

Original Research Article

Abdominal obesity as a risk factor for stroke in Abuja, Nigeria

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ABSTRACT

Background: Obesity in Africa has remained a public health concern, which is been fueled by urbanization and its attendant lifestyle changes which includes less energy demanding jobs, sedentary lifestyle and adopting detrimental western eating habits. There are well established risk factors for stroke, however the association of obesity with that of stroke is less clear.

Methods: This study was designed to determine whether abdominal obesity is independently associated with an increased risk of ischaemic stroke. It is a case control study of 113 patients in which structured questionnaire was administered to consecutive patients admitted into the medical wards. The controls were matched for age and sex from a database with participants of the population-based cohort study. Statistical analysis of data was performed using SAS software (SAS Institute) 9.4.

Results: In the study 85% of the patients had hypertension, 50.5% had hypercholesterolemia and 33.6% had diabetes. The BMI was normal for most of the cases (23.3% vs. 76.7% $p < 0.0001$) while the WHR was increased for most of the cases (70.9% vs. 29.1% $p < 0.0001$). The statistical significance shows that WHR was more sensitive in assessing obesity than BMI. The logistic regression analysis, in model 1 unadjusted and model 2 adjusted for sex and age, BMI showed a positive association with risk of stroke (OR 1.10; 95% CI, 1.04-1.17; $p = 0.002$) this association lost its significance in model 3 after adjusting for diabetes, hypertension and hypercholesterolemia (OR 1.04; 95% CI, 0.96-1.13; $p = 0.3751$). The results of logistic regression analysis for WHR for model 1, model 2 and model 3 did not show any significance before and after adjustment.

Conclusions: Abdominal obesity may increase the risk of ischemic stroke through conventional vascular risk factors, but not as an independent risk factor.

Keywords: Obesity, Stroke, Risk factor

INTRODUCTION

Obesity has continued to play a significant role in the public health space. The prevalence of overweight or obesity in Africa has remained a public health concern, which is been fueled by urbanization and its attendant lifestyle changes which includes less energy demanding jobs, sedentary lifestyle and adopting detrimental western eating habits. Overweight is seen as a disorder of energy metabolism involving excess adipose tissue stored, can be

described as the imbalance between energy intake and expenditure such that energy is stored in fat cells.¹ Several classifications and definitions of obesity are available but the commonly adopted is the definition by the world health organization (WHO), which defines obesity as a body mass index (BMI) of 30 kg/m² or more.² A systematic review showed that the prevalence of overweight and obesity in Nigeria ranged from 20.3%-35.1%, and 8.1%-22.2%, respectively.³ Stroke is the rapidly developing loss of brain functions due to a disturbance in the cerebral blood vessels. Despite

information on the risk factors, stroke still remains a neglected disease in Nigeria, as well as specific diagnosis and treatment in the hospitals.³ There are well established risk factors for stroke, such as increased blood pressure, increased blood cholesterol, cigarette smoking, carotid stenosis, diabetes mellitus, atrial fibrillation and valvular heart disease. The association between obesity with many diseases such as type 2 diabetes mellitus, hypertension, dyslipidemia, gall bladder disease, respiratory disease, sleep apnea, and cancer has been well recognized.⁴⁻⁶ Furthermore even though the association of obesity with coronary heart disease and myocardial infarction is well recognized, that of stroke is less clear.⁷⁻¹⁰

The world health organization (WHO) guidelines state that alternative measures that reflect abdominal obesity such as WC, WHR, and waist-to-height ratio (WHtR) have been found to be superior to BMI.¹¹ Previous studies have demonstrated that abdominal obesity which is measured by waist-to-hip ratio (WHR) is more strongly associated with cardiovascular risk than body mass index (BMI).^{12,13} The WHO states that abdominal obesity is defined as a waist-hip ratio above 0.90 for males and above 0.85 for females.¹¹ The purpose of this study was to determine whether abdominal obesity is independently associated with an increased risk of ischaemic stroke among the patients.

