Validity of Anthropometric Cut-offs for Early Diagnosis of Dyslipidemia among Adults in Jimma Town, Southwest Ethiopia

Sileshi Kenate

Jimma University

Temamen Tesfaye

Jimma University

Solomon Berhanu

Jimma University

Belay Zawdie

Jimma University

Yonas Tesfaye

Jimma University

Lelisa Sena

Jimma University

Mulualem Tadesse

Jimma University

Ayantu Kebede

Jimma University

Esayas Kebede

Jimma University

Dessalegn Tamiru (✉ dessalegn97@gmail.com)

Jimma University

Research

Keywords: Metabolic Syndrome, Lipid Profile, Anthropometric Measurements, Jimma Town

Posted Date: June 22nd, 2020

DOI: <https://doi.org/10.21203/rs.3.rs-36104/v1>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License. [Read Full License](#)

Abstract

Background: Lack of regional and local based cut off points of lipid profile and/or anthropometric measurement remains one of the challenges in prevention, early detection and control of non-communicable diseases. This study was aimed to validate anthropometric based screening of lipid profile in order to prevent potential predictors of major non-communicable diseases.

Methods: Community based cross sectional study was conducted among randomly selected 977 adults in Jimma Town, Ethiopia from July 20 to August 20, 2019. Data were collected using structured questionnaire, anthropometric and biochemical measurements. Data were analyzed using SPSS windows version 20 and Kappa statistic (K) was used to validate the agreement between anthropometric measurement and lipid profile of the study participants. A p-value of < 0.05 was considered statistically significant.

Results: Body mass index (BMI) at ≥ 24.5 was used as screening of dyslipidemia ($TG \geq 150\text{mg/dl}$) with slight Kappa coefficient of 0.138 ($P < 0.001$) among females while it was ≥ 22.2 among males with fair (0.275) Kappa coefficient ($P < 0.001$). Waist circumference based screening of dyslipidemia ($TG \geq 150\text{mg/dl}$) at $\geq 78.0\text{cm}$ had negative (-0.005) Kappa coefficient ($P < 0.001$) among females (sensitivity: 72.6% & specificity: 26.7%). Yet, waist circumference at $\geq 83.7\text{cm}$ had slight Kappa coefficient of 0.13 ($P < 0.005$) among males (sensitivity: 38% & specificity: 74.9%). Waist hip ratio based screening of dyslipidemia ($TG \geq 150\text{mg/dl}$) at ≥ 0.82 among females had negative (-0.001) Kappa coefficient ($p = 0.763$) whereas among males at ≥ 0.88 there was a slight (0.105) Kappa coefficient of ($p = 0.002$) (Sensitivity: 77.5% & Specificity: 36.8%). This study showed that anthropometric based of high-density lipoprotein measurement was not applicable.

Conclusions: Findings of this study indicated that BMI-based screening of triglyceride was applicable for both sexes than other anthropometric measurements. Waist circumference and Waist to hip ratio-based screening of triglyceride was slightly applicable only for males. However, anthropometric based screening of high-density lipoprotein measurement was not applicable for both sexes. In conclusion, researchers and policy makers need to consider local cut off points to conduct screening nutritional status of the community.

Introduction

Metabolic syndrome is a subset of non-communicable diseases (NCDs), which is interconnected by physiological, biochemical, clinical and metabolic factors that directly increases the risk of cardiovascular disease and type 2 diabetes mellitus. Insulin resistance, visceral adiposity, atherogenic dyslipidemia, endothelial dysfunction, genetic susceptibility, elevated blood pressure, hypercoagulable state and chronic stress are among several factors which constitute the syndrome (1). Individuals with metabolic syndrome exhibit a characteristic pattern of abnormalities in serum lipid levels consisting of a low level of high density lipoprotein and an elevated level of triglyceride (2).

Different studies show that the burdens of NCDs on health of the population and health services have been increased in developing countries. Cardiovascular diseases, cancer, chronic respiratory diseases and diabetes are responsible for 82% of deaths. Currently, low income countries are witnessing epidemiological transition from infectious communicable diseases to chronic non-communicable diseases due to changes in the life styles, rapid urbanization and diminishing levels of physical activity (4). Consequently, non-communicable diseases are predicted to increase globally by 17% and by 27% in the African region in the next 10 years and projected to overtake communicable diseases as the major cause of morbidity in sub-Saharan Africa by the year 2030 (3).

