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T Kamalaja
Senior Scientist, Foods & Nutrition, AICRP-H.Sc, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad-30, Telangana, India

K Rajeswari
Senior Research Fellow, Foods & Nutrition, AICRP-H.Sc, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad-30, Telangana, India

Corresponding Author:
T Kamalaja
Senior Scientist, Foods & Nutrition, AICRP-H.Sc, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad-30, Telangana, India

Correlation of body mass index to random blood glucose levels of rural population

T Kamalaja and K Rajeswari

Abstract
The present study was aimed to investigate the relationship between BMI and Random Blood Glucose levels of rural population. Three hundred and seventy four rural people in the age group of 20 to 55 years were randomly selected for the study comprising of 80% (299) women and 20% (75) men. The mean age, BMI, RGS, weight and height were 43.5 years, 23 kg/m^2, 134.5 mg/dl, 56kgs and 156.5cms respectively. Majority (59%) of the people were found in normal weight category followed by overweight (21%), underweight (14%) and obese (6%) category as per BMI. The regression test revealed that only the age had a significant impact on random glucose levels where as gender, BMI, height and weight had no significant impact on random glucose levels of rural population.

Keywords: Random blood glucose levels, BMI, rural population, diabetes, pre diabetes

Introduction
Body mass index (BMI) is the measure of body fat based on height and weight of an individual. Body fat is synthesized to simple carbohydrates such as glucose and has associated with increase in lipid biosynthesis (lipogenesis) and hence, an increase in weight (Nelson DL and Cox MM: Lehninger, 2005) [1]. Glucose also synthesizes fatty acid that constitute body fat content. An increase in blood glucose level will result in increase in body weight by increased lipid biosynthesis and hence body weight. It is therefore expected that body mass index can influence blood sugar levels and blood sugar levels with body fatness. A significant association between BMI and blood glucose also supported by several epidemiological studies, that (Nilsen TI, Vatten LJ., 2001) [2] an increase in BMI is generally associated with an increase in risk of metabolic diseases such as diabetes mellitus, hypertension, chronic kidney diseases (Need AG *et al.*, 2005, Nelson DL and Cox MM: Lehninger, 2005 and Ramachandran, A. *et al.*, 1992) [3, 1, 4]. Recent analysis studies also have been revealed that a lot of critical biochemical investigations have an interrelationship between body mass index (BMI) and other parameters like luteinizing hormone (LH) [Pagan YL, *et al*., 2006] [5], serum 25 hydroxyl vit-D in post-menopausal women [Need AG, *et al*., 2005] [3], blood pressure [Kaufman JS, *et al*., 1997] [6], insulin resistance (Sue RW and Sara LA, 1993) and blood sugar levels (Innocent *et al*., 2013) [8]. However, BMI provides misleading information about body fat [C. L'Ab´ee, *et al.*, 2010, A. M. Prentice and S. A. Jebb, 2001] [9, 10] and its clinical interpretation remains controversial [T. J. Cole *et al*., 2000] [11].
National surveys showed that there has been a marked decrease in under nutrition and significant increase in the prevalence of overweight and obesity, more specifically among the urban populations of India (Ramachandran, A *et al*., 1992, Ram, B.S *et al.*, 1997, McKeigue, P.M., *et al.*, 1985 and Singh, R.B. and M.A. Niaz, 1995) [4, 12, 13, 14]. This might led to increase in incidence and prevalence of diabetes and cardiovascular disease in India and is a result of dietary habits and life style. A number of population based studies have also revealed that there is an increased prevalence of diabetes in both rural and urban populations in the world. In 2010, an estimated 140 million people living in Asia had diabetes and globally 60% of the people with diabetes were of Asian population.
There is a scarcity of epidemiological researches that examined the relationship of blood glucose level with BMI of rural population. Therefore the present study was undertaken to determine the correlation between BMI and blood glucose levels particularly in rural populations of India. This will be of importance for the health and nutritional care professionals to give the recommendations in development of policies for the developing countries.

Materials and Methods

Subjects

This is a cross-sectional study carried out to know the relationship between random blood glucose levels and BMI of population living in rural areas. Three hundred and seventy four (374) people in the age group of 20 to 55 years were randomly selected from seven villages of Moinabad mandal, Telangana state.