METHODS

Study location and data collection

The study was carried out at the university of Abuja teaching hospital, a tertiary health centre, from March 2017 to July 2020. This a case control study in which patient structured questionnaire were administered to consecutive patients admitted into the medical wards who met the inclusion criteria for the diagnosis of ischaemic stroke in the neurology unit, department of medicine, university of Abuja teaching hospital, Gwagwalada. A total of one hundred and thirteen cases were recruited. Detailed clinical records were incomplete for 10 patients, who were therefore excluded from analysis. Each index patient was matched with controls without a history of cerebrovascular disease. All patients who satisfied the WHO clinical criteria for ischemic stroke and had cranial computed tomography or MRI were included in the study

The anthropometric measures BMI, waist circumference (WC), waist-to-hip ratio (WHR) were documented for all study participants. Cases and controls had waist and hip circumference measurements done in supine position in those cases that were unable to stand. Waist circumference was measured at the level of the umbilicus, and hip circumference was measured at the level of the bilateral greater trochanters. Height (in inches) and weight (in kilograms) were measured with a standard scale. About 12% of the patients were too sick for weight measurements and there were no previous medical records of weight for review.

According to international recommendations, BMI is defined as weight in kilograms divided by height in meters squared. In the BMI categories, we distinguished between normal weight (BMI 25.0 kg/m² and below) and overweight (BMI 25.0 to 29.9 kg/m²) and obesity (BMI >30 kg/m²).¹⁴ WHR was measured as waist circumference divided by hip circumference. Obese women had WHR >0.85 and obese men WHR >0.95. Threshold categories for waist circumference in men were 94.0 cm (normal weight), 94.0 to 101.9 cm (overweight) and >102.0 cm (obesity). In women they were 80.0 cm, 80.0 to 87.9 cm and >88.0 cm, respectively.¹⁵

Diabetes, hypertension and hyperlipidemia information were obtained from the medical record of subjects. Diabetes was defined as fasting blood glucose >7mmol/l or on anti-diabetic agents, while hypertension was defined as systolic blood pressure >140 mmHg and/or diastolic blood pressure > 90 mmHg and hyperlipidemia was defined as total serum cholesterol level >5.18 mmol/l. The controls were matched for age and sex from a database with participants of the population-based cohort study. The questionnaire was structured to ask questions about: demographic aspects (gender, age, educational level and occupation), risk factors of a stroke and anthropometric data.

Inclusion criteria

All patients who were admitted into the medical ward with confirmed diagnosis of Ischaemic stroke. All patients had full clinical assessment for stroke was screened clinically by WHO criteria and verified radiologically by cranial computer tomography scan from March 2017 to July 2020 were included in the study.

Exclusion criteria

Patients who had space occupying lesion with neurological deficits or metastatic brain disease and those with human immunodeficiency virus with neurological deficits were excluded from this study. Also excluded from the study were those who were unconscious, haemorrhagic stroke and those people who has other causes of increased abdominal girth like ascites due to any cause, females with pregnancy or any intra-abdominal mass.

Data analysis

Statistical analysis of data collected was performed using SAS software (SAS institute) 9.4. Data collected was analysed by frequency, mean, standard deviation and chi-square test. For all statistical tests, the threshold of significance is fixed at 5%, $p > 0.05$ indicates none significant results and $p < 0.05$ indicates significant results. Multiple logistic regression models for matched case-control data were used to calculate the odds ratio (OR) and 95% confidence interval (CI) for BMI and WHR and

ischemic stroke. Adjusted ORs were calculated after adjusting for potential confounding factors (clinical history of hypertension, diabetes and hypercholesterolemia) and age and sex were evaluated.

RESULTS

A total of 113 patients with ischaemic stroke were evaluated. Of these cases 53.1% were females and 46.9% were males. The demographic characteristic and

distribution of the study population (cases and control) stratified by sex is shown in (Table 1). The cardiovascular risk factors for stroke in cases is shown in (Table 2).

