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The comparison of classical and newly designed anthropometric indices in the assessment of dyslipidemia

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ABSTRACT

It has been shown that dyslipidemia involves low concentrations of high-density lipoprotein cholesterol (HDL) but high concentrations of other plasma lipids. This study reanalyzes the relation between plasma lipids and various anthropometric parameters. In this cross-sectional type of study, the participants (n=53) were recruited for the study. Participants were given one-day free health camps and they were anthropometrically measured. Plasma lipid fractions were accordingly determined. Participants suffering from bacterial/viral infection, hemophilia, diabetes mellitus, cardiovascular disease (CVD), cancer, or anemia were excluded from this study. Statistically significant and non-significant results were obtained for different lipoprotein fractions. Although, Body Mass Index (BMI) was a good classical indicator of obesity, other indicators like A Body Shape Index (ABSI) and Body Roundness Index (BRI), also proved significant in assessing the type and severity of dyslipidemia. Different lipoprotein fractions behaved differently with anthropometric parameters. Relationship of lipoprotein fractions with gender, ethnicity and occupation was also studied. Our study includes 79% of dyslipidemic and 21% of non-dyslipidemic patients. Males were more inclined towards lipid abnormalities than females especially HDL abnormality. Abnormal HDL levels were mostly associated with the rural population. But consumption of fast food may prove fatal for lowering the HDL level in the urban population also. This data gathered may have implications in the characterization and diagnosis of diseases but it can prove helpful in assessing their severity and type.

Keywords: Dyslipidemia, BMI, ABSI, BRI, Anthropometric indices, LDL, HDL

INTRODUCTION

Dyslipidemia involves the abnormal amount of lipids in the blood. It may be triglycerides, cholesterol, and/or fat phospholipids. In dyslipidemia, total cholesterol (TC), low-density lipoprotein cholesterol (LDL) and triglyceride (TG) concentrations are usually higher than the normal contrary to the high-density lipoprotein cholesterol (HDL), having concentrations lower than the normal (Humayun et al., 2009). It is affecting all ages, sexes, and races equally (Humayun et al., 2009). The prevalence of dyslipidemia is more significant in males at younger and middle ages while in women it is more significant above the age of 60 years (Humayun et al., 2009). Common causes of dyslipidemia include obesity, diabetes mellitus, alcoholism, polycystic ovary syndrome, and metabolic syndrome, etc. (Humayun et al., 2009, Sarfraz et al., 2016, Bilal et al., 2018). Dyslipidemia is more common in overweight and obese classes (Humayun et al., 2009). In obesity excessive accumulation of body fat occurs and is known to be the second major cause of mortality and morbidity, worldwide (Humayun et al., 2009). BMI is used as a medical standard to measure obesity and overweight. BMI in between 18.5 and 22.9 kg/m^2 is considered to be normal (Humayun et al., 2009). BMI of 23-24.9 kg/m^2 is known to be overweight and ≥ 25 kg/m^2 is accepted as obese (Humayun et al., 2009). Higher BMI individuals are reported to have dyslipidemia as BMI is directly proportional to the total cholesterol (TC), low-density lipoprotein cholesterol (LDL), and triglyceride concentrations but it is inversely proportional to the high-density lipoprotein cholesterol (HDL) (Humayun et al., 2009). Although BMI and Waist Circumference

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(WC) are the classical indicators of dyslipidemia but, BMI is unable to make a difference between lean body mass and adipose tissue. There are other parameters used to know about the severity of dyslipidemia, which may include, Body Roundness Index (BRI) and A Body Shape Index (ABSI). BRI involves the combination of waist circumference (WC) and height to foretell the body fat percentage. Whereas, ABSI is a body index, composition includes, height, BMI and waist circumference (WC). Also, ABSI involves considerable fraction of abdominal adipose tissue. It is reported that ABSI is able to foretell the onset or presence of diabetes mellitus. ABSI is seen to be a frail anticipator of cardiovascular diseases when it is compared to BMI, rather than BRI, which is a good predictor of CVD, but not better than BMI (Zaid et al., 2017).