The report of 2017 WHO progress monitor also showed that NCDs kill 41 million people each year, which is 71% of all global deaths. In Ethiopia, the proportion of death from NCDs has been reported to 42% of all causes of deaths, which accounts 27% of premature deaths before the age 70 years (5). The increment of NCDs on top of the preexisting highly prevalent communicable diseases, maternal, prenatal and nutritional conditions constrains the already meager health resources and hinders economic development of the country (6).

However, it is only relatively recent that the NCDs have received attention in low-income countries. Consequently, unrecognized/undiagnosed NCDs are found to be major problems as the individuals are unaware of their status in this regard. It has been indicated that the international anthropometric cutoff or detecting obesity is not appropriate for Ethiopians (7). There is a need to re-orient the national health system to ensure recognition of the NCDs burden and improve organization and delivery of NCDs services at primary health care (PHC) level (8, 9).

Lack of local based cut off points remains one of the challenges in management, prevention, control of NCDs and their modifiable risk factors. Optimal anthropometric cut-offs for detecting obesity and markers of metabolic syndrome in Ethiopian adults are lower than the international cut-offs for waist circumference, waist to hip ratio and body mass index underestimate obesity and metabolic syndrome markers. Therefore, developing standardized local cut off points for the measurement of NCDs is crucial for prevention and management of NCDs by early detection. Thus, this study aimed to validate anthropometric measurements cut off points among Ethiopian adults (7) in order to screen at household level by using waist circumference, waist to hip ratio and BMI measurement in Jimma Town, Oromia Regional State, Southwest Ethiopia.

Methods

Community based cross sectional study was conducted in Jimma Town from June to July 2019 among adults aged ≥ 18 years. Jimma is found in Southwest Ethiopia, located at 352 km from capital city of Addis Ababa. Sample size was calculated using sensitivity estimation formula taking highest prevalence of high density lipoprotein (23.4%) based on a study done in Addis Ababa among Ethiopian adults (11), 5% margin of error, 95% confidence level and 90% an anticipated sensitivity (7). Finally, 977 sample size was calculated by considering 10% non-response rate and 1.5 design effects. Study participants were selected using two-stage cluster sampling technique. Six kebeles (smallest administrative unit) out of 17 were randomly selected. Study participants were selected from each kebele proportionally based on the number of households in each selected kebele using systematic sampling technique methods.

Inclusion and Exclusion Criteria

All residents who lived in the town for six months prior the data collection was included into the study. However, adults who had physical deformity (kyphosis and sclerosis), pregnancy, known chronic illness and seriously ill were excluded.

Data Collection Procedure

Data were collected using WHO stepwise questionnaire and adapted to the local context. A survey tools include socio-demographic characteristics, anthropometric measurements and laboratory analyses of lipid profile formats. Height of the study participants was measured to the nearest 0.1 cm using a stadiometer (seca Germany) with the subjects positioned at the Frankfurt Plane and the four points (heel, calf, buttocks and shoulder) touching the vertical stand and their shoes taken off. Before starting the measurements, the stadiometer was checked using calibration rods. Weight was measured using digital weight scale to the nearest 0.1 kg with the subjects wearing light clothes and shoes taken off. The validity of the scale was checked using an object of a known weight of 1kg.

Waist circumference was measured at midpoint between the inferior margin of the last rib and the iliac crest just at wider area using a stretch tape. Just before taking the measurement, participants were requested to stand with their feet together, place their arms at their side of their body with the palms of their hands facing inwards, and breathe out gently. Hip circumference was measured at the level of the greater trochanter of the femur with the subjects wearing a pant. All anthropometric measurements were done in triplicate and the average value was used for further analysis. Standardization of anthropometric measurers were done to reduce inter observer error.

The laboratory parameter was determined according to the standard operating procedures. Five 5 ml venous blood was collected to determine participant's lipid profiles in mg/dl. Serum was carried out in ABX Pentra 400 Automated Chemistry Machine (Horiba ABX SAS, 34184 Montpellier(12) at Jimma medium Clinical chemistry Core laboratory to determine lipid profile including total cholesterol, high-density lipoprotein (HDL) and triglyceride (TAG). Low density lipoprotein level was calculated by using Freidwald formula (13).