In the study 85% of the patient had hypertension, 50.5% had hypercholesterolemia and 33.6 % had diabetes. 22% had a family history of a relative that has had a stroke. The anthropometric characteristics of cases and control stratified by gender is revealed in (Table 3).

Table 1: Sociodemographic characteristics of cases and control stratified by gender.

Parameters	Women N (%)			Men N (%)		
	Control 59 (49.6)	Cases 60 (50.4)	P value	Control 52 (49.5)	Cases 53 (50.5)	P value
Age group (years)						
≤30	4 (6.6)	3 (5.0)	0.9010	2 (3.9)	1 (1.9)	0.4196
31-60	26 (44.1)	28 (46.7)	0.7759	23 (44.2)	18 (34.0)	0.2809
>60	29 (49.2)	29 (48.3)	0.9288	27 (51.9)	34 (64.2)	0.2042
Lifestyle						
Cigarette smoking	0 (0.0)	3 (5.1)	0.0819	2 (3.9)	10 (18.9)	0.0171
Alcohol intake	16 (27.6)	8 (13.3)	0.0545	23 (45.1)	26 (49.1)	0.6860
Marital status						
Single	5 (8.5)	5 (8.3)	0.9778	4 (7.7)	4 (7.7)	0.9999
Married	42 (71.2)	44 (73.3)	0.7937	46 (88.5)	44 (84.6)	0.5656
Separated/divorced	1 (1.7)	1 (1.7)	0.9904	1 (1.9)	3 (5.8)	0.9904
Widowed	11 (18.6)	10 (16.7)	0.7772	1 (1.9)	1 (1.9)	0.9999
Educational status						
Uneducated	1 (1.7)	4 (6.7)	0.1765	4 (7.7)	0 (0.0)	0.0395
Informal	19 (32.2)	2 (3.3)	<0.0001	7 (13.5)	1 (1.9)	0.0254
Primary	8 (13.6)	9 (15.0)	0.8223	8 (15.4)	0 (0.0)	0.0030
Secondary	14 (23.7)	19 (31.7)	0.3335	11 (21.2)	18 (34.0)	0.1422
Tertiary	17 (28.8)	23 (38.3)	0.2717	21 (40.4)	34 (64.2)	0.0148
Occupational status						
Civil servant	7 (11.9)	14 (23.3)	0.1008	11 (22.5)	26 (49.1)	0.0052
Private servant	4 (6.8)	7 (11.7)	0.3574	10 (20.4)	6 (11.3)	0.2074
Self-employed	37 (62.7)	15 (25.0)	<0.0001	26 (53.1)	16 (30.2)	0.0190
Student	2 (3.4)	1 (1.7)	0.5488	0 (0.0)	1 (1.9)	0.3339
Unemployed	9 (15.3)	23 (38.3)	0.0045	2 (4.1)	4 (7.6)	0.4574

Table 2: Cardiovascular risk factor for stroke in cases.

Parameters	All N (%)	Men N (%)	Women N (%)
	113	53 (46.9)	60 (53.1)
Heart disease	21 (19.1)	9 (17.7)	12 (20.3)
Hypertension	96 (85.0)	48 (90.6)	48 (80.0)
Hypercholesterolemia	54 (50.5)	25 (50.0)	29 (50.9)
Diabetes	38 (33.6)	15 (28.3)	23 (38.3)
Family history of stroke	24 (22.0)	12 (24.5)	12 (20.0)

The mean waist circumference for control and cases (87.7±11.9 vs. 94.8±17.4 p=0.0005), while the hip circumference (96.8±12.4 vs. 102.6±12.9 p=0.0011). However the waist to hip ratio (WHR) did not show any statistical significance among control and cases (0.9±0.1 vs. 0.9±0.1 p=0.5735), as well as BMI (25.3±6.3 vs. 26.8±4.8 p=0.0665). The result of the median waist circumference for control and cases (87.0 vs. 93,5 p=0.0001), The hip circumference (98.0 vs. 101.1 p=0.0002). However the waist to hip ratio (WHR) did not show any statistical significance among control and cases (p=0.4105), while the BMI (24.0 vs. 26.0 p=0.0051).