From the literature review, it is evident that in obese people the rate of high-density lipoprotein cholesterol (HDL) is usually lower than the normal rate (Saleheen et al., 2007). Factors responsible for this lower rate may be genetic or environmental (Saleheen et al., 2007). Environmental factors may include fast food consumption or lack of any physical activity (Saleheen et al., 2007). High-density lipoprotein cholesterol (HDL) is also known as good cholesterol; as it helps to eradicate other types of cholesterol from the bloodstream through a reverse transport cholesterol system. According to the ATP-III, HDL levels of greater than 40 milligrams per deciliter (mg/dL) are considered good for the human body. HDL production can be increased by maintaining a good diet and doing any physical activity (Zaid and Hasnain, 2018). HDL is found to be the most usual form of dyslipidemia (17.3%) in the Pakistani population followed by high triglyceride concentration (11.2%) (Zaid and Hasnain, 2018). Regarding gender analysis, males are showing lower HDL levels and higher TG levels than females. As a result of this, males are in the challenging category of developing chronic heart disease (CHD) than females (Zaid and Hasnain, 2018). Dyslipidemia has a strong association with diabetes mellitus (Sarfraz et al., 2016). In diabetic patients, lipid irregularities are more common because major enzymes, that require insulin for their proper functioning, are disturbed due to the low amount of insulin-making and secretion. This is due to the disproportionate ratio between levels of HDL and TC, leading to cardiovascular disease (CVD) (Sarfraz et al., 2016). Dyslipidemia is a popular risk factor for cardiovascular disease (CVD) as well as chronic kidney disease (s) (Maheshwari et al., 2010). The prevalence and incidence of CKD is increasing globally. According to World Health Organization (WHO), CVDs prevalence will double by 2020 surpassing HIV/AIDS infection (Ama Moor et al., 2017). Dyslipidemia has three forms, hypercholesterolemia, hyperlipidemia, and hypertriglyceridemia. Hypercholesterolemia is the most common form of dyslipidemia with total cholesterol ranging above the 190mg/L (Ama Moor et al., 2017). Hypercholesterolemia is considered a less common risk factor for CVD as compared to hypertension and low HDL (Ama Moor et al., 2017). CKD causes a decrease in HDL and an increase in TG which then mimics the lipid dysfunctionalities of the metabolic syndrome and increases the risk for cardiovascular mortality (Maheshwari et al., 2010). This study aimed to understand the lipid profiling for obese and healthy individuals, to study the correlation of BMI, ABSI and BRI with HDL level of the study population, and to study the relation between HDL and various other anthropometric parameters and metabolic indices.

MATERIALS AND METHODS

Selection of Participants for Blood Sample Collection

In this cross-sectional type of study, different anthropometric measurements were taken. A total of 53 participants were recruited for this study. By taking into consideration the resources for the study, participants were limited to a short range. Participants were given one-day free health camps organized by the Department of Life Sciences, School of Science, University of Management and Technology, Lahore during a period of three months from June 2019 to August 2019. Before sample collection, consent was taken from each participant. A questionnaire was duly filled by each participant to know their personal information and also their personal and family disease history. Participants suffering from bacterial/viral infection, hemophilia, diabetes mellitus, CVD, cancer, or anemia were excluded from this study.

Blood Sample Collection

Blood was taken intravenously from all the participants in vials containing EDTA after 10 ± 2 h of fasting. As with all body fluids, blood is found to be a potential biohazard, thus care should be taken in all processes requiring handling of blood. All blood specimens were processed in the first 30 min of sample collection. Blood plasma was separated immediately.

Anthropometric Measurements and Metabolic Indices

A standard analog weighing scale was used to calculate the weight to the nearby kilogram. The measurements for waist circumference and height were taken with an elastic measuring tape to the nearest 0.5 cm. No shoes, sweaters, and jackets were included in these measurements. The waist circumference was taken at minimal respiration in the midway section between the costal margins and the iliac crests. The waist circumference and height measurements were used to evaluate the waist-to-height ratios. An algebraic sphygmomanometer was used to measure the systolic and diastolic blood pressure. Plasma glucose levels were spectrophotometrically determined using a commercially available kit (Glucose-Liqui-zyme GOD-PAP Spectrum). BMI, BRI, ABSI, total body fat mass, and body fat percentage were measured according to these formulas:

Body Mass Index (BMI) = $\text{Weight}/\text{Height}^2$ (Keys et al., 1972)

Body fat percentage (BF %) = $(1.2 \times \text{BMI})+(0.23 \times \text{age})-5.4$ (Deurenberg et al., 1991)

Total body fat mass = $\text{BF \%}/100 \times 100 \times \text{body weight (Kg)}$ (Deurenberg et al., 1991)

ABSI = $\frac{\text{Waist Circumference (WC)}}{\text{BMI}^{\frac{2}{3}} \times \text{Height}^{\frac{1}{2}}}$ (Krakauer and Krakauer, 2012)

BRI = $364.2 - 365.5 \times \sqrt{1- \left(\frac{(\text{WC}/(2\pi))^2}{(0.5 \times \text{Height})^2}\right)}$ (Thomas et al., 2013)

Lipid Profiling

Plasma triglyceride (TG) and total cholesterol (TC) levels were determined spectrophotometrically using commercially available kits (Analyticon Biotechnologies AG, 5052 and 4046 respectively). Lipoprotein fractions were provoked using high-density lipoprotein precipitation reagent (Analyticon Biotechnologies AG, 410), to estimate the high-density lipoprotein cholesterol. HDL estimation was then done by using the aforementioned Analytical kit for the quantitative determination of cholesterol. Low-density Lipoprotein Cholesterol (LDL) was determined by using the adaptable factor for triglycerides (TG), as described by (Martin et al., 2013).