The optimal cut-off values of waist circumference (WC) was 85.3 cm for male and 78.0 cm for females and the values greater than this indicates risk factor for obesity. The optimal cut-off values of waist to hip ratio (WHR) were calculated by dividing waist to hip in centimeters. The cut off values were 0.88 cm to male and 0.82 cm for females; values greater than the cut off value was considered at risk for obesity. Similarly the optimal cut-off of values body mass index (BMI) was 24.5kg/m² for female and 22.2kg/m²for male; values greater than the cut off value was considered as at risk for obesity. A lipid level was classified according to WHO classification and triglyceride was considered as normal when it was <150 mg/dl and HDL-C was considered as normal if it is >40 mg/dl male and >50mg/dl for female (14).

Data Quality Management

Data collectors were trained for five days before the actual data collection on interviewing approach, anthropometric measurement and data recording. To ensure the quality of the data, properly designed data collection instrument was used. Calibration of instruments was done to increase the reliability of the measurements. A questionnaire for the survey was first prepared in English language and translated into local languages (Afan-Oromo and Amharic), then translated back into English to check for consistency. The questionnaire was pre-tested on 5% of sample size in Agaro Town and based on the pretest, additional adjustment was made on terminologies.

Data Processing and Analysis

Data were checked for completeness. The data was cleaned and checked for outliers and missing values. Epi Data version 3.1 and SPSS version 21 were used for data entry and analysis, respectively. The data were checked for normality using QQ-plot. Descriptive analysis was used to describe the study subjects and presented using tables and figures. Validity measures including sensitivity, specificity, positive predictive value, negative predictive values and Kappa agreement were determined to validate anthropometric based screening of lipid profile.

Results

A total of 915 individuals were interviewed with a 93.7% response rate. The mean age of study participants was 38.35 ± 13.51 years. Large proportion of the respondents (71.5%) was married. Majority of participants were Oromo ethnic (66.0%) and Muslim followers (56.0%). Closely

three-fourth (64.5%) of the study participants attended at least primary school (Table 1).

Table 1
The socio-demographic characteristics of adults in Jimma town, Ethiopia

Variable	Categories	Number (n)	Percent (%)
Sex	Male	476	52.0
	Female	439	48.0
Age	≤ 30	323	35.3
	31–40	301	32.9
	41–50	126	13.8
	≥ 51	165	18.0
Educational status	Degree and Above	79	8.6
	Diploma	96	10.5
	Illiterate	150	16.4
	Primary School	377	41.2
	Secondary School	213	23.3
Marital Status	Single	130	14.2
	Married	654	71.5
	Divorced	79	8.6
	Widowed	40	4.4
	Separated	12	1.3
Religion	Orthodox	290	31.7
	Muslim	512	56.0
	Protestant	111	12.1
	Catholic and Wakefata	2(0.2)	2(0.2)
Ethnic Group	Oromo	604	66.0
	Amhara	81	8.9
	Dawuro	97	10.6
	Yemi	30	3.3
	Gurage	33	3.6
	Others*	70	7.7
Occupation	Unemployed	117	12.8
	Student	41	4.5
	Housewife	158	17.3
	Daily laborer	124	13.6
	Merchant	81	8.9
	Government Employee	183	20.0
	Private employee	133	14.5
	Others [†]	78	8.5
*Kafa, Tigre, Hadiya, Silte; [†] Carpenter, Driver, Car Washer, No Specific Job			

Body mass index-based screening of Triglyceride in both sexes had slight Kappa agreement among female and fair agreement among males. Using BMI at ≥ 24 for screening of hyper triglyceride (TG ≥ 150 mg/dl) among females had slight (0.12) Kappa agreement ($P = 0.024$) with 72.6% sensitivity and 65.0% specificity. Similarly, in case of male, BMI at ≥ 22.2 kg/m² based screening of dyslipidemia (TG ≥ 150 mg/dl) had fair (0.275) Kappa agreement ($P < 0.001$) with 64.1% sensitivity and 66.8% specificity. Body mass index-based screening of high-density lipoprotein (HDL-C < 50 mg/dl) among females at ≥ 24.5 kg/m² had negative (-0.003) Kappa coefficient with 58.0% sensitivity and 41.7% specificity, which is not statistically significant ($p = 0.949$). Similarly, BMI at ≥ 22.2 kg/m² had a slight (0.032) Kappa coefficient ($P = 0.449$) with 58.1% sensitivity and 45.45% specificity (Table 2).