The prevalence of obesity among cases with stroke is shown in (Table 4). The BMI showed that most of the

cases were normal (23.3% vs. 76.7% $p < 0.0001$) while the WHR showed that most of the cases were not normal (70.9% vs. 29.1% $p < 0.0001$). The statistical significance shows that WHR was more sensitive in assessing obesity than BMI.

Table 3: Anthropometric characteristics of cases and control.

Parameters	Control	Cases	P value
Mean±SD			
Waist Cir	87.7±11.9	94.8±17.4	0.0005
Hip Cir	96.8±12.4	102.6±12.9	0.0011
BMI	25.3±6.3	26.8±4.8	0.0665
WHR	0.9±0.1	0.9±0.1	0.5735
Median (IQR) N (%)			
Waist Cir	87.0 (17.0)	93.5 (17.0)	0.0001
Hip Cir	95.0 (18.0)	101.0 (15.0)	0.0002
BMI	24.0 (7.0)	26.0 (5.9)	0.0051
WHR	0.9 (0.1)	0.9 (0.1)	0.4105

Table 4: Prevalence of obesity among cases with stroke.

Parameters	Frequency (%)	P value
BMI (N=90)	BMI $\geq 30 \text{kg/m}^2$	21 (23.3)
	BMI $< 30 \text{kg/m}^2$	69 (76.7)
WHR (N=103)	Abnormal WHR	73 (70.9)
	Normal WHR	30 (29.1)

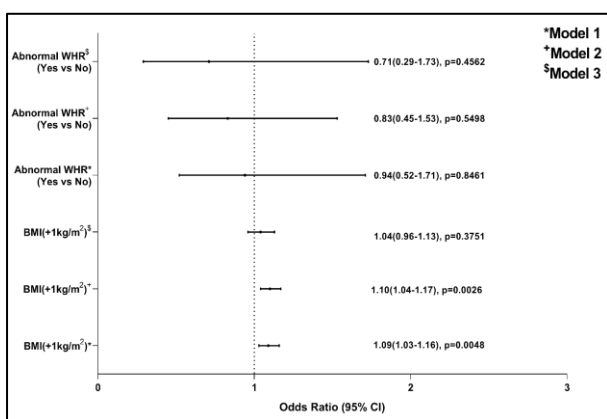


Figure 1: Association of BMI and WHR with stroke; model 1: unadjusted, model 2: adjusted for age and sex and model 3: adjusted for diabetes, hypertension and hypercholesterolemia.

The results of logistic regression analysis, in model 1 unadjusted and then model 2 adjusted for sex and age, BMI showed a positive association with risk of stroke (OR 1.10; 95% CI, 1.04-1.17; $p = 0.002$) this association

lost its significance in model 3 after adjusting for diabetes, hypertension and hypercholesterolemia (OR 1.04; 95% CI, 0.96-1.13; $p = 0.3751$) (Figure 1). The results of logistic regression analysis for WHR for model 1, model 2 and model 3 did not show any significance before and after adjustment.

DISCUSSION

This study assessed the relationship between obesity as a risk factor for stroke among cases and controls. Previous works done have demonstrated that there is an increased atherosclerotic and cardiovascular risk in association of abdominal obesity.^{16,17} Furthermore an increased prevalence of cardiovascular risk factors has been seen with increase in abdominal obesity by other researchers.¹⁸⁻²² In other studies obese people have been found to have an increased risk of developing the ischemic stroke with person with 100 cm waist size or more having a risk of 10%.²³ Current study shows a slight preponderance of females among the study population, with total females among the patients as 53.1% while the males were 46.9%. The prevalence of stroke was more in age group greater than 60 years. The educational characteristics shows 50.5 % of the patient had tertiary education and 32.8 % had secondary education. Although educational level and age has been reported to be associated with knowledge of stroke risk factors,²⁴⁻²⁶ It is important to note that about 80% of the cases had at least secondary education, which was a predictor of stroke knowledge.