Statistical Analysis

The results were scrutinized using Student’s *t*-test (non-parametric) using Graph-Pad Prism VIII Software. *P* values <0.05 were considered statistically significant.

RESULTS

Relationship of Various Lipoprotein Fractions with Gender

We first examined the relation of gender with various lipoprotein fractions including TC, TG, HDL, and LDL, both significant and non-significant results were observed. Considering total cholesterol, people with a normal range of TC showed statistically non-significant results (Figure 1a). People on abnormal levels of TC also showed non-significant results (Figure 1b). Females were more prone to risk towards abnormal TC as compared to males. Next, triglycerides were compared with gender, statistically significant results were obtained for TG abnormal patients (Figure 1d), while people on the normal range of TG showed non-significant results (Figure 1c). For a general assumption, males were at high risk of TG abnormality than females. No statistically significant results were obtained for both HDL normal and HDL abnormal category patients (Figure 1e,f). But males having abnormal HDL were more as compared to females. So, males were more prone to HDL deficiency. Statistically non-significant results were obtained for both LDL normal and abnormal patients (Figure 1g,h).

Relationship of Various Lipoprotein Fractions with Ethnicity

In our study, patients were taken from different ethnic groups, including urban and rural. When TC values were compared with ethnicity, statistically non-significant results were obtained for both urban and rural groups in which the TC ratio was normal and abnormal (Figure 2a,b).

Statistically non-significant values were obtained for the ethnicity of TG normal and TG abnormal patients (Figure 2c,d). People having abnormal TG values generally belonged to urban areas.

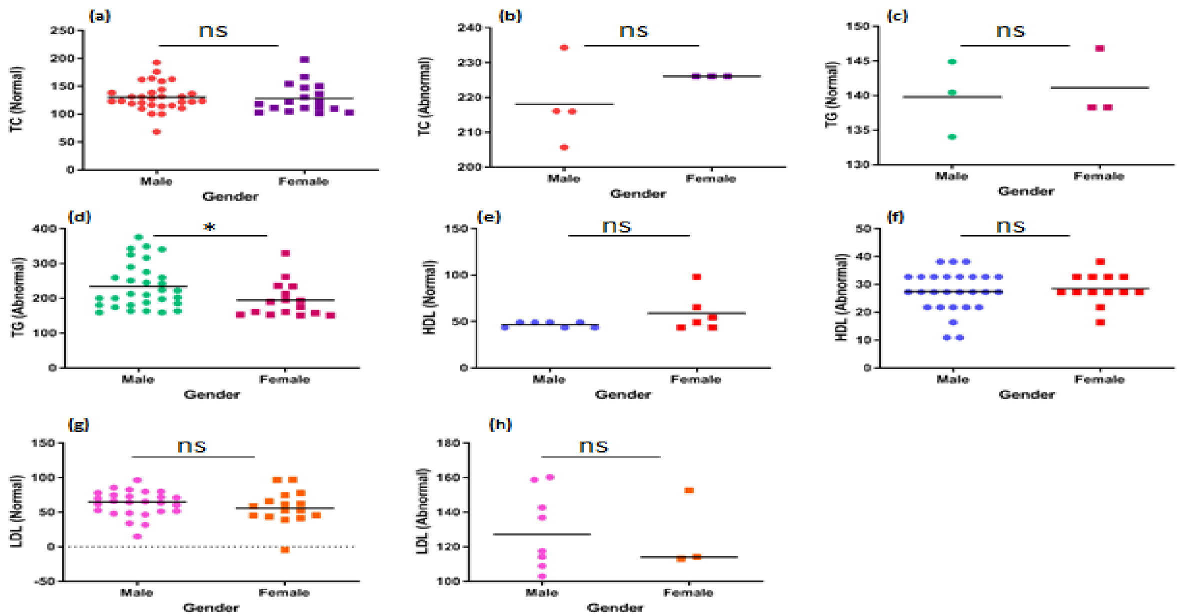

Figure 1: Relation of Lipoprotein Fractions with Gender. (a): TC (normal) relation with gender, (b): TC (abnormal) relation with gender, (c): relation of TG normal values with gender, (d): relation of TG abnormal values with gender, (e): relation of HDL normal values with gender, (f): relation of HDL abnormal values with gender, (g): LDL (normal) relation with gender, (h): LDL (abnormal) relation with gender. (*) is the symbol of statistical significance. Here (*) is showing the *p* values of < 0.05 while (ns) is showing the non-significant values.