Table 2
Comparison of BMI based screening of triglyceride and HDL with laboratory results among Jimma town adults

BMI based screening			Laboratory Results										
Marker	Sex	Cut off point	TP(a)	FP(b)	FN(c)	TN(d)	Total(P)	Sensitivity (%)	Specificity (%)	PPV	NPV	Kappa	P
TG ≥ 150	F	BMI ≥ 24.5	53	114	60	212	439	72.6	65	32	83	0.12	< 0.001
	M	BMI ≥ 22.2	86	101	56	233	476	64.1	66.8	45	81	0.275	< 0.001
HDL < 50	F	BMI ≥ 24.5	160	95	116	68	439	58	41.7	63	37	-0.003	0.949
HDL < 40	M	BMI ≥ 22.2	104	162	75	135	476	58.1	45.5	39	64	0.032	0.449
Key: Sensitivity = $a/a + c$, specificity = $d/b + d$, positive predictive value (PPV) = $a/a + b$, negative predictive value (NPV) = $d/c + d$. Kappa agreement (0 = no/poor), (0.01–0.20:slight), (0.21–0.40 = fair), (0.41–0.60 = moderate), (0.61–0.80 = substantial), and (0.81–1.00 = perfect)													

Waist circumference based screening of dyslipidemia (TG ≥ 150 mg/dl) at ≥ 78.0 among females had - 0.005 Kappa coefficient with 72.6% sensitivity and 26.7% specificity, which was not statistically significant ($p = 0.877$). On the other hand, for males, waist circumference at ≥ 83.7 cm based screening of dyslipidemia (TG ≥ 150 mg/dl) had slight Kappa agreement of 0.13 ($p = 0.005$) with 38.0% sensitivity and 74.9% specificity.

Waist circumference based screening of high-density lipoprotein cholesterol (< 50 mg/dl) at ≥ 78.0 cm had slight Kappa coefficient (0.04) with 27.5% sensitivity and 77.3%, specificity which was not statistically significant ($p = 0.263$). Similarly, for male waist circumference ≥ 83.7 cm based screening of HDL-C had slight Kappa coefficient of 0.02, but not statistically significant (Table 3).

Table 3
Comparison of waist circumference based screening of triglyceride and HDL with laboratory results among adults, Jimma Town

WC Based Screening			Laboratory Results										
Markers	Sex	cut off value	TP(a)	FP(b)	FN (c)	TN(d)	Total (P)	Sensitivity (%)	Specificity (%)	PPV	NPV	Kappa	P
TG ≥ 150	F	WC ≥ 78	82	239	31	87	439	72.6	26.7	25.5	73.7	- .005	0.877
	M	WC ≥ 83.7	54	84	88	250	476	38.0	74.9	39.1	73.9	0.13	0.005
HDL < 50	F	WC ≥ 78	76	37	200	126	439	27.5	77.3	67.3	38.7	0.04	0.263
HDL > 40	M	WC ≥ 83.7	54	84	125	213	476	30.2	71.7	39.1	63.0	0.02	0.661

Waist circumference to hip ratio based screening of triglyceride was valid only for male at ≥ 0.88 cm with slight (0.105) Kappa coefficient ($p = 0.002$) and 77.46% sensitivity and 36.83% specificity. However, in case female, WHR at ≥ 0.82 cm was not statistically significant. WHR based screening of high-density lipoprotein cholesterol was not statistically significant for both female ($p = 0.263$), and male ($p = 0.661$) (Table 4).

Table 4
Comparison of WHR based screening of triglyceride and HDL with laboratory results among adults, Jimma Town

WHR based screening			Laboratory Results										
Markers	sex	cut off value	TP(a)	FP(b)	FN(c)	TN(d)	Total(P)	Sensitivity (%)	Specificity (%)	PPV	NPV	Kappa	P
TG $\geq$ 150	F	WHR $\geq$ 0.82	112	324	1	2	439	99.12	0.613	25.7	66.7	-0.001	0.763
	M	WHR $\geq$ 0.88	110	211	32	123	476	77.46	36.83	34.3	79.4	0.105	0.002
HDL < 50	F	WHR $\geq$ 0.82	274	162	2	1	439	99.28	0.613	62.84	33.3	- .001	0.891
HDL < 40	M	WHR $\geq$ 0.88	137	223	42	74	476	76.5	24.9	38.1	638	0.012	0.721

