Hematocrit (Packed Cell Volume) Values from a Sample of Apparently Healthy Adult Population in Jimma Town, Western Ethiopia

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Abstract: Hematocrit level, a proportion of whole blood cell occupied by red blood cells is a useful tool for the screening of anemia as well as monitor treatment. The main aim of this study was to determine HCT reference values for apparently healthy adult people in Jimma Town, Western Ethiopia. A cross sectional study was conducted in Jimma town to establish HCT reference values for healthy adult people aged above 18 years. A total of 140 permanent residents of the town consisting of [76(54%) males and 64(46%)] of non pregnant women were studied. A capillary blood was collected from each study subject who had no history of chronic and acute diseases. HCT determined using Microhaematocrit method. A Chi square test was performed and P value less than 0.05 were considered significant. From a total of 140 subjects included in this study, 76(54%) were males and the remaining females. The age of participants ranged from 18 – 65 years with a mean of 31 years old and standard deviation of 9 years. The HCT value of subjects was found to be 0.046±0.052 for apparently healthy adult males and 0.43±0.05 for healthy adult non-pregnant women. The HCT values obtained had shown variation between males and females as well as values from other parts of Ethiopia. Hence, the present finding would represent a cut off value for early screening of anemia in this area, though a large scale study considering multiple factors still suggested

Key words: Hematocrit • Value • Apparently healthy adult • Western Ethiopia

INTRODUCTION

Anemia is defined as the lowering of circulating red cell mass below the reference values. There are two physiological mechanisms that cause anemia. It is either due to decreased production of red blood cells or increased destruction of red cells which in turn related as a condition when individual’s HCT or Hemoglobin(Hgb) levels is lower than healthy person’s value of the same age and sex in same environmental condition [1].

Anemia is regarded as mild in men when Hgb concentration is 10-12 g/dl and mild in women with Hgb level of 9-11 g/dl and it is moderate when Hgb level is 8-10 g/dl in men and 7-9 g/dl in women. Values below this represent severe anemia. The main causes of anemia are malnutrition particularly iron deficiency, folate deficiency, hook worm infection, malaria, TB and HIV [2].

Anemia remains a major public health problem. It affects about 1/4th of the world’s population with all age groups to varying degrees, while pregnant women and young children are the most susceptible. The global prevalence of anemia is about 30% with 38% in developing countries [3, 4]. Throughout Africa, about 50% of pregnant and 40% of non pregnant women are anemic with West Africans most affected and South Africa, the least [5,6].

Iron deficiency anemia is the most common and widespread nutritional problem in the world [7]. National socio economic development as well as personal health and self-fulfillment are impaired by IDA. The economic implication of the condition include the cost incurred by the public health and private sectors in therapeutic measures for prevalent level of anemia, the social consequences of increased maternal mortality and resultant restraints on productivity and long term projected negative consequences of impaired development on human capital formation [8].

Measures to control anemia are implemented in almost all countries. The control efforts are based on the very screening of the condition. HCT and or Hgb
measurements remain a key screening tools as the can detect the most severe forms of IDA associated with the majority of clinical symptoms [9]. Establishing reference ranges of HCT values for different age and gender groups is thus a key step in prevention and control of anemia and also in promotion of individual health.

Anemia may not be always due to lowered HCT/Hgb. It may develop due to increases in blood viscosity and polycythemia [9]. When iron deficient erythropoietin occurs, hematocrit values are reduced to below optimal level. When individuals HCT levels are below two standard deviation (2SD) of the distribution mean for Hct in otherwise normal population of the same gender and age group who are living at the same altitude, IDA is considered to be present [10].

HCT and Hgb values and their measurements are more useful and reliable than red blood cell count for the determination and diagnosis of anemia because much less error is associated with it [1, 11]. However the normal values for HCT/Hgb in the peripheral blood vary with age, sex and other physiological conditions. For more practical purposes Hgb level below 13g/dl for men, 12g/dl for non pregnant women is indicative of anemia [1, 2].

As different studies indicate most hospital laboratories perform HCT determinations along with Hgb measurements and some do HCT more regularly [12, 13]. As WHO report HCT and Hgb with other biological parameters are proposed for characterization of anemia as well and the two measurements are closely correlated [14].

In normally distributed human population a 5% of the population would be expected to have HCT levels below the threshold. Hence anemia would be considered a public health problem only when the prevalence of HCT value exceeds 5.0% of the population [10]. In Ethiopia, there is a paucity of information pertaining to HCT reference ranges. With a hypothesis that HCT reference values for apparently healthy adult population of Jimma town are same with people in other parts of Ethiopia, this study was aimed to determine HCT levels for health adult males and non-pregnant women.

