AMLS Archives of Medical Laboratory Sciences

Original Article

# Reference Interval for Fasting Blood Sugar, Triglycerides, Total Cholesterol, Low-Density Lipoprotein, and High-Density Lipoprotein-Cholesterol in Healthy Babolian Individuals

**Mehdi Gholami Bahnemiri[1], Fereshteh Amiri[2], Parisa Khanicheragh[3], Fahimeh Safizadeh[4], Fariba Mohammadi Tahroodi[5], Arefeh Akbari Javar[6], Hourieh Aram[7], Seyed Mostafa Mir[1], Negar Yavari[8*]**

1- Department of Biochemistry, School of Medicine, Babol University of Medical Sciences, Babol, Iran.
2- Department of Biology, Islamic Azad University- Science and Research Branch, Tehran, Iran.
3- Department of Clinical Biochemistry, Lorestan University of Medical Sciences, Lorestan, Iran.
4- Iranian Social Security Organization, Kerman, Iran.
5- Department of Biochemistry, School of Medicine, Kerman University of Medical Sciences, Kerman, Iran.
6- Department of Pathobiology, School of Veterinary Medicine, Shahid Bahonar University of Kerman, Kerman, Iran.
7- Department of Immunology, School of Medicine, Shahid Beheshti University of Medical Sciences, Tehran, Iran.
8- Department of Physiology, Isfahan University of Medical Sciences, Isfahan, Iran.

Received: 12 September 2019, Accepted: 22 November 2019

## Abstract

**Background and Aim:** Sugar and Lipid disorders are the main risk factors for vascular abnormalities. Due to the gender and age, other variables can influence serum Fasting blood sugar and lipid levels, certifying the determination of population-specific reference interval. This study was designed to investigate the age- and gender-specific reference values for serum Fasting blood sugar (FBS), triglycerides (TG), total cholesterol (TC), low-density lipoprotein (LDL), high-density lipoprotein-cholesterol (HDL) in healthy Babolian adults. **Methods:** FBS, TC, TG, and HDL were calculating applying the colorimetric method. The Friedewald equation (LDL=TC−HDL−TG/5) was used to calculate LDL concentrations in individuals. After using the exclusion parameters, 519 participants (199 men and 320 women) aged ≥23 years were included. The Clinical Chemistry guidelines of the International Federation applied for characterizing the reference values for samples. **Results:** Reference values for serum FBS, TG, TC, LDL, HDL were 77.01-107.69 mg/dL, 35.34-204.38 mg/dL, 117.97-242.81 mg/dL, 47.6-137.16 mg/dL and 33.29-67.13 mg/dL in men. In women, reference values for serum FBS, TG, TC, LDL, HDL were 75.03-107.99, 27.49-192.33 mg/dL, 125.84-244.32 mg/dL, 44.08-139.48 mg/dL and 36.66-81.1 mg/dL. FBS, TG, and LDL parameters were higher in men, and TC and HDL parameters were higher in women. **Conclusion:** Reference values for serum FBS, TC, TG, LDL, HDL in healthy Babolian adults were specified, and these data could supply a clear pathway for better decision making in both clinical settings and prevention.

**Keywords:** Cholesterol, Fasting Blood Sugar, Lipid Profile, Reference Interval Values, Triglycerides.

***Corresponding Author:** Negar Yavari; **Email:** negar.yavari94@gmail.com

**Please cite this article as:** Gholami Bahnemiri M, Amiri M, Khanicheragh M, Safizadeh F, Mohammadi Tahroodi F, Akbari Javar A, Aram H, Mir SM, Yavari N. Reference Interval for Fasting Blood Sugar, Triglycerides, Total Cholesterol, Low-density Lipoprotein, and High-density Lipoprotein-cholesterol in Healthy Babolian Individuals. Arch Med Lab Sci. 2019;5(4):14-20. https://doi.org/10.22037/amls.v5i4.29927