Discussion

Developing locally appropriate optimal cut-off points using obesity based anthropometric measurement is important for early detection of metabolic syndrome to prevent farther complication and disabled from unrecognized NCD(7). According to the present study, BMI based screening of triglyceride had fair and slight agreement of Kappa coefficient among males and females, respectively. A similar study done in Brazil also revealed that anthropometric indices had slight differences in screening of triglyceride among males and females. It also revealed that BMI based screening of triglyceride was applicable when compared with other anthropometric measurements (15). Likewise, other hospital based studies done in India and Canada indicated weak correlation between body mass index (BMI) and lipid profiles (16, 17). There is also another study, which showed that BMI based screening for dyslipidemia was applicable (18).

Waist circumference based screening of triglyceride among males showed slight agreement ($k = 0.13$). However, similar studies from Canada and India found that waist circumference was a better predictor of dyslipidemia (TG) in both sexes (17, 19, 20). Similar to waist circumference, the screening of triglyceride based on waist to hip ratio among males had slight Kappa agreement ($k = 0.105$), which is statistically significant ($p = 0.002$). Study done in India among adult population (≤ 60 years old) and aged group of population in Brazil (60 years old and above) revealed that anthropometric indices of waist to hip ratio was the best indicators for screening dyslipidemia (TG) (15, 21). This discrepancy might be due to the difference in sample size, age difference or ethnic differences, which can be addressed by a large scale and multi-centered study involving different populations.

Conclusion

Anthropometric indices can be used as a simple screening of dyslipidemia at primary health care unit. Body mass index cut of points at $\geq 24.5 \text{ kg/m}^2$ for females and $\geq 22.2 \text{ kg/m}^2$ for males can be used for screening of dyslipidemia (TG $\geq 150 \text{ mg/dl}$). Similarly, waist circumference at $\geq 83.7 \text{ cm}$ and waist to hip ratio at ≥ 0.88 can be considered as screening of dyslipidemia (TG $\geq 150 \text{ mg/dl}$) among males. Generally with further investigation health facilities and researchers can use anthropometric indices as alternative to investigate lipid profiles to prevent nutrition related non-communicable diseases.

Abbreviations

TG

Triglycerides, WC:Waist Circumference, WHR:Waist to Hip Ratio

Declarations

Ethics approval and consent to participate

Ethical approval and clearance were obtained from Jimma University Ethical Review Board. Verbal consent was taken from each study subjects after clear disclosure of the study objective. The privacy of patients was respected and results regarding the participants made confidential.

Consent for publication

Not applicable.

Availability of data and materials

The data set used for this study can be shared based on a reasonable request.

Competing interests

The authors declare that they have no competing interests.

Funding

The authors received no financial support for the publication of the article.

Authors' contributions

The authors' responsibilities: All authors had the primary responsibility for the content and finally submitted the paper for publication. All authors read and approved the final manuscript.

Acknowledgements

The authors would like to express their gratitude to Jimma University for facilitating this study. We would also like to thank study participants who gave valuable information.