Blood glucose determination

Random blood glucose levels were estimated using blood glucose monitor i.e. Acc check. The subjects tested for random blood glucose levels were confirmed to not to be taken food in the past 2 hours before the test. The details of age, gender, height, weight of all the subjects were collected to compare the BMI status with Random blood glucose levels.

Body mass index (BMI) estimation

Standard methods were used to measure weight and height [WHO, 1995] [15] of the subjects. Weights were taken to the nearest 0.05kg and height to the nearest 0.05cm. BMI was calculated for each subject using the standard formula; weight/square height (kg/m2).

Body mass index (BMI) principal cut off of points for Asian adults were used to define overweight and obesity [WHO, 2004]. According to which BMI from 18.50 to 24.99 is normal range, ≥25.00 or 25.00 to 29.00 is overweight or pre obese. Obesity is further classified as obese class I (BMI = 30.00-34.99), obesity class II (BMI = 35.00 -39.99) and obesity class 3 (BMI ≥ 40).

Statistics

Means and standard deviations were calculated for each variable using descriptive statistics. The Regression and Pearson's correlation coefficient tests were used to analyze data and level of significance between BMI and RGL. All statistical analyses were performed using SPSS.

Results

A total of 374 participants living in rural areas and over the age of 20 years formed the study population. The study population comprised of 80% (299) women and 20% (75) men. Table 1 depicts the mean ±SD of the study population. Means were found to be 43.5 years for age, 23 kg/m^2 for BMI, 134.5 mg/dl for RBS, 56 kg for weight and 156.5cms for height of total population. Majority of the study population were belong to 21-30 years (38%) followed by > 51 years (27%), 31-40 years (18%) and 41-50 years (17%) (Table 2).

Table 1: Mean Values of rural population (n= 374)

Variable	Mean ± SD		
	Female	Male	Total population
Mean age (years)	39	48	43.5
Mean weight (kg)	53	59	56
Mean height (cm)	152	161	156.5
Mean BMI (kg/m^2)	23	23	23
Mean Random Blood sugar level (RBS) (mg/dl)	130	139	134.5

Table 2: Prevalence of diabetes and pre diabetes in study population as per RBG levels (n= 374)

Health status	Female	Male	Grand Total
Diabetes	64 (21.4)	24 (32)	88 (24)
Normal	212 (76.0)	45 (60)	257 (68)
Pre diabetes	23 (7.6)	6 (8)	29 (8)
Grand Total	299 (80)	75 (20)	374 (100)

Majority of the study population (68%) were identified as normal as per random blood glucose levels test. The prevalence of diabetes and pre diabetes was 24% and 8% respectively in the study population with more pronounced in female than male population (Table 2). King *et al*., 1998 [17] also revealed that Worldwide there are more women than men with diabetes, especially in developed countries. The sedentary life style has profound effect on blood glucose levels (Zaman *et al*., 2016) [18]. Moreover, there are different hormonal and metabolic circumstances in male and female groups too. According to American Diabetic Association 2017, food intake, physical activity, disease condition, medication, stress hormonal condition, dehydration may also contributory key factors that affect the individual's fasting blood glucose levels.

Table 3 shows that majority (59%) of the subjects were found in normal weight category followed by overweight (21%), underweight category (14%) and obese (6%). The prevalence of overweight, obesity and underweight was higher in females than males.

Table 3: Mean Random blood glucose levels (mg/dl) of the subjects as per BMI classification (n= 374)

BMI classification (weight (kg)/m^2)	Female		Male		Total population	
	Number (%)	RGL (Mean ± SD)	Number (%)	RGL (Mean ± SD)	Number (%)	RGL (Mean ± SD)
Normal weight	178 (59.5)	129±67.5	44 (58.7)	126±11.7	222 (59.0)	128 ±47.5
Obese	18 (6.0)	146±37.1	3 (4.0)	117±28.4	21 (6)	142±68.2
Over weight	62 (4.0)	138±22.2	15 (20.0)	152±18.8	77 (21.0)	140±65.4
Under weight	41 (13.5)	125±17.3	13 (17.3)	175±69.3	54 (14.0)	137±60.8

