ORIGINAL RESEARCH ARTICLE

Analysis of Reference Range Values of Lipid Profile and Lipid Ratio in Healthy Young Adult Population in Makassar, Indonesia

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ABSTRACT

Background: Lipids are essential for energy, hormones, digestion, and cell structure. A reference range of population-specific lipid profiles is essential due to variations. This study aimed to determine reference ranges for lipid profiles and ratios in healthy young adults in Makassar, Indonesia, and to identify specific differences by gender.

Methods: We conducted a cross-sectional study of 120 healthy young adults (61 females, 59 males) aged 20-40 years. Lipid profiles (total cholesterol, LDL, HDL, triglycerides) and ratios (cholesterol/HDL, LDL/HDL, triglycerides/HDL) were measured using spectrophotometry (Cobas C311). Data were analyzed using the Kolmogorov-Smirnov test, and reference ranges were established using 2.5-97.5 percentiles.

Results: The overall reference ranges were: cholesterol 133.02-254.75 mg/dL, LDL 73.00-181.82 mg/dL, HDL 23.02-62.97 mg/dL, triglycerides 34.02-319.90 mg/dL, cholesterol/HDL 2.57-8.52, LDL/HDL 1.34-6.13, and triglycerides/HDL 0.60-10.31. Gender-specific ranges showed: women (cholesterol 114.05-252.65 mg/dL, LDL 65.85-175.95 mg/dL, HDL 25.55-75.70 mg/dL, triglycerides 37.30-294.00 mg/dL, cholesterol/HDL 2.55-8.17, LDL/HDL 1.29-5.05, triglycerides/HDL 0. 59-9.64) and men (cholesterol 135.50-255.50 mg/dL, LDL 78.50-196.00 mg/dL, HDL 20.50-61.50 mg/dL, triglycerides 33.50-360.50 mg/dL, cholesterol/HDL 2.54-9.98, LDL/HDL 1.39-6.40, triglycerides/HDL 0.65-17.74).

Conclusion: This study established population-specific and gender-specific reference ranges for lipid profiles and ratios in healthy young adults in Makassar, Indonesia, providing valuable clinical data.

Keywords: Lipid profile, Lipid Ratio, Healthy young adults, Reference Range

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INTRODUCTION

Accurate interpretation of lipid profiles is crucial for assessing cardiovascular risk, a global health concern. Lipid profiles, encompassing cholesterol, LDL, HDL, and triglycerides, are essential indicators of cardiovascular health.[1,2] Deviations from established reference ranges can signify increased risk for atherosclerosis and coronary heart disease, highlighting the necessity for accurate population-specific reference intervals.[3,4]

Clinical laboratories play a pivotal role in healthcare, with laboratory data informing over 70% of clinical decisions. Reliable reference intervals are fundamental for interpreting laboratory results, yet these intervals can vary significantly across populations due to genetic, lifestyle, and environmental factors. Therefore, establishing population-specific reference ranges is essential for precise clinical assessments.[5-7]

Young adulthood (18-40 years) represents a critical period for health monitoring and intervention, as lifestyle habits formed during this phase significantly impact long-term health outcomes.[8,9] In Indonesia, where a substantial portion of the population falls within this age group, there is a need for locally derived reference intervals for lipid profiles.

Lipid profile screening, a series of blood tests measuring fat levels, is vital for determining potential cardiovascular disease, pancreatitis, and diabetes risks.[10] The lipid profile ratio, a comparison between lipid components (LDL/HDL, TG/HDL, total cholesterol/HDL), is increasingly used to predict cardiovascular risk. Establishing reference ranges for these ratios in our target population is essential for accurate risk assessment.[11,12]

Previous studies have demonstrated that reference values can differ significantly between populations, emphasizing the need for locally relevant data. Therefore, this study focused on a cohort of healthy young adults (20-40 years) in Makassar. Lipid profiles were analyzed using standardized spectrophotometric methods, and data were statistically analyzed to determine the 2.5th-97.5th percentile reference ranges.[13,14]