High blood pressure was the most frequently identified risk factor in our study as in other studies.^{27,28} Our study found hypercholesterolemia and diabetes mellitus in 54% and 38% respectively. This finding in our study agrees in part previous works done in our center which showed a prevalence of hypercholesterolemia to be 45% and diabetes to be 33%.²⁹ Current study therefore sought to review prevalence of obesity among stroke patients. Those with abnormal WHR constituted 70.9% ($p < 0.0001$). Abnormal BMI was found in twenty three percent of the patients. This is supportive of previous work done which had lower predictive value of different markers of adiposity Where BMI and WHR were compared as a risk factors among patient with stroke.³⁰ Furthermore because of a loss of lean body mass with age, weight or BMI can decrease with age.^{30,31} What this means is that WHR may be a more useful method to assess abdominal fat, however in clinical practice WHR is a more difficult measure to standardize when compared to measurement of BMI. Waist circumference which is an indicator of abdominal obesity when used alone instead of WHR has not been shown to be a good predictor of stroke as demonstrated in previous works.^{9,30}

Abdominal obesity may increase the risk of ischemic stroke through conventional vascular risk factors, but our study did not demonstrate an effect independent of other cofounders. The odds ratio of waist to hip ratio and BMI

were 0.94 and 1.09 respectively. After the adjustment for age and sex the p-value was still significant for BMI (0.0026) however after adjustment for diabetes, hypertension and hypercholesterinemia the significance was lost. Our result does not support previous studies which was associated with the risk of ischaemic stroke with a p value of 0.01 (OR 1.57, CI=1.28-1.94).³² However, in the case of waist to hip ratio after adjustment for age and sex as well as diabetes, hypertension and hypercholesterinemia the significance was lost. In some cohort studies, WHR was no longer an independent risk factor for stroke after adjustment for hypertension and blood lipid levels or diabetes.^{33,34} In other studies there was a significant relationship between abdominal obesity and BMI ischemic stroke, with the probability of abdominal obesity for ischemic stroke (1.75), and BMI (0.794).³⁵ Despite the loss in significance after adjustment of more risk factors, available evidence suggests that those markers still remain important as shown in other studies.³⁶

In current study we did not consider the pre-morbid patient WHR or BMI which may in part be an explanation for this finding in addition to the different study designs applied and populations studied. It is also important to note that abdominal obesity may indirectly contribute to the incidence of ischemic stroke by influencing other well recognized risk factors. Furthermore, abdominal obesity may increase the risk of ischemic stroke through other mechanisms like insulin resistance or the metabolic syndrome. It is worth to note that our study could not demonstrate an effect independent of these mechanisms and other conventional vascular risk factors. Available evidence suggests that abdominal obesity is related not only to endothelial dysfunction which may be early marker of atherosclerosis, but also disturbances associated with blood flow and atherogenesis, which includes hyperviscosity of blood, hyperfibrinogenemia reduction in erythrocyte aggregability and deformability, and platelet activation.³⁷⁻³⁹

Limitations

Limitations in current study were being single-centered hospital-based study but still highlight the importance of WHR as a determinant of obesity in stroke as a risk factor. Despite these limitations, the argument still favors adding WHR as a measurement to vascular risk assessments.

CONCLUSION

In conclusion, current study highlights the need to increase public awareness about stroke risk factors including obesity. Even though abdominal obesity was not found as an independent risk factor for stroke, it contributes to the risk of stroke through the conventional risk factors.