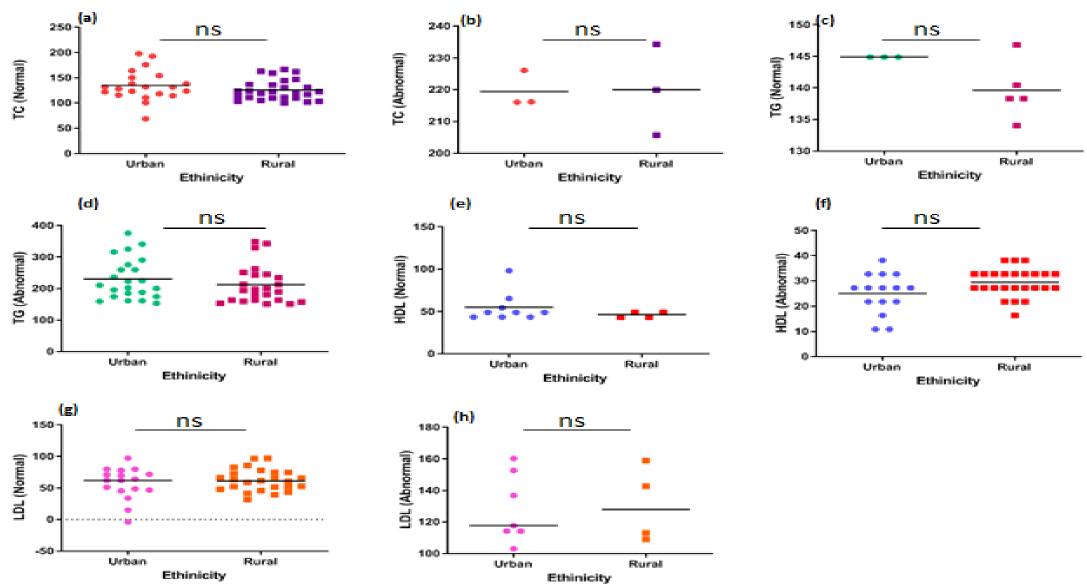

Figure 2: Relation of Lipoprotein Fractions with Ethnicity. (a): TC (normal) relation with ethnicity, (b): TC (abnormal) relation with ethnicity, (c): relation of TG normal values with ethnicity, (d): relation of TG abnormal values with ethnicity, (e): relation of HDL normal values with ethnicity, (f): relation of HDL abnormal values with ethnicity, (g): LDL (normal) relation with ethnicity, (h): LDL (abnormal) relation with ethnicity. (*) is the symbol of statistical significance. Here (*) is showing the *p* values of < 0.05 while (ns) is showing the non-significant values.

Non-significant results were obtained for both HDL normal and HDL abnormal patients (Figure 2e,f). Average values for abnormal HDL were slightly higher in the rural population, as compared to the urban population. Statistically non-significant values were obtained for both LDL normal and abnormal patients (Figure 2g,h).

Relationship of Various Lipoprotein Fractions with Occupation

Our study mostly targeted the students but people from different professional careers were also included. Statistically non-significant values were obtained for TC normal and abnormal individuals for both students and professionals (Figure 3a,b). Different levels of TG were also compared with occupation and non-significant results were obtained for both TG normal and TG abnormal patients (Figure 3c,d). Average values for TG abnormal were slightly more for professionals. Statistically non-significant values were obtained for both HDL normal and HDL abnormal individuals (Figure 3e,f). As a general idea, more professionals were showing abnormal HDL values than students. Statistically non-significant values were obtained for both LDL normal and abnormal patients (Figure 3g,h).

Anthropometric Parameters and Metabolic Indices in the Assessment of Tc Level

Different anthropometric measurements were compared with TC level and statistically non-significant results were obtained for all the parameters. The average BMI for patients with abnormal TC was observed to be 27Kg/m^2 (Figure 4a). For ABSI, the average range of people with abnormal TC lies above 0.45 (Figure 4b). BRI affected the TC level on an average below 3 (Figure 4c). Average values for systolic and diastolic blood pressure were found to be slightly above 120 and 80 respectively (Figure 4d,e). The average waist for TC patients was found to be 34cm (Figure 4f). The average age for TC patients was found to be below 30years (Figure 4g).