Accurate interpretation of laboratory results is critical for clinical decision-making, with reference intervals defining normal ranges in healthy populations.[15,16] However, these intervals vary significantly across demographics due to genetic, lifestyle, and environmental factors, necessitating population-specific standards for reliable assessments. This is particularly relevant for lipid profiles, vital indicators of cardiovascular risk.[17,18] Given the clinical importance of lipid profiles, population-relevant reference intervals are essential. Consequently, this study aims to establish reference ranges for lipid profiles and ratios in healthy young adults in Makassar, Indonesia, a critical age for health intervention. We will provide valuable data to improve lipid profile interpretation and cardiovascular risk assessment by determining these ranges, ultimately enhancing clinical laboratory services and patient care.

Establishing these population-specific reference ranges will provide critical data to enhance the precision of lipid profile interpretation, thereby directly improving cardiovascular risk assessment within the Makassar community. This research contributes significantly to the growing knowledge of population-specific reference intervals, ultimately fostering higher-quality clinical laboratory services and optimizing patient care throughout South Sulawesi, Makassar, Indonesia.

METHODOLOGY

Study Design: This study employed a cross-sectional design to establish reference ranges for lipid profiles in healthy adults. Data were collected between April and March 2024 at the Clinical Pathology Laboratory, Research Unit of Hasanuddin University Hospital (RSUH), Makassar City, Indonesia.

Participants and Sampling: Participants were recruited using convenience sampling from individuals presenting to the Clinical Pathology Laboratory, RSUH, for routine health checkups or other non-lipid-related investigations. To enhance the representativeness of the sample for the general healthy adult population within the study area, the following measures were implemented:

Inclusion Criteria: Males and females aged 18-40 years, residing in Makassar City and surrounding areas, who provided written informed consent.

Exclusion Criteria: Pregnancy, current use of lipid-lowering medications, age outside the 18–40-year range, presence of clinically diagnosed infections or inflammatory conditions, history of tumors or cancer, and visual evidence of icteric, lipemic, or hemolyzed serum.

Assessment of Health Status: Before inclusion, all participants underwent a standardized health assessment, including measurement of weight, height, blood pressure, oral glucose tolerance test (OGTT), and fasting blood glucose (FPG). Body mass index (BMI) was calculated. This comprehensive assessment aimed to identify and exclude individuals with potential confounding health conditions.

The study received ethical approval from the Health Research Ethics Committee with ethical approval number 255/UN4.6.4.5.31/PP36/2024.

Sample Collection and Preparation: Blood samples were collected by trained phlebotomists using standard venipuncture techniques. Sterile syringes, needles, and vacuum tubes were used, and skin disinfection was performed with 70% alcohol swabs. Blood samples were allowed to clot for 15-30 minutes at room temperature before centrifugation at 3000 rpm for 5-10 minutes to separate the serum.

The separated serum was then aliquoted into sample cups and stored at -20°C until analysis.

Laboratory Analysis: Serum lipid profile (total cholesterol, triglycerides, HDL-cholesterol, and LDL-cholesterol) was measured using the Cobas c311 automated analyzer (Roche Diagnostics) at the Clinical Pathology Laboratory of Labuang Baji Hospital, Makassar City, Indonesia. The spectrophotometric method for each lipid parameter followed the manufacturer's standardized protocol based on enzymatic colorimetric assays. The specific protocols used are those provided by Roche Diagnostics for the Cobas c311 platform. The measurement ranges were as follows: triglycerides <150 mg/dL, HDL 40–60 mg/dL, LDL <100 mg/dL, and total cholesterol <200 mg/dL.

Statistical Analysis: Data were analyzed using IBM SPSS Statistics software version 25. Descriptive statistics, including range, median, mean, and standard deviation, were calculated for each lipid parameter. The normality of data distribution was assessed using the Kolmogorov-Smirnov test.