## Introduction

Glucose and Lipid disorders, leading risk factors for vascular diseases, especially cardiovascular diseases (CVD), are the primary reason for mortality worldwide (1-3). Circulating levels of FBS, (3) total cholesterol (TC), (4) low-density lipoprotein-cholesterol (LDL-C), (4, 5) high-density lipoprotein-cholesterol (HDL-C) (6) and triglycerides (TG) (7, 8) are characterized to be associated with many diseases. Reference intervals are the most comprehensive decision-making tools used by medical scientists and doctors (9, 10) that help doctors and clinicians interpret laboratory

results, and therefore these references are the main criteria for clinical experiments (11-13). In addition to age and gender, serum lipid profiles would be affected by other factors such as lifestyle, dietary habits, ethnicity, genetic background, and environment (14). Different populations own different ranges of serum glucose and lipid profiles, which show why the International Federation of Clinical Chemistry (IFCC) insists on determining population-specific reference values (15-17). There are different ways adopted for glucose and Lipid measuring, and it is one of the reasons that may have some role in variation, which could not be ignored (18-20). Developing countries, including Iran, are following the pattern of developed countries for measuring reference values. However, in Iran, most clinical Labs follow the reference intervals ranged in the Western population. However, due to the different lifestyles of Iranian society, these international data usually do not match with the Iranian community, especially in the case of FBS and lipid profile (15, 21, 22). Thus, there is a significant need to set up some studies for calculating reference values of the specific population's biochemical parameters rather than take a set of reference values determined for one people and apply it to another community since there is a few investigations have been proceeded in Iran(15, 23). The present experiment was established to assess the reference interval of FBS, TG, TC, LDL, and HDL in a reference population taken from 519 patients in the Razi laboratory of Babol city.

## Methods

The present study was a descriptive study conducted in 2017, apparently healthy individuals and residents in Babol city (Mazandaran Province, Iran), ranging in age from 23 to 82 years old. Samples were chosen randomly from 519 individuals (199 men (38.3%) and 320 women (61.7%)) referring to the Razi laboratory in Babol, who had no history of blood sugar lowering drugs (Glibenclamide or/and metformin), antihypertensive agents (losartan) or HMG-CoA Reductase Inhibitors (Statins). The participants' blood pressure and blood sugar were normal and did not have any underlying diseases such as diabetes, metabolic syndrome, obesity, heart failure, skin, neurological and renal failure, thyroid, malignancy, and history of hormonal disorders. Exclusion criteria were patients with a history of previous illness, smoking, and alcohol abuse. Patient acceptance and demographic information were recorded by a trained expert and obtained with ethical consent.

The clients were fasting for 12 to 14 hours at the time of sampling. We also sampled people who had avoided eating high fat, smoking, and heavy exercise the day before the experiment time at 8 am, and 11 am were selected for taking Samples. Blood samples were taken from all clients in a standard and seated way. It was careful to unlocking the tourniquet in less than a minute. After sampling in less than one hour, samples were centrifuged for 10 minutes, and serum was separated from the clot. Hemolysis and lipemic specimens were excluded from the study. Serum samples were transferred to the biochemistry section after separation and were analyzed. The FBS, TG, LDL, HDL, FBS, TG tests were performed with the Bionic Diagnostic Kit and proceeded by the Japanese Hitachi 917. The triglyceride kit limit ranged from 0.53 mg/dL to the linear limit of 1000 mg/dL (sensitivity: 1mg/dL=0.0015(A)). The HDL kit limit ranged from 2.5 mg/dL to the linear limit of 200 mg/dL (sensitivity: 1mg/dL=0.0012(A)). The LDL kit limit ranged from 7 mg/dL to the linear limit of 1000 mg/dL (sensitivity: 1mg/dL=0.0012(A)). The cholesterol kit ranged from 0.113 mg/dL to the linear limit of 750 mg/dL [sensitivity: 1mg/dL=0.0015(A)]. The glucose kit ranged from 5 mg/dL to the linear limit of 400 mg/dL [sensitivity: 1mg/dL=0.0039(A)]. No difference was observed between the results obtained from the bionic diagnostic kit and other commercial kits comparing the accuracy of the kits (correlation coefficient(r)=0.997). The Mean±Sd of inter-assay for FBS, TG, TC, LDL and HDL were 94.9±1.99 (%CV=2.10), 127.92±2.012 (%CV=1.573), 185.309±1.405 (%CV=0.758), 112±0.7 (%CV=0.6), and 50.6±0.2 (%CV=0.5). The Mean±SD of Intra assay for FBS, TG, TC, LDL,

and HDL were 98.6±3.04 (%CV=2.10), 184.962±12.773 (%CV=6.906), 107±1.89 (%CV=0.758), 112±0.7 (%CV=1.76), and 50.0±0.7 (%CV=1.5).