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REFERENCES

1. Heymsfield SB, Wadden TA. Mechanisms, pathophysiology, and management of obesity. *N Engl J Med.* 2017;376:1492.
2. Physical Status: The Use and Interpretation of Anthropometry. Available at: <https://apps.who.int/iris/handle/10665/37003>. Accessed on 20 March 2021.
3. Chukwuonye II, Chuku A, John C. Prevalence of overweight and obesity in adult Nigerians – A systematic review. *Diabetes Metab Syndr Obes.* 2013;6:43-7.
4. Burton BT, Foster WR, Hirsch J, Van Itallie TB. Health implications of obesity: an NIH consensus development conference. *Int J Obes.* 1985;9:155-69.
5. Must A, Spadano J, Coakley EH, Field AE, Colditz G, Dietz WH. The disease burden associated with overweight and obesity. *JAMA.* 1999;282:1523-9.
6. The practical guide: identification, evaluation, and treatment of overweight and obesity in adults. Available at: <http://www.nhlbi.nih.gov/guidelines/obesity/practgde.htm>. Accessed on 2 February, 2020.
7. Hubert HB, Feinleib M, McNamara PM, Castelli WP. Obesity as an independent risk factor for cardiovascular disease: a 26-year follow-up of participants in the Framingham Heart Study. *Circulation.* 1983;67:968-77.
8. Fraser GE, Strahan TM, Sabate J, Beeson WL, Kissinger D. Effects of traditional coronary risk factors on rates of incident coronary events in low-risk population. *Circulation.* 1992;86:406-13.
9. Prineas RJ, Folsom AR, Kaye SA. Central adiposity and increased risk of coronary disease mortality in older women. *Ann Epidemiol.* 1993;3:35-41.
10. Rimm EB, Stampfer MJ, Giovannucci E, Ascherio A, Spiegelman D, Colditz GA, Willett WC. Body size and fat distribution as predictors of coronary heart disease among middle-aged and older US men. *Am J Epidemiol.* 1995;141:1117-27.
11. Waist Circumference and Waist-Hip Ratio. Available at: <https://www.who.int/publications-detail-redirect/9789241501491>. Accessed on 20 March 2021.
12. Yusuf S, Hawken S, Ounpuu S. Obesity and the risk of myocardial infarction in 27,000 participants from 52 countries: a case-control study. *Lancet.* 2005;366:1640-9.
13. Rimm EB, Stampfer MJ, Giovannucci E. Body size and fat distribution as predictors of coronary heart disease among middle-aged and older US men. *Am J Epidemiol.* 1995;141:1117-27.
14. Preventing and managing the global epidemic. Available at: <https://apps.who.int/iris/handle/10665/42330>. Accessed on 20 March 2021.

