% CI= 0.25-0.61; OR: normal versus obese 2.69 95% CI= 1.71-4.26). In the abnormal waist circumference (WC) category as high as 72% were preobese/obese (OR: 8·27; 95% CI 4·94-13·99) compared to 18·1% with normal waist circumference (P=0·001).

The prevalence of systolic hypertension (≥ 140mmHg) was 7.5%while diastolic hypertension (≥ 90mmHg) was 10.3%.Both systolic and diastolic blood pressure revealed statistically significant association with BMI categories. Among the systolic hypertensives 52.3% were pre-obese/obese and 16.6% were normotensive. Similar findings were seen among diastolic hypertensives also (53.3% and 23.3%).

Association of BMI with laboratory findings (Table 4): Of the 186 subjects for whom laboratory investigations were done, 16 (8·6%) were found to have fasting blood glucose level of ≥110mg/dl. In the FBS ≥ 110mg/100ml category, 62.5% were pre-obese/obese while 35.9% had FBS <110mg/100ml. Although an OR of 2·13(95% CI 0·62-8·37) was noted, it was not statistically significant. Prevalence of hypertriglyceridemia was 17.7% and abnormal HDL was found in 72.6%. Statistically significant association was observed between fasting triglycerides (P=0·001) and BMI and fasting HDL (P=0·038) and BMI.

Multinomial logistic regression analysis was carried out on 572 subjects to find out independent predictors for underweight and pre-obese/obese subjects. WC or HC (HC) could not be recorded for 13 subjects since 9 subjects were unwilling and 4 subjects had spinal deformities (kyphosis/scoliosis). Variables included for analysis were sex, age group, education, occupation, WC, WHR, systolic , and diastolic blood pressure. Laboratory parameters were available for 186 subjects but 8 of them were excluded for multinomial regression analysis (4 of them due to kyphosis and 4 were not willing to get waist and hip measurements taken) Hence multinomial regression with all laboratory parameters were done for 178 subjects.

Normal BMI versus underweight: The analysis indicated that females were at a higher risk (OR=2·25,0R CI:1·31-3·86) for being underweight after adjusting for all other factors. A lower risk to be underweight was noted in the age group of 40-49 (OR 0·25, 95% CI 0·08-0·79) and 50-59 (OR 0·18, 95%CI 0·05-0·61) years, abnormal WHR (OR 0·42, 95%CI 0·26-0·67) and WC (OR 0·20, 95%CI 0·07-0·62).Although the odds ratio for hypertension among underweight was 2·9, it was not statistically significant (CI 0·61-13·73),(Table 1,2).

Normal BMI versus preobese/obese: Females had a lower risk of obesity (OR 0·48, 95%CI 0·27-0·86), while educated subjects (OR 3·46, 95% CI 1·86-6·44; OR 2·29,95% CI 1·00-5·23; OR 4·87, 95%CI 2·03-11·7), abnormal WC(OR 12·22, 95% CI 6·45-23·1), systolic pre-hypertensives (OR 3·99, 95%CI 2·18-7·34) showed higher risk of pre-obesity/obesity. Although some of the other factors such as substantially increased WHR, systolic and diastolic hypertension showed higher odds ratios, they failed to reveal statistical significance, (Table 1, 2).

Table 4: Distribution (%) of BMI and its association with fasting blood glucose and lipid profile

Variables	BMI categories				Univariate Odds ratios		Multivariate Odds ratios (with lab investigations) (n=178)@	
	Normal (18·5-22·99) n=263	Underweight (<18·5) n=148	Pre and obese (23·0+) n=174	P@ value	OR 95%CI*	OR 95%CI#	OR 95%CI*	OR 95%CI#
Fasting blood glucose (mg/dl) (%)								
<110	38·2	25·9	35·9	·07	1·0	1·0	1·0	1·0
≥110	31·3	6·3	62·5		0·30(0·01-2·80)	2·13 (0·62-8·37)	2·27 (0·10-52·38)	2·05 (0·23-18·55)
Fasting triglycerides (mg/dl) (%)								
Desirable	45·5	26·4	28·1	·0001	1·0	1·0	1·0	1·0
Borderline	21·9	31·3	46·9		2·46 (0·75-8·34)	0·76 (0·33-1·70)	3·41 (0·39-29·45)	3·28 (0·49-22·07)
High	24·2	9·1	66·7		0·64 (0·10-2·94)	4·45 (1·66-12·76)	0·68 (0·11-4·45)	0·40 (0·08-1·94)
HDL cholesterol (mg/dl) (%)								
Normal	31·4	37·3	31·4	·038	1·0	1·0	1·0	1·0
Abnormal	40·0	19·3	40·7		0·41 (0·17-0·99)	1·02 (0·43-2·42)	6·45 (2·04-20·61)	1·87 (0·49-7·07)

Normal ≥40(M), ≥50(F) Abnormal<40(M), <50(F);

*Normal versus underweight, #Normal versus pre-obese/obese; @adjusted for all other factors

DISCUSSION

In this rural area in Karnataka, where both chronic underweight and overweight were equally present, association of BMI with other risk factors for non-communicable diseases has been observed. High BMI is known to be associated with the development of NCDs.[4,5,8]Hence modification of BMI can impact other risk factors which can in turn reduce the burden of NCDs. The proportions of these risk factors were greater amongst pre-obese and obese individuals. As high as one forth individuals were found to have substantially increased risk based on WHR and obesity. Similarly, one in ten individuals had abnormal cholesterol level with obesity.