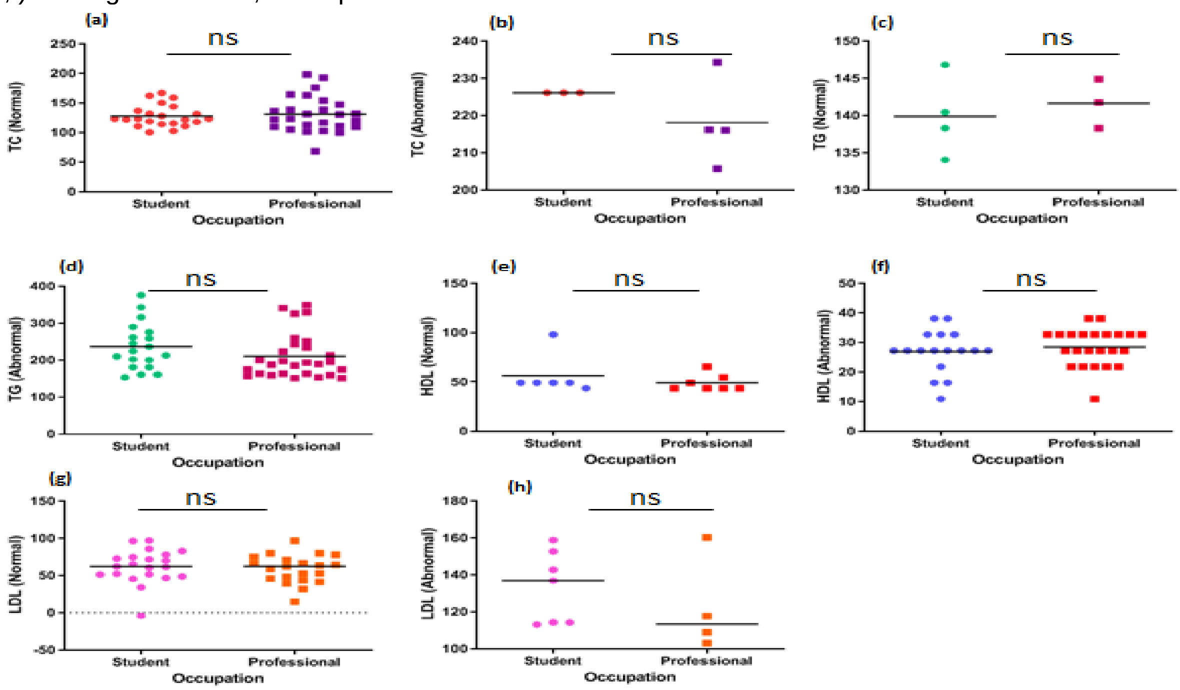

Figure 3: Relation of Lipoprotein Fractions with Occupation. (a): TC (normal) relation with occupation, (b): TC (abnormal) relation with occupation, (c): relation of TG normal values with occupation, (d): relation of TG abnormal values with occupation, (e): relation of HDL normal values with occupation, (f): relation of HDL abnormal values with occupation, (g): LDL (normal) relation with occupation, (h): LDL (abnormal) relation with occupation. (*) is the symbol of statistical significance. * is showing the *p* values of < 0.05 while (ns) is showing the non-significant values.

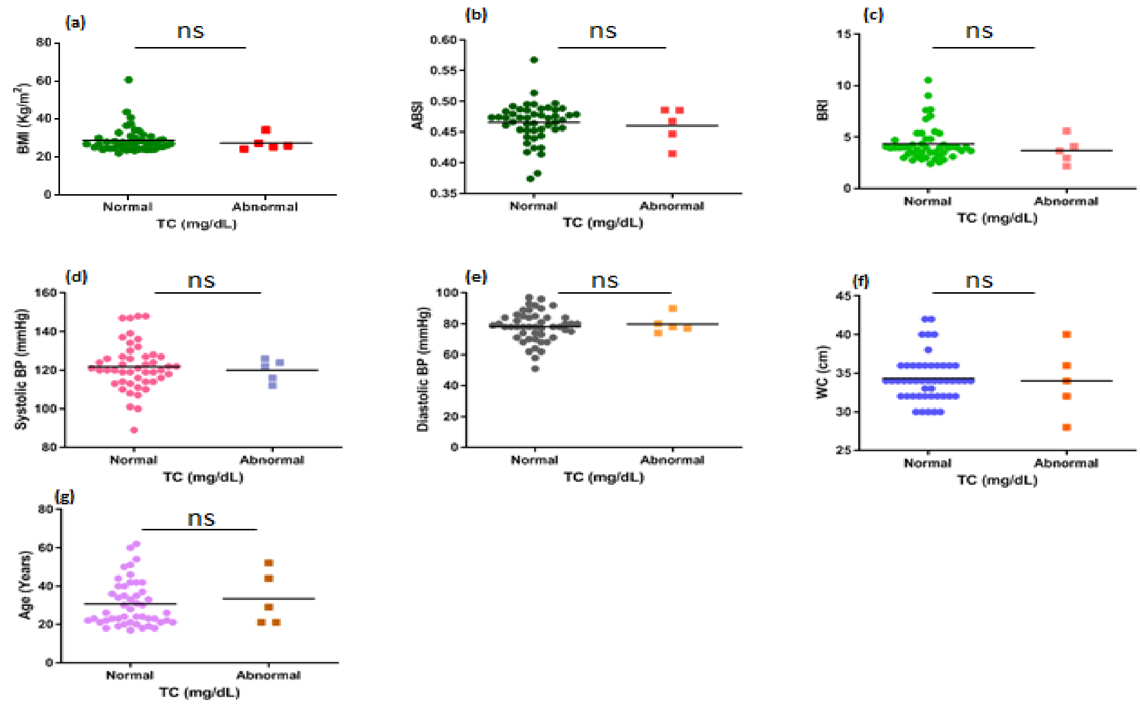

Figure 4: Anthropometric parameters in the assessment of TC. (a): BMI and severity of TC level, (b): ABSI relation with TC level, (c): BRI effect on TC level, (d): systolic BP relation with TC level, (e): diastolic BP relation with TC level, (f): wc effect on TC level, (g): age and severity of TC level. (*) shows the statistically significant values of < 0.05 while (ns) shows the non-significant values.