15. Lean ME, Han TS, Morrison CE. Waist circumference as a measure for indicating need for weight management. *BMJ.* 1995;311:158-61.
16. Sacco RL, Boden-Albala B, Gan R. Stroke incidence among white, black and Hispanic residents of an urban community: The Northern Manhattan Stroke Study. *Am J Epidemiol.* 1998;147:259-68.
17. Sacco RL, Elkind M, Boden-Albala B. The protective effect of moderate alcohol consumption on ischemic stroke. *JAMA.* 1999;281:53-60.
18. Folsom AR, Prineas RJ, Kaye SA, Munger RG. Incidence of hypertension and stroke in relation to body fat distribution and other risk factors in older women. *Stroke.* 1990;21:701-6.
19. Blair D, Habicht J-P, Sims EAH, Sylwester D, Abraham S. Evidence for an increased risk for hypertension with centrally located body fat and the effect of race and sex on this risk. *Am J Epidemiol.* 1984;119:526-40.
20. Folsom AR, Burke GL, Ballew C. Relation of body fatness and its distribution to cardiovascular risk factors in young blacks and whites: the role of insulin. *Am J Epidemiol.* 1989;130:911-24.
21. Gillum RF. The association of body fat distribution with hypertension, hypertensive heart disease, coronary heart disease, diabetes and cardiovascular risk factors in men and women aged 18-79 years. *J Chronic Dis.* 1987;40:421-8.
22. Daniels SR, Morrison JA, Sprecher DL, Khoury P, Kimball TR. Association of body fat distribution and cardiovascular risk factors in children and adolescents. *Circulation.* 1999; 99:541-5.
23. Zhong CK, Zhong ZY, XU TZYH. Measures of abdominal adiposity and risk of stroke : A. *Biomed Environ Sci.* 2016;29(1):12-23.
24. Zeng Y, He GP, Yi GH, Huang YJ, Zhang QH, and He LL. Knowledge of stroke warning signs and risk factors among patients with previous stroke or TIA in China. *J Clin Nurs.* 2012;21(20):2886-95.
25. Sundseth A, Faiz KW, Rønning OM, and Thommessen B. Factors related to knowledge of stroke symptoms and risk factors in a Norwegian stroke population. *J Stroke Cerebrovascular Dis.* 2014;23:7:1849–55.
26. Shravani K, Parmar MY, Macharia R, Mateti UV, Martha S. Risk factor assessment of stroke and its awareness among stroke survivors: A prospective study. *Adv Biomed Res.* 2015;4:187.
27. Pancioli AM, Broderick J, Kothari R. Public perception of stroke warning signs and knowledge of potential risk factors. *JAMA.* 1998;279:1288-92.
28. Kim JS, Yoon SS. Perspectives of Stroke in persons living in Seoul, South Korea: a survey of 1000 subjects. *Stroke.* 1997;28:1165-9.
29. Onwuegbuzie GA, Reng RS. Serum Lipid Profile of Patients with Ischaemic Stroke in A Tertiary Centre in Nigeria. *J Dent Med Sci.* 2016;15(11):60-4.
30. Walker SP, Rimm EB, Ascherio A, Kawachi I, Stampfer MJ, Willett WC. Body size and fat distribution as predictors of stroke among US men. *Am J Epidemiol.* 1996;144:1143-50.
31. Flegal KM, Carroll MD, Kuczmarski RJ, Johnson CL. Overweight and obesity in the United States: prevalence and trends, 1960-1994. *Int J Obes Relat Metab Disord.* 1998;22:39-47.
32. Mitchell AB, Cole JW, Mcardle PF, Cheng Y, Ryan KA, Sparks MJ, et al. obesity in the United States: prevalence and trends. *HHS.* 2016;46(6):1690-2.
33. Lapidus L, Bengtsson C, Larsson B, Pennert K, Rybo E, Sjöström L. Distribution of adipose tissue and risk of cardiovascular disease and death: a 12 year follow up of participants in the population study of women in Gothenburg, Sweden. *Bio Med J.* 1984;289:1257-61.
34. Larsson B, Svardsudd K, Welin L, Wilhelmsen L, Björntorp P, Tibblin G. Abdominal adipose tissue distribution, obesity, and risk of cardiovascular disease and death: 13 years follow up of participants in the study of men born in 1913. *Bio Med J.* 1984;288: 1401-4.
35. Siti Rohmatul Laily, Santi Martini, Atik Choirul H, Eva Flourentina K. Abdominal Obesity as a Risk Factor of Ischemic Stroke Incidence in Lamongan Distric, Indonesia. *Mal J Med Health Sci.* 2020;16(1): 88-93.
36. Suk SH, Sacco RL, Boden-Albala B. Abdominal obesity and risk of ischemic stroke: the Northern Manhattan Stroke Study. *Stroke.* 2003;34:1586-92.
37. Arcaro G, Zamboni M, Rossi L. Body fat distribution predicts the degree of endothelial dysfunction in uncomplicated obesity. *Int J Obes.* 1999;23:936-42.
38. Solerte SB, Fioravanti M, Pezza N. Hyperviscosity and microproteinuria in central obesity: relevance to cardiovascular risk. *Int J Obes.* 1997;21:417-23.
39. Davi G, Guagnano MT, Ciabattini G. Platelet activation in obese women: role of inflammation and oxidant stress. *J Am Med Assoc.* 2002;288:2008-14.

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