***Statistical analysis*:** The results were collected in an Excel file and then transferred to SPSS software version 18 for descriptive analysis. Kolmogorov-Smirnov test was performed to determine data normalization. Due to a large number of samples and the normality of the data, parametric tests were used. The results were shown as mean, SD, and reference range obtained.

# Results

In the current study, 519 individuals were investigated; 320 (61.7%) were women, and 199 (38.3%) were men with a mean age of 45.81 ± 14.79, and the age range of 23-82. FBS levels in men and women were 91.51 and 92.35, 109.91 and 119.86 TG, 185.08 and 180.39 TC, 91.78 and 92.38 LDL, 58.88 and 50.21 mg/ dL, respectively. Figures 1-5 show how FBS, TG, TC, LDL, and HDL are distributed in the whole, healthy population of Babol. Reference values for measured chemical parameters in the current study and values reported in international references are summarized in Table 1; in these studies, reference values are presented as the mean ±SD. As shown in Table 1, there is significant accommodation between our resulted reference values with international references. The mean ± SD of FBS of the total study population was 92.35 ± 7.65 mg/dL for men and 91.51 ± 8.24 mg/dL for women with reference interval 70-110 mg/dL. The owned reference range for the total study was 77.01-107.69 and 75.03-107.99 for men and women, respectively. The value of TG was 119.86 ± 42.26 mg/dL (mean ± SD) for men and 109.91 ± 41.21 mg/dL (mean ± SD) for women. The total population's obtained reference range was 35.34-204.38 and 27.49-192.33 for men and women, respectively, with the reference interval of Desirable: <150, Borderline high: 150-199, and high: ≥200. The TC's received reference ranges were 117.97-242.81 and 125.84-244.32, with the mean ± SD of the 180.39 ± 31.21 and 185.08 ± 29.62 for men and women, respectively (reference interval: Desirable:<200 Borderline high:200-239, High: >240). The mean ± SD, our resulting reference ranges, and reference interval for HDL were 50.21 ± 8.46 mg/dL, 33.29-67.13 mg/dL, and ≥ 40 mg/dL men and 58.88 ± 11.11 mg/dL, and ≥ 50 mg/dL for women respectively. For men's LDL, The mean ± SD and the obtained reference range was 92.38 ± 22.39 mg/dL and 47.6-137.16 mg/dL, and for women's, the mean ± SD and the obtained reference range was 91.78 ± 23.85 mg/dL respectively with the reference interval of Desirable: <130, Borderline high:130-159 and high: ≥160.