Preobese/obese representing an extreme of BMI is a preventable risk factor for NCDs.[14]On the other hand, underweight causes reduced physical capacity and economic productivity and poorer reproductive outcomes.[15-16]A study carried out to examine patterns of adult female overweight and underweight in the developing world in urban and rural areas has reported that over 40% of rural Indian women were thin, while prevalence of overweight was nearly 7%.[17] Our study also revealed similar findings (35% women were underweight). Since pre-obese women were combined with obese women in our study, a higher prevalence of 21·9% was noted. The growing concern of increasing rates of obesity and under-nutrition remains a major health problem in India. The present study revealed that the prevalence of risk factors in subject's ≥ 18years of age, for non- communicable diseases in a rural area near Bengaluru was high. Almost one in three persons studied had a BMI≥23 in this population.

The relative percentage of body fat at different BMIs depends on several factors such as urban or rural residence, diet, physical activity, and physiological factors. The WHO expert committee has also opined that a higher percentage of body fat at lower BMI may indicate increased risk of diabetes and cardiovascular disease,[10]hence,recommending lowering the normal/overweight threshold for South East Asian body types to BMI of 23.[3]

Preobese / obese were higher in the middle age groups of 30-50 years. Hence the most productive age groups are also the ones that are most at risk for obesity. Educational status of the subjects seemed to be inversely associated with BMI. Similar findings were reported in other studies in India.[6] The prevalence of preobese/ obese individuals (BMI≥23) was found to be 33·7 and 41·9% among males and females respectively in a study done in rural India in 18 states of the country.[2]In our study 38.4% of males and 21.9% of females and were pre-obese/obese.

Our study findings did not show statistically significant association between occupation and BMI. The possible reason could be that the majority of the population were in labour intensive occupations such as unskilled or semiskilled workers. Nearly one third of the subjects (32·2%) were unemployed in whom BMI was <18·5. Only a small proportion of the people were likely to lead a sedentary lifestyle since 13% were educated beyond high school and the economy in this rural area is based on agriculture and sericulture (silk worm rearing) during which there is moderate to intense physical activity.

Studies have suggested other measurements like WC and WHR be used as screening or diagnostic tools for obesity. WC has been shown to be a better predictor for all-cause mortality as compared to WHR and BMI.[18]In our study, a high proportion of subjects in the pre-obese/obese category had abnormal WC (72.5%) and WHR (41%) respectively.

Although the proportion of subjects with systolic and diastolic hypertension in our study was7.5% and 10.3% respectively, subjects with hypertension in the pre-obese/obese category were 52.3% and 53.3%. A positive association has been observed between BMI and development of hypertension in many epidemiological studies.[14-17]In a study conducted in rural Maharashtra in 2009, the overall prevalence of hypertension in the study subjects was 7·24%.[19]Jajoo et al from Sevagram reported 3·41% prevalence in rural population.[15]In a study in rural India covering 18 states, self reported hypertension (≥140/90) was found to be 19·5% and 21·9% in males and females respectively.[2] This study, further revealed that diabetes (diagnosed as ≥7mmol/L) was prevalent in 6% (95 CI 4·7-7·3) of men and 5·1% (95%CI 3·5-6·8)of women. Although nearly two-thirds of subjects with FBS ≥ 110mg/100ml were pre-obese/obese, we did not find an association between BMI and blood glucose, probably because of the small sample size.

The prevalence of hypertriglyceridemia (≥1·69 mmol/L) was 26·9% and 27·4% in males and females repectively.[2]In a study to assess the prevalence of risk factors for development of type-2 diabetes mellitus among working women in a town in Orissa, India, it was reported that the prevalence of diabetes increased as the BMI increased.[20] In the same study, 92% of those with diabetes/IGT had a WHR of ≥0·85.

Although the eligible subjects in the village were 722, we covered 585 persons (81%) which was more than the required sample size of 559. The age and sex wise distribution of the subjects who could not be covered in the study was similar to those who were covered (P = 0·78).

The leading risk factors for chronic disease globally are raised blood pressure and raised total cholesterol.[21]The same factors have been shown to be associated with BMI in our study also. Obesity has emerged as a serious health problem in association with several risk factors for NCDs such as increased WC, dyslipidemia, increased FBS, and hypertension. The risk factors for NCDs observed in the present study is an indicator to the fact that India will have to tackle the double burden of NCDs and communicable diseases that are already present in the country. Hence awareness about non communicable diseases and its prevention and control needs more attention.

There are attempts towards developing National Programmes for the control of mental illness, cancer, diabetes mellitus, road traffic accidents, cardiovascular diseases in India[22]. The need of the hour is development of a comprehensive package for health promotion for the prevention of non communicable diseases through primary health care in rural, urban, and tribal communities, with a focus on community participation and utilization of available resources.

Conclusion: Obesity, increased waist circumference, dyslipidemia, increased fasting blood glucose and hypertension are serious health problems in rural India also. BMI is associated with several of these risk factors for NCDs. Hence a greater than normal BMI may indicate the presence of other risk factors for NCD in the person. This finding indicates that India has to deal with the double burden of NCDs as well as communicable diseases for which the heath system must be prepared to handle both types of illnesses. It is felt that awareness programmes for the control and prevention of NCDs will be beneficial not only in urban but in rural areas also.

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