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Comparison of Random Blood Sugar Level between Obese and Non-obese Individual and its Association with Obesity Indicators

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ABSTRACT

Background: Obesity is a primary cause of non-communicable diseases, including diabetes mellitus. Early detection of elevated blood sugar levels (hyperglycemia) is essential for preventing diabetes and reducing undiagnosed cases. This study compares random blood sugar levels between obese and non-obese individuals and assesses the association of random blood sugar with obesity indicators and selected variables.

Methods: A cross-sectional study used consecutive sampling. 136 samples were selected, comprising 68 obese and 68 non-obese individuals. Random blood sugar (RBS) and anthropometric measurements were taken using a glucometer (On-call advance), non-stretchable measuring tape (GDMINLO), and weighing machine (LARS-MS810). Chi-square, t-test and spearman correlation tests analyzed associations. ROC curves predicted obesity indicators for hyperglycemia (RBS≥140mg/dl).

Results: Mean± S.D of RBS among obese individuals was (120.6±33.7) mg/dl, and among non-obese, it was (118.9±34.5) mg/dl, with no significant difference (P-value 0.272). Family history of chronic illness had a significant positive association with RBS among obese individuals (P-value 0.01). Waist-hip ratio was a better predictor of hyperglycemia (P-value 0.02, AUC- 0.661), followed by waist circumference (P-value 0.01, AUC 0.648).

Conclusions: RBS levels do not significantly differ between obese and non-obese individuals. However, RBS is associated with a family history of chronic illness, and the waist-hip ratio is the best predictor of hyperglycemia. Screening camps utilizing cost-effective methods like waist-hip ratio and waist circumference should be conducted for early diabetes detection.

Keywords: *Obese and non-obese individuals, Obesity indicators, Random blood sugar*

INTRODUCTION

Diabetes is one of the fastest growing global health emergencies of the 21st century. As per International diabetic fedriation in 2019, it is estimated that 463 million people have diabetes and this number is projected to reach 578 million by 2030, and 700 million by 2045. Over four million people aged 20–79 years are estimated to die from diabetes-related causes in 2019.[1]

According to Non-communicable disease risk: steps survey of Nepal 2019 prevalence of obesity in Nepal is 4.3% while prevalence of raised blood sugar in Nepal is 5.8.[2] NDHS (National demographic health Survey) report of Nepal 2022 shows 26% of adult are overweight while 8% of women and 6% of men are obese.[3] Obesity and over weight is a significant risk factor for cardiovascular disease, the leading cause of death in Nepal, It can increase risk for high blood pressure, heart attack, strokes along with type 2 diabetes and some type of cancer including breast, colon and endometrial.[4]

In most instances harmful impact of obesity was revealed by measuring level of blood glucose.[3] Early identification of hyperglycemia is critical for the prevention of diabetes as well as reduction of undiagnosed cases. Given the logistical challenges of measuring fasting blood sugar at the community level, capillary random blood sugar serves as a practical alternative.

While BMI is commonly linked to blood sugar levels, notably there is a scarcity of studies which explore the relationship between random blood sugar levels and obesity indicators (waist circumference, hip circumference, and waist-hip ratio) within our context. Thus, this study aims to compare random blood sugar levels between obese and non-obese individuals, exploring associations with various obesity indicators and socio-demographic variables simultaneously it helps in screening for increased blood sugar.

METHODS

A cross-sectional study which was comparative in nature was conducted in selected ward of Dharan sub-metropolitian city of Sunsari district of eastern Nepal suited in Khosi Province. The study was conducted after ethical clearance from Institution Review Committee (IRC) of BPKIHS. Permission was taken from ward office. Before data collection, all respondents were informed about the study's purpose and significance and written informed consent was taken from each participant. Participants were interviewed and observation was done they were informed of their right to participate, refuse or withdraw from the study at any time and were assured that their data would be kept private and confidential. Individuals whose RBS was found greater than 200mg/dl were advised to go hospital for check-up of diabetes mellitus and obese individuals were advised to decrease weight. Information is used for study purpose and publication only. Study Population consists of individual aged between (30-60) years because hyperglycemia is mostly seen in 45 years over age group and increasing number of cases in younger people. American diabetic association recommended for screening above 45 years of age. Study sample were collected by consecutive sampling technique by selecting sample door to door consecutively meeting inclusive criteria matched with age and sex in obese and non- obese until sample size was achieved.

Inclusion criteria: For obese individual are: Obese BMI ≥ 27 kg/m^2 (Asian criteria of obesity), age group 30-60 years irrespective of sex. For non-obese: BMI 18-26.9 Kg/m^2, age group 30-60 years irrespective of sex.