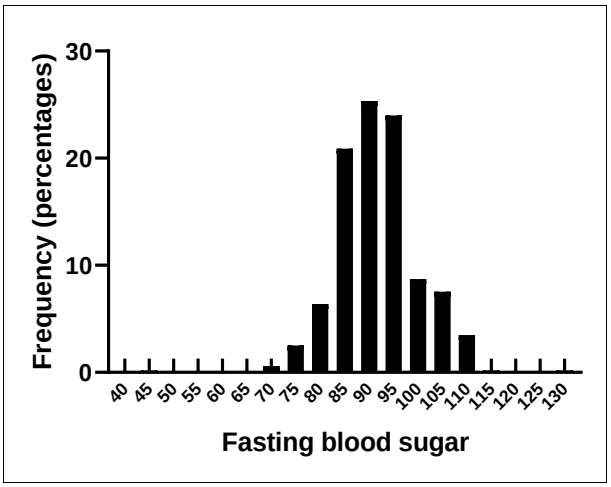


**Figure 1.** Distribution of fasting blood sugar (FBS) (N=519, mean=91.83, Std.Dev=8.032)

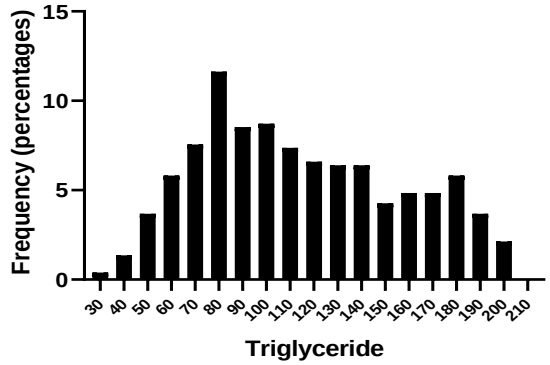


**Figure 2.** Distribution of lipid profile parameters (triglyceride) (N=519, mean=113.73, Std.Dev=41.861).

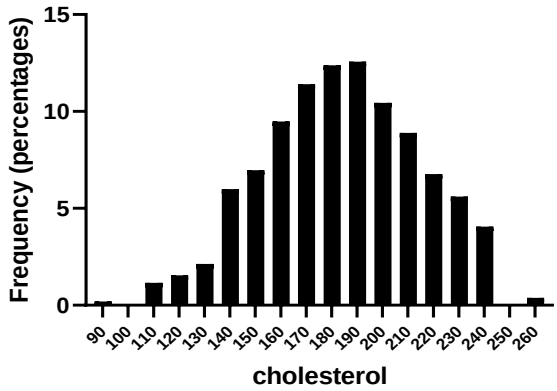


**Figure 3.** Distribution of lipid profile parameters (cholesterol) (N=519, mean=183.28, Std.Dev=30.299).

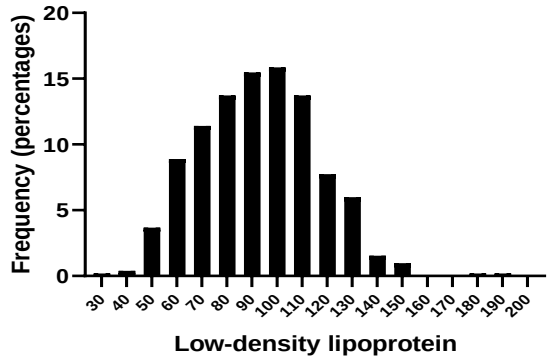


**Figure 4.** Distribution of lipid profile parameters (LDL) (N=519, mean=92.01, Std.Dev=23.288).

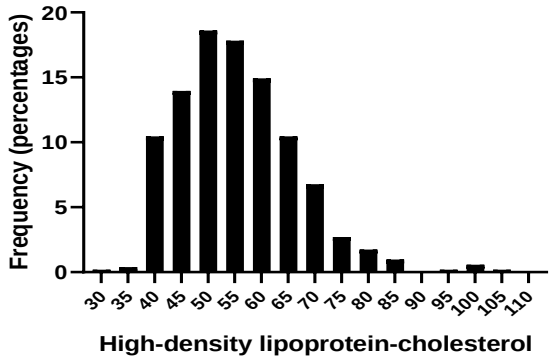


**Figure 5.** Distribution of lipid profile parameters (HDL) (N=519, mean=55.55, Std.Dev=11.009)

**Table 1.** Mean standard deviation,s and reference ranges of fasting blood glucose and triglyceride, cholesterol, LDL, and HDL in 320 women and 199 men by gender in Babol.