Inferential statistical tests were performed to determine if there were significant differences in lipid values between male and female participants. Specifically, independent samples t-tests were used for normally distributed data, and the Mann-Whitney U test was used for non-normally distributed data. Reference ranges for lipid profiles and ratios were established by calculating the 2.5th and 97.5th percentiles of the data distribution.

RESULTS

This study was conducted from March to May 2024 at Hasanuddin University Hospital Makassar and the Labuang Baji Hospital Clinical Pathology Laboratory with a total sample size of 120 subjects consisting of 59 males and 61 females with an average age of 31.5 years. In the study, there was a height with an average of 160.92 cm, an average body weight of 66.49 Kg, an average BMI of 25.39 Kg/m2, FPG with an average of 97.88 mg/dL and OGTT 100.86 mg/dL, An average of 116.53 mmHg for the systolic and 74.41 mmHg for the diastolic blood pressure, then cholesterol with an average of 182.34 mg/dL, LDL with an average of 115.99 mg/dL, HDL with an average of 40.71 mg/dL, triglycerides with an average of 106.71 mg/dL, for the lipid profile ratio, namely LDL/HDL with an average of 3.09, Triglycerides/HDL with an average of 3.09, and cholesterol/HDL with an average of 4.83. This study used serum samples and examined lipid profiles and ratios using spectrophotometric methods at the Labuang Baji Hospital Laboratory. Considering the characteristics of the research participants, the following data were obtained in Table 1.

Through the Kolmogorov-Smirnov test in Table 2, the resulting p-value on cholesterol in female subjects is p-value> 0.05, so the data is usually distributed.

Table 1: General Characteristics of Research Subjects

Variables	Mean ± SD	Median	Min-Max
Age (years)	31.54±4.83	32.00	20-40
Height (cm)	160.92±8.56	159.00	145-184
Body weight (Kg)	66.48±16.53	64.85	38,0-130,1
BMI (Kg/m)^2	25.39±5.02	25.20	15,3-45,0
FPG (mg/dL)	97.88±13.55	96.00	69-192
Systolic BP (mmHg)	116.53±9.47	120.00	90-150
Diastolic BP (mmHg)	74.41±7.63	70.00	60-95
OGTT (mg/dL)	100.86±39.15	97.50	5-386
Cholesterol (mg/dL)	182.34±31.15	185.00	108-262
LDL (mg/dL)	115.99±28.59	116.50	62-201
HDL (mg/dL)	40.71±11.24	41.00	19-79
Triglycerides(mg/dL)	106.71±68.97	86.50	33-378
LDL/HDL ratio	3.09±1.19	2.81	1.25-6.53
Triglyceride/HDL Ratio	3.09±2,88	2.01	0.57-19.89
Cholesterol/HDL Ratio	4.83±1,63	4.56	2.42-10.32

Source: Primary data
Description: Mean = Average, SD = Standard Deviation, Median = Middle Value, Min = Minimum, Max = Maximum

Table 2: Normality Test

Variables	p-value	Description
Female (n=61)		
Cholesterol	>0.05	Normally distributed
LDL	>0.05	Normally distributed
HDL	>0.05	Normally distributed
Triglycerides	<0.05*	Not normally distributed
Cholesterol/HDL Ratio	<0.05*	Not normally distributed
LDL/HDL Ratio	>0.05	Normally distributed
Triglyceride/HDL Ratio	<0.05*	Not normally distributed
Male (n=59)		
Cholesterol	>0.05	Normally distributed
LDL	>0.05	Normally distributed
HDL	<0.05*	Not normally distributed
Triglycerides	<0.05*	Not normally distributed
Cholesterol/HDL Ratio	<0.05*	Not normally distributed
LDL/HDL Ratio	<0.05*	Not normally distributed
Triglyceride/HDL Ratio	<0.05*	Not normally distributed