Exclusion criteria (for both obese and non-obese): People suffering from endocrine, metabolic disorder e.g diabetes mellitus (known cases), hypothyroidism or hyperthyroidism (known cases), pregnant women.

In this study sample size consist of 136 (68 obese and 68 non-obese individuals) based on previous study conducted by Ranadip Mukherjee et.al. (2018)[4]

Research Instruments consist of part 1: Socio-demographic information, part 2: Anthropometric measurement: Weight was measured by weighing machine nearest to 0.5kg with model number: LARS-MS810. Height was measured to the nearest 0.5 cm using a non-stretchable tape measure (GDMINLO). Part 3: Random blood glucose measurement was done by a glucometer (On-call Advance). The On-call Advance glucometer is ISO 15197:2003 certified. Descriptive statistics such as frequency, percentage, mean and standard deviation was used to describe the variable socio-demographic variable. Inferential statistics such as chi-square test, independent t test and spearman correlation test were used to find out the association between variables ROC (Receiver operating curve) was to identify obesity indicator for prediction of hyperglycemia.

RESULTS

Table 1: Association of socio-demographic variables and RBS level among obese and non-obese individuals n=136

Socio-demographic characteristic	Obese RBS			Non-obese RBS		
Age in completed years	**<140 mg/dl n(%)**	**≥140 mg/dl n(%)**	**P value**	**<140 mg/dl n(%)**	**≥140 mg/dl n(%)**	**P value**
<45 years	43(63.2)	10(14.7)	0.233	47(69.1)	6(8.8)	0.138
≥45 years	10(14.7)	5 (7.4)		11(16.2)	4(5.9)	
Gender						
Male	8(11.8)	2(2.9)	0.865	9(13.2)	1(1.5)	0.649
Female	45(66.2)	13(19.1)		49(72.1)	9(13.2)	
Religion						
Hindu	36(52.9)	11(16.2)	0.689	45(66.2)	7(10.3)	0.601
Others	17(25)	4(5.9)		13(19.1)	3(4.4)	
Ethnicity						
Disadvantaged janajatis	33(48.5)	10(14.7)	0.755	24(35.2)	5(7.4)	0.611
Others	20(29.4)	5(7.4)		34(50.0)	5(7.4)	
Occupation						
Homemaker	27(39.7)	9(13.2)	0.535	40(58.8)	7(10.3)	0.948
Others	26(38.3)	1(8.8)		18(26.5)	3(4.4)	
Socio-economic status						
<1.9USD/day	34(50.0)	13(19.2)	0.096	45(66.2)	6(8.8)	0.236
>1.9USD/day	19(27.9)	2(2.9)		13(19.1)	4(5.9)	
Marital status						
Married	50(73.5)	14(20.6)	1.000[f]	57(57.1)	10(14.7)	1.000[f]
Others	3 (4.4)	1 (1.5)		1(1.5)	0(0)	
Family history of chronic illness						
Hypertension	8(20.5)	5(12.8)	**0.01[f]**	8(26.7)	3(10.0)	0.316[f]
Diabetes	11(28.2)	0(0)		7(23.3)	0(0)	
Others	14(35.9)	1(2.6)		10(33.3)	2(6.7)	

**f= Fisher exact test.*

Chi- square test was calculated to association if socio-demographic variable with RBS .Table-1 depicts family history of chronic illness showed significant association of RBS among obese individuals (P-value 0.01) whereas there was no significant association of other socio-demographic variables with RBS among both obese and non-obese individuals.

Table 2: Association of cigarette smoking habit and random blood sugar level among obese and non-obese individuals
n=136

Smoking habit	**Obese**			**Non-obese**		
	RBS			**RBS**		
Current smoking	**<140 mg/dl n(%)**	**≥140 mg/dl n(%)**	**P value**	**<140 mg/dl n(%)**	**≥140 mg/dl n(%)**	**P value**
Yes	7(10.3)	2(2.9)	0.990	4(5.9)	0(0)	1.000[f]
No	46(67.6)	13(19.2)		54(79.4)	10(14.7)	
Duration of smoking						
<10 years	8(25.8)	3(9.7)	0.317[f]	13(54.2)	0(0)	0.458[f]
≥10 years	17(54.8)	3(9.7)		10(41.6)	1(4.2)	
Past history of smoking						
Yes	9(15.3)	6(10.2)		7(10.9)	4(6.3)	
No	37(62.7)	7(11.8)	**0.052**	47(73.4)	6(9.4)	**0.037**
No. of years ago quit smoking						
<10 years	3(25.0)	1(8.3)		4(44.4)	1(11.1)	
≥10 years	5(41.7)	3(25)	1.000[f]	3(33.2)	1(11.1)	1.000[f]

**f= Fisher exact test.*

Chi- square test was calculated to association of smoking habit with RBS .Table 2 depicts few obese individuals (11.9%) with no past history of smoking had RBS ≥ 140 mg/dl in contrast to non-obese individuals (9.4%) with no past history of smoking. There was significant association between the past history of smoking and RBS among both obese and non-obese individuals (P-value 0.05, 0.03).