| Analyte | Gender | Mean±Sd | Reference range obtained | reference interval range |
|---|---|---|---|---|
| **BS(mg/dl)** | Men | 92.35±7.67 | 77.01-107.69 | 70-110 |
| | Women | 91.51±8.24 | 75.03-107.99 | |
| **TG(mg/dl)** | Men | 119.86±42.26 | 35.34-204.38 | Normal: <150<br>Borderline high: 150-199<br>High: >200 |
| | Women | 109.91±41.21 | 27.49-192.33 | |
| **TC(mg/dl)** | Men | 180.39±31.21 | 117.97-242.81 | Desirable:<200<br>Borderline high: 200-239<br>High : >240 |
| | Women | 185.08±29.62 | 125.84-244.32 | |
| **LDL(mg/dl)** | Men | 92.38±22.39 | 47.6-137.16 | Desirable:<130<br>Borderline high :130-159<br>High : ≥160 |
| | Women | 91.78±23.85 | 44.08-139.48 | |
| **HDL(mg/dl)** | Men | 50.21±8.46 | 33.29-67.13 | ≥ 40 |
| | Women | 58.88±11.11 | 36.66-81.1 | ≥ 50 |

## Discussion

In the present study, reference values for serum FBS, TC, TG, LDL, HDL in healthy Babolian adults were presented. Clinical parameters levels may vary with the dietary habit, geographical areas, and other criteria. It is, therefore, prudent to establish normative data for each community (24-26). The population-based reference interval is a standard used tool for reporting and interpreting individual patient laboratory test results (27). Some studies on lipid and glucose reference intervals have been conducted. Ghasemi et al. reported reference values for serum glucose concentrations in 926 adult individuas (age range 20–78 years) to be 4.0 to 5.7, 3.8 to 5.6, and 3.9 to 5.7 mmol/L in men, women, and total population, respectively (28). In a report of 1147 healthy adults in Tehran (aged ≥20 years), reference values for TC, TG, LDL-C,, and HDL-C reported to be 121.0–261.0, 46.9–301.2 mg/dL, 54.1–175.2, and 30.9–71.9 in men, and 117.8–235.9, 38.1–184.2 mg/dL, 49.9–160.9 and 36.0–83.9 in women, respectively (29). The present study shows the age- and gender-specific reference values for FBS, TC, TG, HDL, and LDL in healthy Babolian adults selected from a population-based investigation. FBS's reference value was found to be 77.01-107.69 mg/dL for men and 75.03-107.99 mg/dL for women with a reference interval from 70-110 mg/dL. According to table 1, it seems that reference values for serum FBS in our study are higher than Ghasemi's study (28). Also, reference values in our study for TC, TG, LDL-C, and HDL-C were 117.97-242.81, 35.34-204.38, 47.6-137.16, and 33.29-67.13 mg/dL in men, and 125.84-244.32, 27.49-192.33, 44.08-139.48 and 36.66-81.1 mg/dL in women, respectively. These results for the reference range of lipid profiles differed from the healthy Tehranian adult's reference range (29). These differences in the reports from different Iran regions could be attributed to population size, increased education, the different living patterns, dietary patterns, climatic conditions, the methodology adopted, and differences in the exclusion and inclusion criteria. Vaneet Kaur et al., studying 1031 individuals of Punjab (age range 21–85 years), reported the mean ± SD for serum TC, TG, HDL-C, and LDL-C concentrations to be 182.2 ± 33.9, 122.4 ± 33.4, 44.1 ± 6.8, 113.9 ± 32.0, respectively (23). In this study, different mean ± SD of blood lipids were reported compared to our study, which could be due to differences in race, different dietary habits, and the education and culture levels between the two countries.

No substantial difference was observed between men and women in reference intervals of FBS, TC, TG, LDL, and HDL. The present study resulted in a reference range for five important biochemical constituents of FBS, TG, TC, LDL, and HDL in Babol city. All values were similar to those in the reference books (18). Given that the method of testing and apparatus used was identical to that of the most reputable laboratories in the world and all devices were fully calibrated, it can be concluded that the interval references can also be relied-on. Since the standard deviation for TG, LDL, and HDL was very high, a similar study is recommended, but more samples are needed to reach the actual reference range. It is also suggested that due to a large number of HDL specimens that were the least normal range and less than that increases the risk of cardiovascular disease, it is necessary to assess the reason for this reduction, and more research proceeded into the prevalence of heart disease in this region.