References

1. Kaur J. A Comprehensive Review on Metabolic Syndrome. *Cardiol Res Pract*. 2014;1–22.
2. Brinck J, Thomas A, Lauer E, Jornayvaz F, Brulhart-Meynet M, Prost J, Pataky Z, Löfgren P, Hoffstedt J, Eriksson M, Pramfalk C, Morel S, Kwak B, van Eck M, James R, Frias M. Diabetes Mellitus Is Associated With Reduced High-Density Lipoprotein Sphingosine-1-Phosphate Content and Impaired. *Arterioscler Thromb Vasc Biol*. 2016;36(5):817–24.
3. World Health Organization. Global Report On Diabetes. 2016; https://apps.who.int/iris/bitstream/10665/204871/1/9789241565257_eng.pdf.
4. Kavishe B, Biraro S, Baisley K, Vanobberghen F, Kapiga S, Munderi P, Smeeth L, Peck R, Mghamba J, Mutungi G, Ikoona E, Levin J, Maria Monclús A, Katende D, Kisanga E, Hayes R, Grosskurth H. High prevalence of hypertension and of risk factors for non-communicable diseases (NCDs): a population based cross-sectional survey of NCDs and HIV infection in Northwestern Tanzania and Southern Uganda. *BMC Med*. 2015;13:126.
5. Shiferaw F, Letebo M, Misganaw A, Feleke Y, Gelibo T, Getachew T, Defar A, Assefa A, Bekele A, Amenu K, Teklie H, Tadele T, Taye G, Getnet M, Gonfa G, Bekele A, Kebede T, Yadeta D, GebreMichael M, Challa F, Girma Y, Mudie K, Guta M, Tadesse Y. Non-communicable Diseases in Ethiopia: Disease burden, gaps in health care delivery and strategic directions. *Ethiop. J. Health Dev*. 2018;32(3).
6. Misganaw A, Haregu T, Deribe K, Tessema G, Deribew A. National mortality burden due to communicable, non-communicable, and other diseases in Ethiopia, 1990–2015 : findings from the Global Burden of Disease Study 2015. *Popul Health Metr*. 2017;15:29.
7. Sinaga M, Worku M, Yemane T, Tegene E, Wakayo T, Girma T, Lindstrom D, Belachew T. Optimal cut-off for obesity and markers of metabolic syndrome for Ethiopian adults. *Nutr J*. 2018;17:109.
8. Federal Democratic Republic of Ethiopia. The Ethiopia Noncommunicable Diseases and Injuries (NCDI) Commission Report Summary: Addressing the Impact of Noncommunicable Diseases and Injuries in Ethiopia. <https://static1.squarespace.com/static/55d4de6de4b011a1673a40a6/t/5bfc17ab21c67c558106119e/1543247788342/Ethiopia+NCDI+Commission+Report+Summary+FINAL.pdf>.
9. Asfaw D, Teshome E. Tobacco control and prevention efforts in Ethiopia pre- and post-ratification of WHO FCTC: Current challenges and future directions. *Tob Induc Dis*. 2019;17:13.
10. Sorana D. Medical Diagnostic Tests: A Review of Test Anatomy, Phases, and Statistical Treatment of Data. *Comput Math Methods Med*. 2019; 2019: 1891569.
11. Gebreyes Y, Goshu D, Geletew T, Argefa T, Zemedu T, Lemu KA, et al. Prevalence of high bloodpressure, hyperglycemia, dyslipidemia, metabolic syndrome and their determinants in Ethiopia. *PLoS ONE* 13 (5): e0194819.
12. GreenSebastian R, Wachsmann-Hogiu W. Development, History, and Future of Automated Cell Counters. *Clin Lab Med*. 2015;35(1):1–10.
13. KarimollahHajian-Tilaki. Sample size estimation in diagnostic test studies of biomedical informatics. *J Biomed Inform*. 2014;48:193–204;.
14. Sinaga M, Yemane T, Tegene E, Lidstrom D, Belachew T. Performance of newly developed body mass index cut-off for diagnosing obesity among Ethiopian adults. *J Physiol Anthropol*. 2019;38:14.

15. Silva R, Faresll D, Rodrigues A, Dél T. Matos W, Henrique M. Anthropometric indicators as predictors of serum triglycerides and hypertriglyceridemia in older adults. *MedicalExpress*. 2014;1:4.
16. Manjareeka M, Nanda S, Mishra J, Mishra S. Correlation between anthropometry and lipid profile in healthy subjects of Eastern India. *J Midlife Health*. 2015;6(4):164–8.
17. Brenner D, Tepylo K, Eny K, Cahill L, El-Sohemy A. Comparison of body mass index and waist circumference as predictors of cardiometabolic health in a population of young Canadian adults. *Diabetol Metab Syndr*. 2010; 12;2(1):28.
18. Ramoteme L, Martinique S, Sarah J, Makama A. The association between dyslipidemia and anthropometric indicators in black and white adolescents residing in Tlokwe Municipality, North-West Province, South Africa: the PAHL study. *Afr Health Sci*. 201; 14(4): 929–938.
19. Rao S, Parab-Waingankar P. Performance of waist circumference relative to BMI in predicting risk of obesity and hypertension among affluent Indian adults. *Health*. 2013;05(08):16–22.
20. Silvana C, Miralles W, Wollinger LM, Marin D, Genro JP, Contini V, et al. Waist-to-height ratio (WHtR) and triglyceride to HDL-c ratio (TG / HDL-c) as predictors of cardiometabolic risk. *Nutr Hosp*. 2015;31(5):2115–21.
21. Rocha F, Menezes TN, De, Lustosa R, Melo P, De. Correlation between indicators of abdominal obesity and serum lipids in the elderly. *MED BRAS*. 2013;59:48–55.