Table 3: Association of alcohol intake habit and random blood sugar level among obese and non-obese individuals
n=136

Socio-demographic characteristic	**Obese**			**Non-obese**		
	RBS			**RBS**		
Currently drinking alcohol	**<140 mg/dl n(%)**	**≥140 mg/dl n(%)**	**P-value**	**<140 mg/dl n(%)**	**≥140mg/dl n(%)**	**P-value**
Yes	26(38.2)	6(8.8)	0.535	22(32.4)	2(2.9)	0.273
No	27(39.6)	9(13.2)		36(52.9)	8(11.8)	
Duration of alcohol drinking						
<20years	18(56.3)	4(12.5)	1.000[f]	15(62.5)	1(4.2)	1.000[f]
≥20 years	8(25.0)	2(6.2)		7(29.1)	1(4.2)	
Past history of alcohol drinking						
Yes	10(27.9)	4(11.4)	0.693	7(15.9)	2(4.5)	0.725
No	17(47.3)	5(13.9)		29(65.9)	6(13.7)	

f= fisher exact test

Chi- square test was calculated to association of alcohol intake with RBS. Table 3 shows there was no significant association between alcohol intake and RBS among obese and non-obese individuals.

Table 4: Comparison of RBS level between obese and non-obese individuals n=136

RBS	Obese (%)	Non-obese (%)	P-value
<140 mg/dl	53(39%)	58(42.6%)	0.272
≥140 mg/dl	15(11%)	10 (7.4%)	
Mean±S.D	(120.6±33.7)mg/dl	Mean±S.D (118.9±34.5) mg/dl	

P-value was calculated via independent t- test.

Table 4 depicts some obese individuals (11%) had RBS ≥ 140 mg/dl compared to a few non-obese individuals (7.4%). The mean RBS among obese was 120.6±33.7 mg/dl, while the mean RBS among non-obese was 118.9±34.5 mg/dl. There was no significant association between random blood sugar levels among obese and non-obese individuals (P-value 0.27).

Table 5: Correlation of random blood sugar with obesity indicators

Obesity indicators	RBS	
	Correlation coefficient(r_s)	P value
Weight	0.147	0.087
Waist circumference	0.229	**0.007**
Hip circumference	0.155	0.071
Waist hip ratio	0.251	**0.003**
Body mass index	0.127	0.140

Spearman correlation was used to show association of RBS with obesity indicators. Table-5 shows there was significant positive correlation of RBS with waist circumference and waist-hip ratio (P-value0.007, 0.003), whereas no significant correlation of RBS with weight, hip circumference, and body mass index|.

Table 6: Obesity indicators for the prediction of hyperglycemia (RBS≥140mg/dl)

Obesity indicators	Area under curve (95% CI)	P- value	Cut-off point	Specificity	Sensitivity
Weight	0.587	0.173	60.5	72%	55.9%
Waist circumference	0.648	**0.021**	88.5	88%	73%
Hip circumference	0.579	0.218	94.5	84%	79.3%
Waist hip ratio	0.661	**0.012**	0.93	80%	61.3%
Body mass Index	0.590	0.162	25.65	84%	66.7%

ROC (Receiver Operating Characteristic) curve was used for prediction of hyperglycemia. Comparing all of the above obesity indicators (Table-6), the waist-hip ratio in ROC curve with significant P-value 0.02 had an area under the curve of 0.661, with the cutoff being 0.93 at specificity of 80% and sensitivity of 61.3%, making it the best predictor of hyperglycemia, followed by waist circumference with P-value 0.01, area under the curve of 0.648 and a cutoff of 88.5 cm, specificity of 88%, and sensitivity of 73%.