***Kolmogorov-Smirnov test. (**<0.05*: Mann-Whitney U test, >0.05: Independent samples t-test)

The p-value on LDL of female subjects is p-value> 0.05 for the data to be deemed regularly distributed. The p-value of HDL in female subjects is p-value>0.05. Consequently, the data is considered to be regularly distributed. The p-value on Triglycerides of female subjects is p-value <0.05*, so it is stated that the data is not normally distributed. The p-value on the Cholesterol/HDL ratio of female subjects is p-value <0.05*; thus, the data is said to be non-normally distributed. The p-value in the LDL/HDL ratio of female subjects is p-value> 0.05, so it is stated that the data is usually distributed. The p-value on the Triglyceride / HDL ratio of female subjects is p-value <0.05*, so it is noted that the data is not normally distributed. The p-value on the Cholesterol of male subjects is p-value >0.05 so that the data is declared normally distributed. The p-value on LDL of male subjects is p-value >0.05, so it is stated that the data is usually distributed. The p-value on HDL of male subjects is p-value <0.05*; consequently, it is claimed that the data is not regularly disseminated.

Table 3: Lipid profile and lipid ratio reference range values by gender

Variables	Mean ± SD	Reference range (2.5- percentile 97.5%)
Female (n=61)		
Cholesterol	180.23±33.50	114.05 – 252.65
LDL	111.72±28.47	65.85 – 175.95
HDL	42.66±11.90	25.55 – 75.7
Triglycerides	93.59±62.66	37.3 - 294
Cholesterol/HDL Ratio	4.51±1.38	2.55 – 8.17
LDL/HDL Ratio	2.74±0.94	1.29 – 5.05
Triglycerides/HDL Ratio	2.47±2.05	0.59 – 9.64
Male (n=59)		
Cholesterol	184.53±28.64	135.5 – 255.5
LDL	120.41±28.28	78.5 - 196
HDL	38.71±10.23	20.5 – 61.5
Triglycerides	120.29±72.99	33.5 – 360.5
Cholesterol/HDL Ratio	5.17±1.81	2.54 – 9.98
LDL/HDL Ratio	3.39 ±1.34	1.39 – 6.4
Triglycerides/HDL Ratio	3.72±3.44	0.65 - 17.74
Total (n=120)		
Cholesterol	182.34±31.15	133.02 – 254.75
LDL	115.99±28.59	73 – 181.82
HDL	40.71±11.24	23.02 – 62.97
Triglycerides	106.71±68.97	34.02 – 319.9
Cholesterol/HDL Ratio	3.09±1.19	2.57 – 8.52
LDL/HDL Ratio	3,09±2,88	1.34 – 6.13
Triglycerides/HDL Ratio	4.83±1.63	0.60 – 10.31

Source: Primary Data

Since the p-value on triglycerides of male subjects is less than 0.05*, it may be said that the data is not regularly distributed. The p-value on the Cholesterol/HDL ratio of male subjects is that it is said that the data is not regularly distributed since the p-value is less than 0.05*. The P-value on the LDL/HDL ratio of male subjects is p-value <0.05*, so it is stated that the data is not normally distributed. The p-value on the Triglyceride/HDL ratio of male subjects is p-value <0.05*, so it is claimed that the data is not distributed regularly.

Based on the normality test of lipid profile levels and lipid ratios, it was concluded that the data were usually and abnormally distributed. The results are tested for percentile statistics to determine the reference range of lipid profiles and lipid ratios based on gender (Table 3).