## Conclusion

This investigation will suggest the progress of better strategies for prevention, which will ultimately raise the quality of primary care. In order to “abnormality” in biological parameters, we recommend that it is more appropriate to apply reference intervals confirmed by IFCC. By the way, we also suggest that clinical labs assess their reference values concerning genetics, lifestyle, and diet habits in each population.

## Conflict of Interest

The authors declare that they have no conflict of interest.

## Acknowledgement

Thanks to Dr. Mojtaba Abbasi for helpful comments on the article and prepare the manuscript and formatting of tables, figures.

## Funding/Support

There is no financial support for this work.

## References

1. Colantonio LD, Bittner V, Reynolds K, Levitan EB, Rosenson RS, Banach M, et al. Association of serum lipids and coronary heart disease in contemporary observational studies. Circulation. 2016;133(3):256-64.

2. Aguilar-Salinas CA, Tussié-Luna T, Almeda-Valdés P. Lipid Disorders: Advances in Research and Challenges in Clinical Practice. Revista de Investigación Clínica. 2018;70(5):209-10.

3. Mongraw-Chaffin M, Bertoni AG, Golden SH, Mathioudakis N, Sears DD, Szklo M, et al. Association of Low Fasting Glucose and HbA1c With Cardiovascular Disease and Mortality: The MESA Study. Journal of the Endocrine Society. 2019;3(5):892-901.

4. Zhao Q, Li J, Yang J, Li R. Association of total cholesterol and HDL-C levels and outcome in coronary heart disease patients with heart failure. Medicine. 2017;96(9).

5. Cohen SS, Chamberlain AM, Killian JM, Monda KL, Weston SA, Okerson T. LDL-C Monitoring Frequency After the Diagnosis of Diabetes or Atherosclerotic Cardiovascular Disease. Circulation. 2017;136(suppl_1):A15727-A.

6. Rosenson RS, Brewer Jr HB, Ansell BJ, Barter P, Chapman MJ, Heinecke JW, et al. Dysfunctional HDL and atherosclerotic cardiovascular disease. Nature reviews cardiology. 2016;13(1):48.

7. Ding X, Ye P, Wang X, Cao R, Yang X, Xiao W, et al. The predictive value of baseline LDL-TG level on major adverse cardiovascular events in a followed up cohort population. Eur Rev Med Pharmacol Sci. 2017;21(5):1060-4.

8. Abazari O, Divsalar A, Ghobadi R. Inhibitory effects of oxali-Platin as a chemotherapeutic drug on the function and structure of bovine liver catalase. J Biomol Struct Dyn. 2020;38(2):609-15.

9. Arndt T. Normal values and reference intervals. TIAFT Bulletin. 2018;48:4-8.

10. Shaw JL, Binesh Marvasti T, Colantonio D, Adeli K. Pediatric reference intervals: challenges and recent initiatives. Critical reviews in clinical laboratory sciences. 2013;50(2):37-50.

11. Ghasemi A, Zahediasl S, Azizi F. Reference values for serum nitric oxide metabolites in pediatrics. Nitric Oxide. 2010;23(4):264-8.

12. Trujillano J, Muiño JM, March J, Sorribas A. A more flexible parametric estimation of univariate reference intervals: A new method based on the GS-distribution. Clinica chimica acta. 2007;379(1-2):71-80.

13. Abazari O, Shafaei Z, Divsalar A, Eslami-Moghadam M, Ghalandari B, Saboury AA. Probing the biological evaluations of a new designed Pt (II) complex using spectroscopic and theoretical approaches: Human hemoglobin as a target. J Biomol Struct Dyn. 2016;34(5):1123-31.

14. Poggio R, Elorriaga N, Gutierrez L, Irazola V, Rubinstein A, Danaei G. Associations between dietary patterns and serum lipids, apo and C-reactive protein in an adult population: evidence from a multi-city cohort in South America. British Journal of Nutrition. 2017;117(4):548-55.

15. Tohidi M, Ghasemi A, Hadaegh F, Derakhshan A, Chary A, Azizi F. Age-and sex-specific reference values for fasting serum insulin levels and insulin resistance/sensitivity indices in healthy Iranian adults: Tehran Lipid and Glucose Study. Clinical biochemistry. 2014;47(6):432-8.