The subjects with blood glucose levels of 130-140mg/dl and ≥140 termed as pre-diabetics and diabetics respectively. In the present study the mean random blood glucose levels of the population according to BMI revealed that higher mean blood glucose levels were found in obese (142mg/dl), overweight (140mg/dl) and underweight (137mg/dl) subjects compared to normal weight subjects (128mg/dl). In female group, only obese and overweight subjects had higher blood glucose levels with 146 mg/dl and 138 mg/dl respectively whereas in male group over weight and underweight subjects had higher blood glucose levels with 152 mg/dl and 175 mg/

Table 4: Mean Random blood glucose levels (mg/dl) of the subjects as per age group (n= 374)

Age group (Years)	Female		Male		Total population	
	Number (%)	RGL (Mean ± SD)	Number (%)	RGL (Mean ± SD)	Number (%)	RGL (Mean ± SD)
21-30	124 (41.0)	114±28.6	19 (25.0)	122±57.1	143 (38.0)	115±57.3

31-40	56 (19.0)	129±37.3	11 (15.0)	143±62.9	67 (18.0)	131±27.3
41-50	54 (18.0)	133±54.5	10 (13.0)	145±47.4	64 (17.0)	143±67.3
≥51	65 (22.0)	153±39.2	35 (47.0)	150±33.3	100 (27.0)	152±47.3

Table 4 revealed that the mean random blood glucose levels were increased with increase in age group in both female and male groups. In males pre diabetic indicated random blood glucose levels were observed from 31-40 year's age group and in females from 41-50 years age group. At >51 years, random blood glucose levels were observed at diabetic stage in both genders. In developing countries, the majority of people with diabetes are in the age range of 45-64 years (King *et al*., 1998) [17]. The mean random blood sugar levels are high in males than females with increase in age group. The results are in accordance with a study by Onyesom Innocent *et al*, 2013 [8]. The study revealed that as the age group increases that is, from 16-20 to 21-25 and then to 26-30 years, BMI and blood glucose levels (BGL) showed a corresponding increase for both male and female subjects although values were proportionately higher for the female subjects.

Table 5: Prevalence of pre-diabetes and diabetes in the subjects as per BMI (n= 374)

Category	Normal weight		Obese		Over weight		Under weight	
	Female	Male	Female	Male	Female	Male	Female	Male
Diabetes	38 (10)	11 (3)	4 (1)	1 (0)	15 (4)	6 (2)	7 (2)	6 (2)
Normal	126 (34)	29 (8)	14 (4)	2 (1)	38 (10)	7 (2)	34 (9)	7 (2)
Pre-diabetes	14 (4)	4 (1)	0 (0)	0 (0)	9 (2)	2 (1)	0 (0)	0 (0)
Grand Total	178 (48)	44 (12)	18 (5)	3 (1)	62 (16)	15 (4)	41 (11)	13 (3)

The prevalence of pre diabetes and diabetes as per BMI status of population was presented in Table 5. The results revealed that the percentage of population with diabetes and pre diabetes were found in all types of population irrespective of BMI status i.e. with normal weight, obese, over weight and underweight. Even though the prevalence is more pronounced in normal weight category people (10%, female and 3%, males- diabetes and 4% females and 1%, males-Pre diabetes) compared to obese, over weight and underweight categories of population. These results indicated that there was no association found between BMI and diabetes and pre diabetes status in the rural population. Even though diabetes is the condition may resulted from combination of many reasons like dietary habits, regular foods consumed, less physical activity levels sedentary life style and personnel habits like smoking, alcohol consumption etc. that could have influence on blood glucose levels.