Table 3 shows that based on the statistical test results of the 2.5% - 97.5% percentile, *the reference range of* lipid profiles and lipid ratios in a healthy young adult population of female gender is obtained, namely cholesterol 114.05 - 252.65 mg/dL, LDL 65.85 - 175.95 mg/dL, HDL 25.55 - 75.7 mg/dL, Triglycerides 37.3 - 294 mg/dL, Cholesterol/HDL ratio 2.55 - 8.17 mg/dL, LDL/HDL ratio 1.29 - 5.05 mg/dL, Triglyceride/HDL ratio 0.59 - 9.64 mg/dL. The results of the statistical test of percentiles 2.5% - 97.5% obtained a *reference range of* lipid profiles and lipid ratios in the healthy young adult population of male sex, namely cholesterol 135.5 - 255.5 mg/dL, LDL 78.5 - 196 mg/dL, HDL 20.5 - 61.5 mg/dL, Triglycerides 33.5 - 36.5 mg/dL, the ratio of triglyceride/HDL to cholesterol.

Cholesterol/HDL 2.54 - 9.98 mg/dL, LDL/HDL ratio 1.39 - 6.4 mg/dL, and ratio Triglycerides/HDL 0.65 - 17.74 mg/dL. Based on the normality test of lipid profile levels and lipid ratios, it was concluded that the data were usually and abnormally distributed. To find out the *reference range of* lipid profiles and lipid ratios in the healthy young adult population, the results are tested in percentile statistics Table 3.

Table 3 shows the statistical test results of the 2.5% - 97.5% obtained *reference range of* lipid profiles and lipid ratios in the overall healthy young adult population, namely cholesterol 133.02 - 254.75 mg/dL with a mean value of 182.34 mg/dL, LDL 73–181.82 with an average of 115.99 mg/dL, HDL 23.02–62.97 mg/dL with an average of 40.71 mg/dL, Triglycerides 34.02–319.9 mg/dL with an average of 106.71 mg/dL, Cholesterol/HDL ratio 2.57–8.52 mg/dL with an average of 182.34 mg/dL, LDL/HDL ratio 1.34–613 mg/dL with an average of 3.09 mg/dL, and Triglyceride/HDL ratio 0.60–10.31 mg/dL with an average of 182.34 mg/dL.

Discussion

This study aimed to determine the reference range of lipid profile and lipid ratio in the healthy young adult population in Makassar, which was conducted at Hasanuddin University Hospital and Labuang Baji Hospital Clinical Pathology Laboratory. Involving 120 healthy young adult subjects (59 males and 61 females) aged 18-40 years, this study provides important data regarding lipid profiles in the local population.

The study findings consistently showed variability in the reference ranges of lipid profiles across different populations, which included total cholesterol, LDL, HDL, triglycerides, and lipid ratios. Significant variations were evident, although the observed reference ranges generally aligned with those reported in other studies. This underscores the importance of considering population-specific factors when interpreting lipid profiles. Studies such as those conducted by Balder et al.[19] (Netherlands, 2017), Ireshanavar et al.[20] (India, 2019), Prameela CR et al.[21] (India, 2021), Mohammed O et al.[22] (Ethiopia, 2024), and Shim et al.[23] (Korea, 2016) highlight the influence of age, gender, ethnicity, and environmental factors on lipid levels. These studies collectively emphasized the need to establish and use local reference intervals rather than relying solely on generic standards or standards provided by manufacturers to ensure accurate clinical interpretation and patient management.

Comparison with Other Studies and In-depth Analysis: The findings of this study contribute to the growing body of evidence highlighting the variability of lipid profile reference ranges across different populations. Our results showed significant variation in total cholesterol, LDL-C, HDL-C, triglycerides, and lipid ratios. These observations are consistent with previous studies emphasizing the importance of establishing population-specific reference intervals for accurate cardiovascular risk assessment and management.

