Hepatic Functional Status of the Tea Garden Workers of West Tripura District, Tripura, India

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ABSTRACT: This cross-sectional study was conducted to examine hepatic function via liver enzymes/proteins assessments, along with the nutritional status of the male and female tea garden workers of West Tripura district, Tripura, India. Nutritional status was analyzed by using body mass index (BMI) and other anthropometric indices. Hepatic function was studied by the analysis of serum alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), serum proteins, total bilirubin, and direct bilirubin. Results revealed that except total protein and globulin, all other parameters of liver function test were significantly higher in males than the female workers. About 60.73% of males were having elevated levels of liver function test measures than the females (49.53%). Analysis of the severity of the liver function damage by albumin-bilirubin score (ABLI) revealed that that 72.63% of the male and 70.70% of the female workers were having less good liver function (Grade 2). 23.77% of the male and 29.30% of the female population were having good liver function (Grade 1). However, no workers were having worst liver function damage (Grade 3). This study revealed that the hepatic functional status of the tea garden workers of the West Tripura district of Tripura is in alarming condition and males are more affected than females.

Key Words: Tea Garden Workers; West Tripura District; Nutritional Status; Liver Function Test

1.INTRODUCTION

Tea garden workers are an integral part of the agro-based tea industry of India. As reported by several studies and investigation by the BBC (Panwar, 2017), their living conditions of many tea plantation workers in India are either poor or not given nearly as much importance. Several studies had revealed that the tea garden workers are vulnerable to various communicable diseases and malnutrition due to the poor socio-economic conditions, ignorance due to illiteracy, over-crowded and unhygienic living conditions in the residential colonies. In a study with the male workers of tea processing factory of West Bengal, India by Sengupta and Sahoo, (2014), it was found that the workers are suffering from malnutrition. A study by Debnath and Debnath (2017) with the workers of a garden of West Tripura district revealed that they are living in a poor socio-economic condition. In recent cross-sectional study by Nath et al., (2018) based on the anthropometric analysis it was reported that both nutritional and health status of the tea garden workers of the West Tripura district of Tripura are in critical situations.

Nutrition screening with the anthropometric measurements is an important first step in the early identification of malnutrition in any community and it initiates the whole nutrition care process. Poor nutritional status has been found to be associated with hepatic disorders. It is well established that malnourished patients with liver diseases generally have a higher risk of developing adverse clinical outcomes and increased healthcare costs (Purnak and Yilmaz, 2013).

In a cross-sectional study, close relationship between liver function and the degree of liver damage to growth and nutritional status was found (Hurtado-López et al., 2007). Moreover, poor nutrition is frequently associated with liver disorders (Jackson, 2017). Our previous study with tea garden worker revealed that tea garden workers West Tripura district are suffering from chronic energy deficiencies (Nath et al., 2018). This study revealed that 45.99% of the studied population is suffering from CED. In addition, report also suggests that tea garden workers are susceptible to a number of hazards in their workplaces. These may occur due to different physical, biological, mechanical, chemical and psychosocial factors (Borgohain, 2013). In view of this background the aim of this study was to analyse the health status...
of the tea garden workers with special reference to the functional status of the liver of these workers of West Tripura district of Tripura, India.

2. MATERIALS & METHODS

2.1 Sampling Method:
This cross sectional study was carried out during the period from December, 2017 to March, 2018. The studied population was from the workers of tea gardens of the West Tripura district, Tripura, India, of age 18-60 years. A multistage stratified random sampling method was utilized to finally select the subjects of this study. Participants were provided knowledge about the purpose and objectives of this research. A written consent was obtained from each respondent prior to the commencement of the anthropometry measurements and collection of blood specimen.