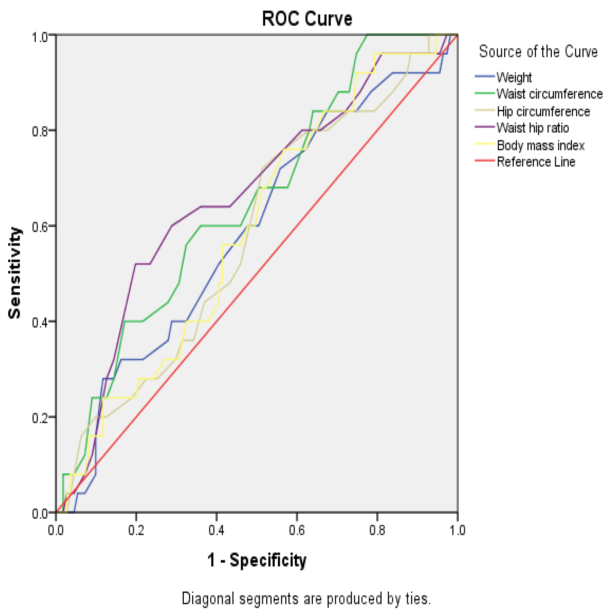

Figure 1: Receiver operating curve (ROC) of obesity indicators for prediction of hyperglycemia.

When comparing obesity indicators in the ROC curve (Figure 1), waist-hip ratio had a greater area under the curve followed by waist circumference; thus, waist-hip ratio was better predictor of hyperglycemia followed by waist circumference.

DISCUSSION

The socio-demographic profile of this study illustrates that 3/4th of obese individuals belonged to the 30-40 years age group. Rekha Timalsina (2017) conducted a cross-sectional study in Kathmandu where the maximum overweight and obese individuals belonged to the ≥50 years age group, which is contradictory to the findings of this study.[6] The Non-communicable Disease Risk Factors: STEPS survey of Nepal 2019 has also shown that obesity and overweight are high among individuals aged 40-54 years at the national level, which is in contrast to the findings of the present study.[2]

In present study majority of obese individuals were female (85.3%) this may be due to, high prevalence of obesity in females at national level (5.3%) as indicated by Non-communicable disease risk factors: STEPS survey of Nepal 2019.[6]Study conducted by Rekha Timalsina (2017) in Kathmandu where obese female 66.7% which is lower than present study.[6]

This study illustrates that more than half of the obese individuals belonged to disadvantaged Janajatis, which include Tamang, Rai, Limbu, and Sherpa. In Dharan, there is a maximum population of Rai, Limbu, and Marwadi communities. Shraddha Adhikari (2020) conducted a cross-sectional study in Chitwan where 22.9% of the obese and 41.7% of the overweight individuals belonged to ethnicities other than Brahmin/Chhetri, which is similar to the findings of this study.[5] Additionally, more than half of the obese individuals were Hindu. This may be attributed to the fact that around 82% of the population in Nepal is Hindu, according to the Central Bureau of Statistics 2011 AD.

In the present study, more than half of the obese individuals (69.1%) are homemakers. Similar findings were shown in a study conducted by Rekha Timalsina (2017), where the majority of overweight and obese individuals (61.1%) were homemakers.[6]

Some obese individuals (14.7%) and non-obese individuals (8.8%) aged <45 years had RBS ≥140 mg/dl. There was no significant association of RBS with age among both obese and non-obese individuals. A similar study was conducted in Korea by Hang-Me Nam et al., in which 43.6% of obese individuals and 20.1% of normal-weight individuals had impaired fasting glucose, which is higher than the findings of this study.[8] Additionally, there was no significant association of impaired fasting glucose level with age among obese and normal-weight individuals. A prospective observational study conducted in India by Rajesh Venkataraman (2018) showed a positive correlation between age and RBS at a significance level of 0.01, which is contradictory to the findings of the present study.[9]

The present study illustrates that among participants with RBS ≥140 mg/dl, most of them are obese females (19.1%) and non-obese females (13.2%). There was no significant association of RBS with sex in both obese and non-obese individuals. A similar study was conducted in Korea by Hang-Me Nam et al., in which the majority of obese males (33.3%) and 20.2% of normal-weight males had impaired fasting glucose, which is contradictory to the findings of this study. Additionally, there was no significant association of impaired fasting glucose with sex among obese and normal-weight individuals.[8] Prospective observational study done in India by Rajesh Venkataraman (2018) showed positive correlation between gender and RBS at 0.01 significance level which is contrast to the present study.[9]

“Homemakers comprise a higher percentage in both obese and non-obese individuals with RBS ≥140 mg/dl, as the study includes more than three-quarters of females who are mostly homemakers. The prevalence of raised blood sugar level among obese individuals is 5.3%, according to the STEP survey 2019.