Several studies have documented how lipid profiles differ based on demographic factors such as age, gender, ethnicity, and lifestyle. For instance, a study on a large Dutch population (Balder et al., 2017) revealed significant age- and gender-related differences in lipid levels, with men showing a steeper increase in LDL-C and triglycerides with age, and women exhibiting a significant increase in LDL-C after 35 years of age. This highlights the importance of considering age and gender when interpreting lipid profiles.[19]

Furthermore, research conducted in India has indicated that reference ranges for lipid profiles in the Indian population tend to be broader than Western standards (Ireshanavar et al., 2019). This observation was attributed to diet, ethnicity, and environment differences, underscoring the need for localized reference intervals.[20] Similarly, another study in Kerala, India (Prameela CR et al., 2021), established reference intervals for total cholesterol, HDL-C, LDL-C, and triglycerides, noting that these were higher than the desirable limits suggested by international guidelines and also found gender differences.[21]

Population-specific studies are further emphasized by research on children and adolescents. For example, studies in Addis Ababa, Ethiopia (Mohammed et al. 2024), and Korea (Shim et al., 2016) revealed significant gender differences in lipid values. They highlighted the need for individualized interpretations of lipid profiles in younger populations. These studies demonstrate that reference intervals established in one population may not apply to another, particularly in pediatric populations.[22,23]

The variability in lipid profile reference ranges across different populations, as observed in our study and supported by existing literature, underscores the need for further population-specific studies. Age, gender, ethnicity, and lifestyle are crucial in influencing lipid levels, and establishing localized reference intervals is essential for accurately assessing and managing cardiovascular risk.

Table 4: Reference range of lipid profiles and lipid ratios from various countries

Reference	Country	Age group	Variables	Methods	Reference range	Unit system
(Aziz Khan et al., 2014)	India	27-58 years old	Cholesterol HDL LDL Triglycerides Cholesterol/H DL	Spectrophoto metric	150-250 60 60-130 100-150 4.0	mg/dL
(Diareme et al., 2009)	Greece	18-46 years old	Cholesterol Triglyceride HDL LDL	Enzymatic assay of CHOD-PAP, GPO-PAP	62.34-103 7.38-32.25 14.95-40.4 5.4-71.14	mg/dL
(Piechota Staszewski, 1992)	Poland	17-44 years old	Cholesterol HDL LDL Triglycerides	Boehringer-Mannheim enzymatic assay	73.69-117 15.85-41.98 40.54-78.2 10.3-34.95	mg/dL
(Taha et al., 2013)	Iran (Female)	1-55 years	Cholesterol HDL LDL Triglycerides	enzymatic assay of CHOD-PAP, GPO-PAP	175.3 ± 37.07 46.37 ± 11.91 107.11 ± 33.52 108.95 ±51.81	mg/dL
(Taha et al., 2013)	Iran (Male)	1-55 years	cholesterol HDL LDL Triglycerides	enzymatic assay of CHOD-PAP, GPO-PAP	177.07 ± 42.48 38.13 ± 9.45 111.48 ± 32.8 127.58 ±54.97	mg/dL
(Abe et al., 2015)	Japan	9-16 years	cholesterol HDL LDL Triglycerides	enzymatic assay of CHOD-PAP, GPO-PAP	171-216 63-85 102-151 99-211	mg/dL
This research, 2024	Indonesia	18-40 years old	cholesterol HDL LDL Triglyceride Cholesterol/HDL Ratio LDL/HDL ratio Triglyceride/HDL ratio	Spectrophoto Metric, enzymatic colorimetric	133.02-254.75 23.02 - 62.97 73 -181.82 34.02 - 319.9 2.57 -8.52 1.34 -6.13 0.6 -10.31	mg/dL

Explanation of Gender-Based Lipid Profile Differences: The complex interactions between hormonal factors, body fat distribution, lifestyle, and genetics can explain the significant lipid profile differences between men and women in this study. Men generally tend towards higher triglyceride and LDL levels, while women have higher HDL levels. Hormonally, estrogen in women exerts a protective effect by increasing HDL and decreasing LDL, in contrast to testosterone in men, which tends to increase triglycerides and decrease HDL. In addition, differences in body fat distribution between the sexes also affect lipid metabolism. Lifestyle factors, such as smoking habits, alcohol consumption, and physical activity levels, contribute to variations in lipid profiles. Finally, underlying genetic factors also play a role in determining an individual's lipid profile, where genetic differences between men and women can affect overall lipid metabolism.