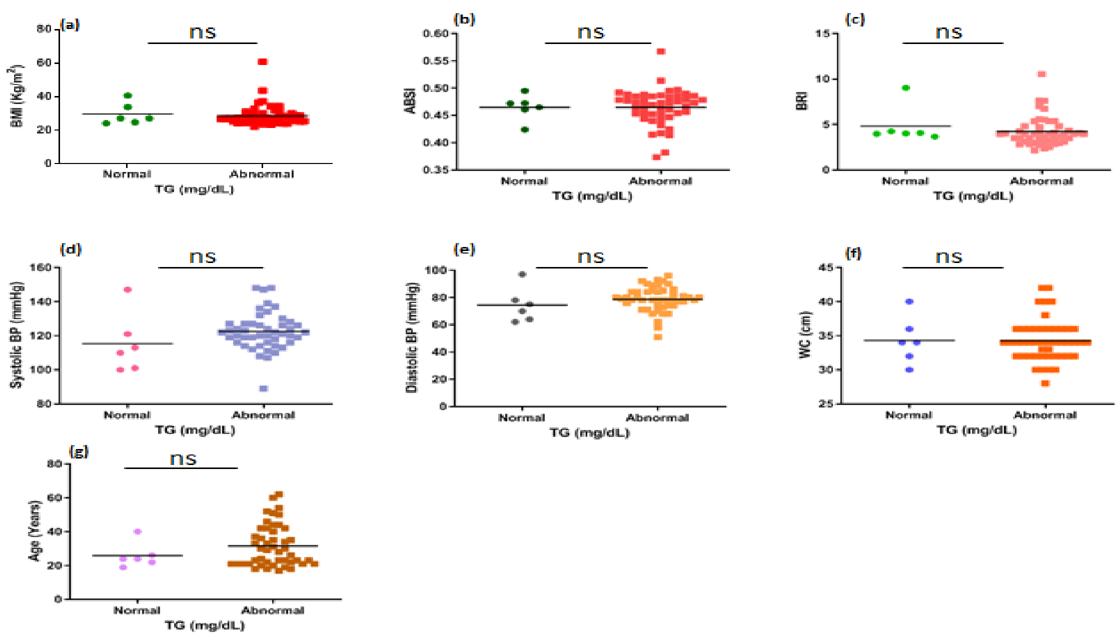

Figure 5: Anthropometric parameters in the assessment of TG. (a): BMI and severity of TG level, (b): ABSI relation with TG level, (c): BRI effect on TG level, (d): systolic BP relation with TG level, (e): diastolic BP relation with TG level, (f): wc effect on TG level, (g): age and severity of TG level. (*) shows the statistically significant values of < 0.05 while (ns) shows the non-significant values.

Anthropometric Parameters and Metabolic Indices in the Assessment of TG Level

The effect of various metabolic indices and anthropometric measurements was also determined on TG level, and statistically non-significant results were obtained. When these values were compared with TG level, a slightly high ratio was found in BMI, ABSI, BRI, systolic and diastolic blood pressure, WC, and age in TG abnormal patients (Figure 5a,b,c,d,e,f,g). The average BMI for TG patients was found to be slightly above 26Kg/m^2. Non-significant results were obtained for both ABSI and BRI, with average ranges of 0.47 and 3 respectively. WC had also a non-significant impact on TG values with an average waist of 34cm. Non-significant results were obtained for impact of age on TG levels. Average age was found to be below 30years.

Anthropometric Parameters and Metabolic Indices in the Assessment of HDL Level

In checking the effect of different metabolic indicators and anthropometric measurements on HDL level, mostly non-significant results were obtained. BMI, ABSI, and BRI had a non-significant impact on HDL concentration with average values lying above 25Kg/m^2, 0.45, and 3, respectively (Figure 6a,b,c). Systolic blood pressure had a statistically non-significant (Figure 6d) and diastolic blood pressure also had a non-significant result for patients with HDL abnormalities (Figure 6e). WC had a non-significant impact on HDL levels, with average values of about 34cm (Figure 6f). Average age was found to be below 25years (Figure 6g).

Anthropometric Parameters and Metabolic Indices in the Assessment of LDL Level

The effect of various anthropometric and metabolic indices on LDL level was also taken into consideration and both statistically significant and non-significant results were obtained. Significant values were obtained for the effect of BMI on LDL level (Figure 7a). While all other parameters showed non-significant results (Figure 7b, c, d, e, f, g). Average value for ABSI was found to be nearly 0.48, however, in the case of BRI it was 3. When we considered age as a factor for LDL level, although it did not show significant results as a general trend we might say that the LDL level was mostly disturbed above age 30years.