There was no significant association of ethnicity, occupation and socio-economic status with RBS among both obese and non-obese individuals this is consistent with study done in Venezuela by Valmore Bermudez et al.[10] but different from the study done in India by Rajesh Venkataraman (2018) where there is positive correlation of occupation and income with RBS.[9]

There was significant association of family history of chronic illness and RBS among obese (p=0.01) individuals which is contradictory to study conducted in India by Vanitha S S (2017) where there was no significant association of family history of diabetes and RBS.[11] However, a study by Shankar Radhakrishnann (2015) in Tamil Nadu, India, shows a significant association between family history of diabetes and RBS category.[12]

There was a significant association between past history of cigarette smoking and RBS among both obese (p=0.05) and non-obese (p=0.03) individuals. A cross-sectional study conducted in Italy by Maria Masulli et al. showed a significant association of cigarette smoking and blood glucose among overweight individuals, which is consistent with the findings of the present study.[13]

There was no significant association of current cigarette smoking habit and alcohol intake with RBS which is similar to study conducted in south India by Setharam K (2019).[7,14]

The present study illustrates that 11% of obese individuals and 7.4% of non-obese individuals have RBS ≥140 mg/dl. The mean RBS among obese individuals was 120.65±33.74, while among non-obese individuals, it was 118.9±34.46. There was no significant difference (p-value 0.272) in RBS between obese and non-obese individuals. Mohammad Faheem (2010) conducted a similar study in Pakistan where the RBS among obese individuals was 120.37±53.87, which is similar to the present study. However, the RBS among normal-weight individuals was 107.82±41.65, which is lower than in this study. There was a significant association of RBS with BMI groups, which is contradictory to the present study. Another study in India by Vanitha S S (2017) shows no significant association between RBS and BMI category, which is similar to the present study.[23]The study conducted by Neeti Singh (2019) in Chandragiri, Kathmandu shows no significant association of RBS with BMI.[16]

There was a positive correlation of RBS with waist circumference (rs=0.229, p=0.007) and waist hip ratio (rs=0.251, p=0.003). Contradictory results were shown in a study conducted in Andhra Pradesh, India, by Harshal Gajanan Mendhe (2016), where there was no correlation of RBS with waist circumference and waist hip ratio. Other obesity indicators like weight, hip circumference, and BMI showed no correlation with RBS in the present study, which is similar to the findings of the study by Harshal Gajanan Mendhe (2016).[21] The study by Sunil K. Yadav (2018) in Kathmandu, Nepal, showed a positive correlation of random blood glucose with BMI sand waist circumference at a significance level of 0.01.[22]

Upon further analysis of the ROC curve, the present study shows that waist hip ratio (area under curve=0.661) is the most significant predictor of hyperglycemia, with a cutoff of 0.93 at a specificity of 80% and sensitivity of 61.3%. This is followed by waist circumference (area under curve=0.648) with a cutoff of 88.5 cm, specificity of 88%, and sensitivity of 73%. These findings are similar to a study conducted in Kavre, Nepal, by Shah (2009), where waist circumference and waist hip ratio were identified as the best predictors of type 2 diabetes mellitus in both male and female populations.[19] similar finding was shown in study conducted Uttar Pradesh India by N Rai (2021) Similar findings were also shown in a study conducted in Uttar Pradesh, India, by N Rai (2021), where waist circumference predicted hyperglycemia with a cutoff of 93.50 cm in females (sensitivity=83.3%, specificity=66%) and in males with a cutoff of 83.5 cm (sensitivity=100%, specificity=29.4%).[20] Result could not be generalized as consecutive sampling was used.

CONCLUSIONS

Obesity is regarded as an independent factor for the rise in blood sugar levels, but this study shows that there was no difference in RBS levels between obese and non-obese individuals. The statistical data of this study provides evidence that a family history of chronic illness and a past history of smoking are associated with an increase in blood sugar levels. This study also illustrates that with the rise in waist circumference and waist-hip ratio, there is also a rise in blood sugar levels and vice versa. Further analysis showed that waist-hip ratio and waist circumference can be used to predict an increase in blood sugar levels, which is a cost-effective, simple, and non-invasive method.

RECOMMENDATIONS

Future research involving longitudinal studies to examine how change in obesity indices over tine influence RBS level. Screening camp that focus on cost-effective, simple and non-invasive methods like waist hip ratio and waist circumference should be conducted for the detection of diabetes in early stage. Awareness camp for the prevention of diabetes should be conducted.

CONFLICT OF INTEREST

None

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