Table 6: Prevalence of pre-diabetes and diabetes in the subjects as per age group (n= 374)

Age group	Diabetes		Normal		Pre diabetes		Grand Total
	Female	Male	Female	Male	Female	Male	
>51 years	27 (7)	15 (4)	34 (9)	16 (4)	4 (1)	4 (1)	100 (27)
21-30 years	10 (3)	2 (1)	107 (29)	17 (5)	7 (2)	0 (0)	143 (38)
31-40 years	9 (2)	2 (1)	40 (11)	7 (2)	7 (2)	2 (0.5)	67 (18)
41-50 years	18 (5)	5 (1)	31 (8)	5 (1)	5 (1)	0 (0)	64 (17)
Grand Total	64 (17)	24 (6)	212 (57)	45 (12)	23 (6)	6 (2)	374 (100)

The age wise distribution of diabetes and pre diabetes subjects in the selected rural population is presented in Table 6. The results depict that diabetes was highly prevalent in the population with >51yaers age group (11%) followed by 41-50yaers age group (6%). Lesser percentage (6%) of Pre diabetes population was found with more prevalent in females at the age group of 31-40 years age group (2%) and 41-50 years age group (2%).

Table 7: Regression to know the impact of independent variables (age, gender, BMI, Height and weight) on dependent variable Random blood glucose level (n= 374)

Mode	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta	B	Std. Error
(Constant)	107.762	167.874		.642	.521
Age	.995	.186	.279	5.342	.000
Gender	2.301	8.119	.017	.283	.777
BMI	1.024	3.075	.096	.333	.739
Height	-.145	1.123	-.022	-.129	.897
Weight	-.356	1.348	-.084	-.264	.792

a Dependent Variable: RGL

Table 7 revealed that only age had a significant impact on random glucose level. Other variables such as gender, BMI, height and weight had no significant impact on random glucose levels.

Table 8: Correlation Coefficient (p) between BMI, Height, Weight and random blood glucose levels (n= 374)

	Age	Gender	RGL	BMI	Height	Weight
Age	1	.244(**)	.285(**)	.013	-.029	.003
Gender	.244(**)	1	.061	.004	.426(**)	.183(**)
RGL	.285(**)	.061	1	.029	-.065	-.007
BMI	.013	.004	.029	1	-.064	.860(**)
Height	-.029	.426(**)	-.065	-.064	1	.428(**)
Weight	.003	.183(**)	-.007	.860(**)	.428(**)	1

** Correlation is significant at the 0.01 level (2-tailed).

Correlation analysis revealed that (Table 8) only age had significant (.285, ($p<0.01$)) impact with random glucose levels, which was proven by the present study results that the mean random blood glucose levels were increased with age in both genders.

Gender (.061) and BMI (0.29) was also positively correlated with random blood glucose levels but not at significant level. The results are supported with Janghorban *et al*., 1991 and Innocent *et al*., 2013 [8] and Dowlings and Pi-sunyer, 1993 study results which showed a positive but not significant correlation between random blood sugar levels with BMI. This could also support with Racial and other biological factors, as the present study is carried in rural population of India whose dietary habits and physical activity pattern are quiet differed with urban population.

BMI (.860 ($p<0.01$)), and height (.428, ($p<0.01$)) had positive significant correlation with weight whereas height was negatively correlated with BMI. Body weight is positively

and significantly correlated with BMI (.860, p<0.01), gender (.183, p<0.01), and height (.428, p<0.01). Gender had a significant correlation with age (.244, p<0.01), height (.420, p<0.01) and weight (.183, p<0.01) but not with RGL and BMI. Weight is significantly correlated with gender (.183 (p<0.01)), BMI (.860 (p<0.01)), and height (.428, (p<0.01)).

Conclusion

In the present study, though it was not a significant, a positive correlation was observed between random blood glucose levels and BMI in rural population. The food habits, intensive lifestyle modifications and regular exercise may prevent the onset of diabetes and pre diabetes. However, prevalence of diabetes and predicates was observed in study population as per random blood glucose levels of both genders. Random Blood Glucose levels were found at diabetic stage in obese and overweight category females whereas over weight and underweight male population. The study clearly indicated that the Random Blood Glucose levels were increased with increase in age group of both genders.

The present study concluded by stating a point that since it was a cross sectional study, a cohort based study is desirable for scrutinizing the intensified relationship between Random Blood Glucose levels and BMI status. The present study was carried out in certain group of rural population from whom the results cannot be generalized to other study subjects especially to urban population. Hence, this type of studies can be implemented in a large and varietal group of populations for strengthening the outcome.

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