**MATERIALS AND METHODS**

**Study Area:** A cross-Sectional study was conducted in Jimma town, a capital of Jimma zone, Western Ethiopia. Jimma is a located 346 Kilometers away from Addis Ababa, the capital city of Ethiopia. The annual rain fall of the town is 1749.3mm and the temperature ranges from 11.5 to 28°C. It is found at an altitude of 1178 above sea level. The town has a total of 19 keels/ the smallest administrative units in Ethiopia

**Study Population:** A randomly selected apparently health adult population in Jimma town constituted the study subjects. Adults in this study were defined as subjects above 18 years old. And apparently healthy people as “individuals with no history of chronic and infectious diseases including TB, HIV, Malaria and others”.

Eligibility of subjects was assessed based on a standardized questionnaire consisting of information on history of chronic and acute diseases, pregnancy, smoking and known hematological problems. Accordingly individuals who had been resided in the town for at least 6 months prior to study, non smokers and those with no history of previous chronic and acute diseases known to affect HCT values were included. And those with the aforementioned conditions, pregnant women and non-permanent members of the town were excluded.

**Sampling:** The town had 19 kebeles/ administrative units. Three Kebeles were first randomly selected and then a random walk was undertaken in each of the chosen kebeles to select households. In each household of interest a simple lottery method was employed to select individual study subject amongst family member. Subjects were taken proportionally from each kebele based on the number of population each Kebele had. Accordingly, from the first kebele(K1) 55 subjects, from the second(K2) 40 and from the third kebele(K3) 45 subjects totaling 140 participants.

**Data Collection Questionnaire:** A pre-tested, semi-structured questionnaire was used to collects subject’s sociodemographic information, history of acute and chronic infectious diseases, pregnancy, smoking status and residency status. It was first prepared in English language and then translated to Oromifa and Amharic languages to make the best understanding of the questions to participants. The sociodemographic component of the tool had comprised of the participant’s age, gender, ethnicity, educational level and marital status.

**Blood Sample Collection:** A capillary blood was collected in to capillary tube immediately following a finger tip prick with a sterile lancet. The internal of capillary tube was already coated with heparin antiquagualt from the company so there was no a need to add antiquagulat to the sample.

A 3/4ths of the capillary tube was filled with blood then sealed by vertically placing the dry end into a tray of sealing compound (wax). The sealant plug was assured to be 4-6mm long [15].
Hematocrit Measurement by Micro Method

**Equipment:** Hawksley Haematospin 1300 haematocrit centrifuge, wax as a sealant, gloves and sterile lancet were used. A capillary HCT tube about 7 cm long with a uniform bore of about 1 mm was used [16-19].

**Procedure:** For blood collection directly from a skin puncture, heparinized capillary tubes were used. The blood filled and properly sealed capillary tube was then placed in the grooves (slots) of the Microhematocrit centrifuge (Fig 1a) with the sealed end toward the periphery. The centrifuge was spun for 5 minutes at 10,000-15,000g of speed. After successful centrifugation three defined layer as Plasma, Buffy coat and RBC were formed (Fig 1b). The buffy coat is the red-gray layer between the red cells and the plasma; it includes platelets and leukocytes [20].

HCT, value was read using a reading device by placing the tube against arithmetic graph ruler [19]. The HCT is the ratio of the volume of erythrocytes to that of the whole blood. It was expressed as a percentage (conventional) or as a decimal fraction (SI units) as needed in this study. The units L/L was used to imply height of RBC column converted to Liters to height of whole blood in Liters. The relative heights of the red cell column, buffy coat and plasma column was noted after successful centrifugation.

**Data Analysis:** Data were initially entered into Excel 2007 worksheet. SPSS version 14.0 software package for Windows was used for further analysis. Descriptive statistics were employed to generate frequencies, tables and figures. A $X^2$ test was computed and $P$-values value less than 0.05 was considered as statistically significant association.

**Ethical Consideration:** Before data collection, permission clearance was obtained from Jimma University research and publications office. Informed consent was obtained from all subjects explaining the procedure, its risks and benefits. The study subjects were not obliged to participate in the study.

**Quality Assurance:** Completeness and consistency of our data were monitored each time it was collected by the PI of the study. Hemolyzed samples were rejected from being analyzed and replaced with a back up capillary blood. Any inappropriately centrifuged, read or collected samples were discarded. Standard operating procedure (SOP) for HCT determination was strictly followed [20].

**RESULTS AND DISCUSSION**

**Socio Demographic Characteristics of Subjects and HCT Values:** A total of 140 adult permanent residents of Jimma town who were apparently healthy took part in the study and 76(54%) were males. Fifty five (39%) subjects were from Kebele one (K1), 40(29%) from K2 and 45(32) from K3. The age of participants ranged from 18 – 65 years with a mean of 31 years old and standard deviation of 9 years.