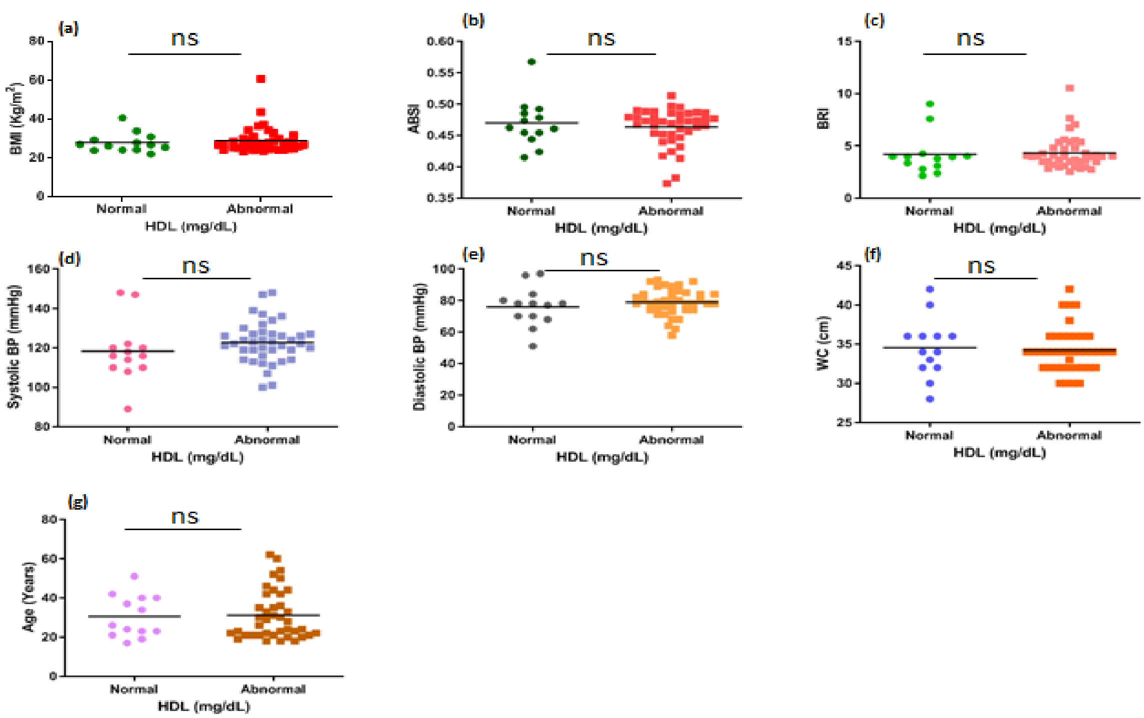

Figure 6: Anthropometric parameters in the assessment of HDL. (a): BMI and severity of HDL level, (b): ABSI relation with HDL level, (c): BRI effect on HDL level, (d): systolic BP relation with HDL level, (e): diastolic BP relation with HDL level, (f):

wc effect on HDL level, (g): age and severity of HDL level. (*) shows the statistically significant values of < 0.05 while (ns) shows the non-significant values.