16. Ozarda Y, Sikaris K, Streichert T, Macri J, intervals ICoR, Limits D. Distinguishing reference intervals and clinical decision limits–A review by the IFCC Committee on Reference Intervals and Decision Limits. Critical reviews in clinical laboratory sciences. 2018;55(6):420-31.

17. Abazari O, Shafaei Z, Divsalar A, Eslami-Moghadam M, Ghalandari B, Saboury AA, et al. Interaction of the synthesized anticancer compound of the methyl-glycine 1, 10-phenanthroline platinum nitrate with human serum albumin and human hemoglobin proteins by spectroscopy methods and molecular docking. Journal of the Iranian Chemical Society. 2020:1-14.

18. Bishop ML, Fody EP, Schoeff LE. Clinical chemistry: principles, techniques, and correlations: Lippincott Williams & Wilkins; 2013.

19. Blaurock MG, Kallner A, Menzel S, Masuch A, Nauck M, Petersmann A. Impact of Glucose Measuring Systems and Sample Type on Diagnosis Rates of Diabetes Mellitus. Diabetes Therapy. 2018;9(5):2029-41.

20. Wadhwa N, Krishnaswamy R. Comparison of LDL-cholesterol estimate using various formulae with directly measured LDL-cholesterol in Indian population. Journal of clinical and diagnostic research: JCDR. 2016;10(12):BC11.

21. Jalali MT, Honomaror AM, Rekabi A, Latifi M. Reference ranges for serum total cholesterol, HDL-cholesterol, LDL-cholesterol, and VLDL-cholesterol and triglycerides in healthy iranian ahvaz population. Indian Journal of Clinical Biochemistry. 2013;28(3):277-82.

22. Abbasi M, Abazari OO. Probing the Biological evaluations of a new designed Palladium (II) complex using spectroscopic and theoretical approaches: Human Hemoglobin as a Target. Arch Med Lab Sci. 2018;3(3).

23. Kaur V, Verma M, Kaur A, Gupta S, Singh K. To establish the reference intervals of lipid profile in Punjab. Indian Journal of Clinical Biochemistry. 2012;27(3):290-5.

24. Martin SS, Blaha MJ, Elshazly MB, Toth PP, Kwiterovich PO, Blumenthal RS, et al. Comparison of a novel method vs the Friedewald equation for estimating low-density lipoprotein

cholesterol levels from the standard lipid profile. Jama. 2013;310(19):2061-8.

25. Nordestgaard BG, Langsted A, Mora S, Kolovou G, Baum H, Bruckert E, et al. Fasting is not routinely required for determination of a lipid profile: clinical and laboratory implications including flagging at desirable concentration cut-points—a joint consensus statement from the European Atherosclerosis Society and European Federation of Clinical Chemistry and Laboratory Medicine. European heart journal. 2016;37(25):1944-58.

26. Asadi A, Nezhad DY, Javazm AR, Khanicheragh P, Mashouri L, Shakeri F, et al. In vitro Effects of Curcumin on Transforming Growth Factor-β-mediated Non-Smad Signaling Pathway, Oxidative Stress, and Pro-inflammatory Cytokines Production with Human Vascular Smooth Muscle Cells. Iran J Allergy Asthma Immunol. 2019:1-10.

27. Miller WG, Horowitz GL, Ceriotti F, Fleming JK, Greenberg N, Katayev A, et al. Reference intervals: strengths, weaknesses, and challenges. Clinical chemistry. 2016;62(7):916-23.

28. Ghasemi A, Zahediasl S, Azizi F. Reference values for fasting serum glucose levels in healthy Iranian adult subjects. Clinical laboratory. 2011;57(5-6):343-9.

29. Rahmani M, Jeddi S, Ghanbari M, Momenan AA, Azizi F, Ghasemi A. Reference Values for Serum Lipid Profiles in Iranian Adults: Tehran Lipid and Glucose Study. Archives of Iranian Medicine (AIM). 2019;22(1).