Original Article

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

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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.

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**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=0.0039(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=0.6), 127.9±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 \(98.6 \pm 3.04\) \((\%CV=2.10)\), 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)](image)
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.

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