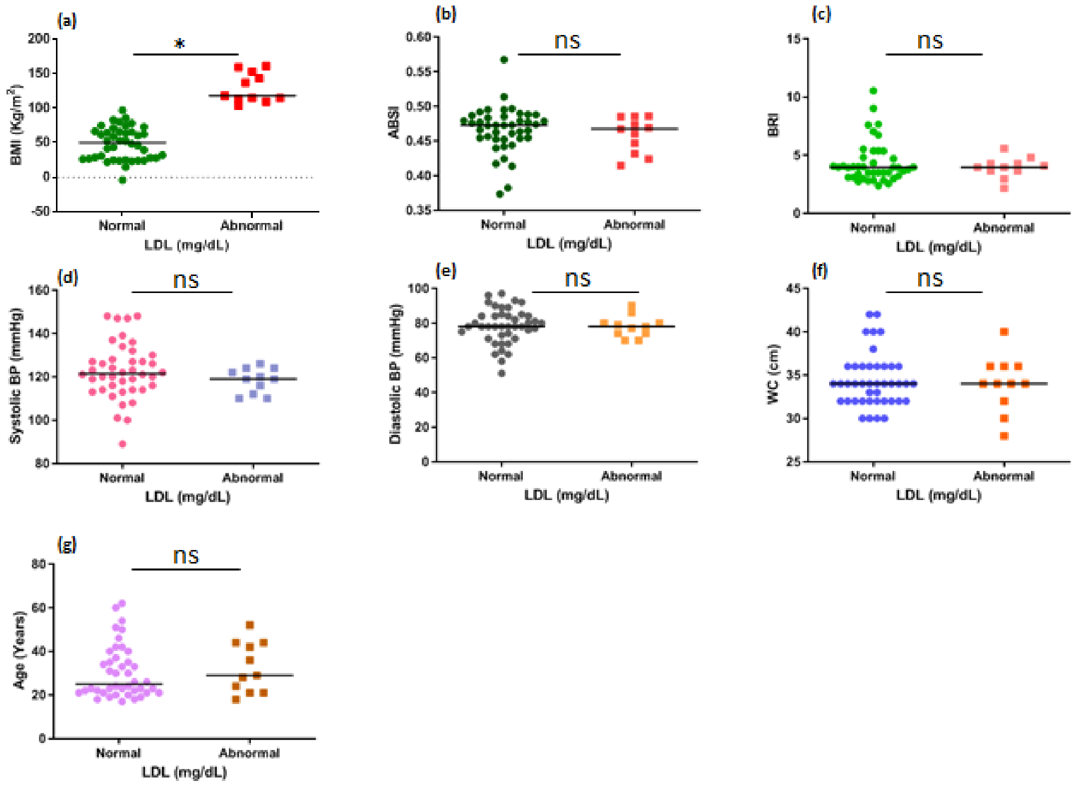

Figure 7: Anthropometric parameters in the assessment of LDL. (a): BMI and severity of LDL level, (b): ABSI relation with LDL level, (c): BRI effect on LDL level, (d): systolic BP relation with LDL level, (e): diastolic BP relation with LDL level, (f): wc effect on LDL level, (g): age and severity of LDL level. (*) shows the statistically significant values of < 0.05 while (ns) shows the non-significant values.

DISCUSSION

The major target of the presented study was to find out the correlation between dyslipidemia and various anthropometric parameters and metabolic indices. Our study included 79% of dyslipidemic and 21% of non-dyslipidemic patients. A previous study investigated the relationship between body mass index (BMI) and dyslipidemia but it was unable to present a statement on other body parameters like a body shape index (ABSI) and body roundness index (BRI) (Humayun et al., 2009). In our study, different body parameters were also compared like ABSI and BRI and statistically non-significant results were obtained, however, BRI was found significant in detecting dyslipidemia in studies conducted by (Zaid et al., 2017). BMI was found significant in assessing the severity of LDL in our population. Next, lipid profiling was performed for all the patients. Different lipoprotein fractions were compared for the statistical analysis like total cholesterol (TC), triglycerides (TG), high-density lipoprotein cholesterol (HDL), and low-density lipoprotein cholesterol (LDL), both significant and non-significant results were obtained. These lipoprotein fractions were compared with different factors like gender, ethnicity, and occupation, to know the relation between them, statistically significant and non-significant results were obtained. Further, these lipoprotein fractions were compared with different metabolic indices and anthropometric parameters. Considering the TG levels, values for different anthropometric parameters were found significant for TG abnormal category patients. We also considered TC levels by comparing them with different metabolic indices and anthropometric parameters, non-significant results were found to be associated with TC normal patients. Our study also targeted the relation of lipoprotein fractions with gender, ethnicity and occupation, both significant and non-significant results were found. When TG values were compared, males were more prone to risk towards TG abnormality than females. Considering the HDL values, males showed a high percentage of abnormal HDL as compared to females. For a general trend, people living in urban areas were more directed towards abnormal levels of TC. The rate of abnormal HDL was slightly higher in rural populations, same as studied by (Sarfraz et al., 2016). Our study revisits the information provided on dyslipidemia and plasma lipid fractions in the local Pakistani population. In our study, two lipoprotein fractions (TG and HDL), although results were not significant, generally showed more abnormal values. Abnormal levels of HDL were found to be related to the prevalence of dyslipidemia (Zaid & Hasnain, 2018). This data may have implications in the characterization and diagnosis of diseases but it can prove helpful in assessing their severity and type. Additional studies are required to know the effect of various lipoprotein fractions on HDL on a large number of population.

CONCLUSION

The current study was able to discriminate between different lipoprotein fractions and their association with different anthropometric parameters and metabolic indices. Our study includes 79% of dyslipidemic and 21% of non-dyslipidemic patients. In general, males were more prone to abnormal levels of lipoprotein fractions than females. Rural population was more susceptible to abnormal HDL levels than urban population. The newly introduced anthropometric parameters showed the same results for all the parameters in comparison with the classical indicators which were still significant in determining dyslipidemia. In future, research should be done on wide number of participants and also considering and comparing the lipoprotein fractions with other anthropometric indices, which may prove useful in assessing the type and severity of dyslipidemia. Studies should also be done on the type of polymorphisms responsible for patients having dyslipidemia, to know their genetic link.

LIST OF ABBREVIATIONS

ABSI	A body shape index
BMI	Body mass index
BRI	Body roundness index
CKD	Chronic kidney disease
CVD	Cardiovascular disease
HDL	High density lipoprotein cholesterol
LDL	Low density lipoprotein cholesterol
TC	Total cholesterol
TG	Triglycerides
VLDL	Very low-density lipoprotein cholesterol

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