**Table 1:** Below shows age and sex wise distribution of HCT values for apparently healthy adult population in Jimma Town, West Ethiopia

<table>
<thead>
<tr>
<th>Age in years</th>
<th>Men N (%)</th>
<th>Mean HCT (%)</th>
<th>Non pregnant women N (%)</th>
<th>Mean HCT (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-28</td>
<td>16(21)</td>
<td>44</td>
<td>13(20)</td>
<td>42</td>
</tr>
<tr>
<td>29 - 38</td>
<td>10(18)</td>
<td>45</td>
<td>10(20)</td>
<td>43</td>
</tr>
<tr>
<td>39 - 48</td>
<td>9(16)</td>
<td>47</td>
<td>9(16)</td>
<td>44</td>
</tr>
<tr>
<td>49 - 58</td>
<td>9(16)</td>
<td>48</td>
<td>7(17)</td>
<td>41</td>
</tr>
<tr>
<td>59 - 68</td>
<td>7(12)</td>
<td>41.5</td>
<td>7(17)</td>
<td>45</td>
</tr>
</tbody>
</table>
Table 2: A summary of overall hematocrit normal values for apparently healthy adult subjects in Jimma town, West Ethiopia

<table>
<thead>
<tr>
<th>Age over 18 years old (Adults)</th>
<th>Gender</th>
<th>Non - Pregnant women</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HCT (Mean±2SD) in l/l</td>
<td>HCT (Mean±2SD) in l/l</td>
</tr>
<tr>
<td></td>
<td>0.46±0.052</td>
<td>0.43±0.05</td>
</tr>
</tbody>
</table>

Table 3: Association between HCT value and gender among healthy adults

<table>
<thead>
<tr>
<th>Gender</th>
<th>Hematocrit</th>
<th>Mean</th>
<th>n</th>
<th>St.Dev</th>
<th>t</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>46</td>
<td>76</td>
<td>5.2</td>
<td>-4.23</td>
<td>0.007</td>
<td></td>
</tr>
<tr>
<td>Non-pregnant women</td>
<td>43</td>
<td>64</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

According to this study 16(21%) of apparently healthy adult male subjects had HCT value of 44%(0.04), 10(18%) had 45%(0.45), 9(16%) had 47%(0.47), 9(46%) of 48%(0.48) (Table 2). And majority of non-pregnant women had HCT values between 42-44 % (Tabel 3).

In the present study it was reported that the HCT values for apparently healthy adult population tends to decreases slightly as the age of subjects increased. The overall HCT normal values for healthy adults obtained in this study expressed arrange between mean plus 2SD and mean minus 2SD was 0.46±0.052 or (40.8% – 51.2%) for men and 0.43 ±0.05(38%-48%) for non-pregnant women. The variations in HCT values between men and women was statistically significant ($X^2 = 14$, $P = 0.0081$). The HCT value for women was lower than that of men. This could be speculated to the fact that females had high fat composition and low red cell mass than men.

The HCT level obtained in this study was lower by 5% for non pregnant women and by 8% for adult men as compared to a cross-sectional study conducted on 203 males and 170 females in Indonesia and by 3% higher for women and 5% for men compared to American reference [17]. The differences are attributable to sample size, altitude and racial background. Moreover ours sample size was small to be compared with large scale population level studies.

HCT values reported for apparently healthy adult population in Democratic republic of German was however, in line with ours finding [17]. But values established in Northern China reflected higher HCT levels for women and lower for men [17]. There is also evidence that genetics influences HCT level. In United States for example, individuals of African origin had HCT values 10-15% lower than do those of European origin [15]. The correct interpretation of Hgb/HCT therefore, requires the consideration of modulating factors in selecting appropriate cut of values.

HCT values established in different parts of Ethiopia indicate appreciable variations between locations. The HCT level obtained in this study was lower for both males and females than the recommended values for Ethiopian high land areas [2]. In these areas anemia is likely to be present if HCT value is less than 0.44 l/l for adult men and less than 0.41 l/l for non pregnant women. Our HCT lower limit (cut off value) was only slightly higher compared to CDC guide lines in which anemia is supposed to occur when HCT value is below 0.39 l/l in men above 15 years old age and 0.36 l/l in non pregnant women between 15-49 years old [18]. It is well studied that HCT values vary with age, sex, stages of pregnancy and altitude [16]. Ethnicity, sample size and laboratory method used for HCT determination would also matters.

Similar study conducted in Asendabo town, west Ethiopia on 107 adult men and 87 non pregnant women reported a HCT value of 0.46±0.068 for men and 0.44±0.066 for non pregnant women. This was closely similar to our finding for women and slightly higher than ours for men subjects. But HCT cut off values obtained in this study was lower for men than the findings reported in Gondar by Peter and his colleagues [2].

**CONCLUSION**

Having determined the HCT values for both sexes, we found that there was a variation between men and women as well as values reported in other parts of Ethiopia and elsewhere. HCT values tend to decreases as age increased. Therefore, we suggest a large scale population based study to produce a more robust data on HCT values in this area.

**REFERENCES**

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18. CDC guide lines for screening of anemia, 2002. Hgb and HCT levels below which anemia is present in a population.