Potential Confounding Factors: In interpreting the results of this study, it is important to acknowledge the potential confounding factors that could affect the subjects' lipid profiles. These factors include a diet rich in saturated fat, trans fat, and cholesterol, which can directly increase blood lipid levels. In addition, a family history of cardiovascular disease or dyslipidemia suggests a genetic predisposition that may affect an individual's lipid profile. A sedentary lifestyle, smoking, and excessive alcohol consumption are also known to hurt lipid levels. Certain medical conditions, such as diabetes, thyroid disorders, and kidney disease, can affect lipid metabolism and alter lipid profiles. Finally, certain medications, including beta-blockers and corticosteroids, can affect lipid levels. Therefore, it is important to consider and control these factors in future studies to obtain more accurate and reliable results.

This study provides important data regarding the reference range of lipid profiles and lipid ratios in Makassar, Indonesia's healthy young adult population. Comparison with other studies showed significant variation, emphasizing the importance of population-specific reference ranges. Differences in lipid profiles by gender may be explained by hormonal factors, body fat distribution, lifestyle, and genetics. Potential confounding factors, such as diet, genetics, lifestyle, medical conditions, and medications, must be considered when interpreting the results.

Strengths and Limitations

This study is valuable for understanding lipid profiles and ratios within a healthy young adult demographic. The methodology employed, characterized by rigorous participant selection criteria and a defined sample size (n=120), enhances the internal validity of the findings. Establishing a reference range within the specific geographical context of Makassar, South Sulawesi, provides a clinically relevant tool for local healthcare practitioners in assessing cardiovascular risk. Furthermore, this research contributes to the broader knowledge base regarding lipid parameters in young adults, a population often underrepresented in such studies.

However, several limitations must be acknowledged. Firstly, the relatively restricted sample size and the participant cohort's geographically specific nature may limit the findings' external validity and generalizability to broader populations. Future investigations incorporating more extensive, diverse samples encompassing varied ethnicities and geographic locations are warranted to confirm and expand upon these results. Secondly, excluding lifestyle factors, such as dietary habits and physical activity levels, constitutes a significant methodological limitation. These variables are well-established determinants of lipid profiles, and their omission may introduce potential confounding effects that may influence the observed reference ranges. Consequently, the interpretation of these findings should be undertaken with caution, considering the potential impact of unmeasured lifestyle influences.

Furthermore, the cross-sectional design of this study precludes the establishment of temporal relationships or the assessment of long-term trends in lipid profiles. Longitudinal studies employing repeated measurements over extended periods are necessary to elucidate the dynamic changes in lipid parameters and their associations with cardiovascular risk in young adults. Finally, while the study employed the Kolmogorov-Smirnov test to assess normality, the presence of non-normally distributed variables, particularly triglycerides and related ratios, as indicated in Table 2, necessitates the use of non-parametric statistical methods for comparisons. This methodological consideration should be explicitly addressed in subsequent analyses and interpretations to ensure the robustness of the findings. Addressing these limitations in future research endeavors will contribute to a more comprehensive and nuanced understanding of lipid profiles and ratios in young adults.

Conclusion

This study established reference range values for lipid profiles and ratios in a healthy young adult population aged 18-40 in Makassar. Findings showed variations in these values between genders. Both male and female subjects showed a wide range of lipid profiles and ratios, highlighting the importance of individual assessment. These reference values may serve as a valuable tool for clinicians in assessing cardiovascular risk and guiding appropriate interventions in this population. Further research is needed to explore the impact of lifestyle factors and genetic influences on this demographic's lipid profiles and ratios.

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Availability of Data: Data are available from the corresponding author upon request

No use of generative AI: This article was prepared without the use of generative AI tools for content creation, analysis, or data generation. All finding s and interpretations are based solely on the authors independent work and expertise.

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