At first 6 tea gardens were randomly selected from the 21 tea gardens of the West Tripura district. On the next stage, 450 tea garden workers were randomly selected and asked for their age. The information provided by the subjects was subsequently verified from official records. In the subsequent stages, subjects were further screened based on their compliance or noncompliance for all kinds of tests and measurements, history of chronic disease or chronic medication or consumption of alcohol or tobacco use for prolonged period. At this stage 31 workers were excluded. Finally, after explanation of objective and protocol of the research work, only the voluntarily participated subjects with written consent were included in this study. At this stage 14 workers were excluded. The final sample size of both groups of subjects was 405 [Group A: Male (n=190) and Group B: Female (n=215)]. Among these participants, 50 males and 75 female workers were randomly selected for the detail anthropometric study. As the number of female workers is more than the male workers in the tea garden, the equal number of subjects could not be achieved. Most of them work as tea plucker, and very few of them work in factory and office.

2.2 Ethical considerations:
Ethical approval for human studies was obtained from the Advisory Committee of the Institutional Human Ethics Committee (Memo No. adtu/ethics/PhD Scholar/2017/003 dated: 21/11/2017).

2.3 Anthropometric Measurements:
Each subject was measured for stature, weight, circumference [Mid upper arm circumference (MUAC), Thai circumference, forearm circumference and cuff circumference] and skin fold thickness at desirable sites (triceps, frontal thigh, mid-calf and subscapular skinfolds). All the anthropometric measurements were made on the right side of the body by trained investigators by using the standard techniques (Lohman et al., 1988; Kannieappanet et al., 2013). BMI was calculated as the weight in kilograms divided by the square of the height in meters (WHO), 1995.

Similar procedures were used to standardized height and weight measurements. Body weight was measured with a standard weighing scale to the nearest 0.1 kg with minimum clothing and standing height to the nearest 0.1 cm in the standard arm hanging position with Harpenden type Anthropometer. Triceps, subscapular and cuff skin folds were measured to the nearest 0.1mm with a Holtain skin fold calliper (Holtain Ltd.). MUAC, Thai circumference, forearm circumference and cuff circumference with a metal tape, with the right arm hanging relaxed at the subject’s side. All the circumferences were measured to the nearest 0.1cm. Measurements were taken twice by the same trained persons.

For estimation of fat free mass (FFM), the percentage body fat was calculated by using Slaughter et al.’s skinfold thickness equations for adult males and for all females (Slaughter et al., 1988) as mentioned below.

% body fat (male) = 1.21 (triceps skinfold + subscapular skinfold) − 0.008 (triceps skinfold + subscapular skinfold)² - 6.8
% body fat (female) = 1.33 (triceps skinfold + subscapular skinfold) − 0.013 (triceps skinfold + subscapular skinfold)² - 2.5

FFM (kg) = body weight − (% body fat × body weight)/100

For estimation of FFM index (FFMI), FFM was divided by height squared in meters to give fat free mass index (FFMI) (Bisai and Bose, 2009).

Upper arm muscle area (UAMA) was calculated by using the following equation of Jelliffe and co-workers (Jelliffe and Jelliffe, 1969; Gurney and Jelliffe, 1973).

UAMA = [arm circumference − (π X triceps skinfold)]² / 4π

Skeletal Mass (SKM) was estimated by using the equation of Martin (1991) as given below.

SKM (kg) = 0.60 ×10⁻⁴ × S × (∑bi)²
Where ‘S’ is height in cm and ‘bi’ are the individual skeletal diameters (elbow, wrist, knee and ankle) in cm.

For estimation of muscle mass (MM), first corrected mid thigh girth (CMTG) and corrected calf girth (CCG) were calculated as [mid thigh girth – 3.14 X frontal thigh skin fold/10]² and [calf girth – 3.14 X mid calf skin fold /10]², respectively. MM was then estimated following the equation of Martin et al., (1990):

\[
MM = \text{height} \times \{(0.0553 \times \text{CMTG}^2) + (0.0987 \times \text{forearm girth}^2) + (0.0331 \times \text{CCG}^2)\} - (2445) / 1000
\]

Maximal isometric grip force of the non-dominant hand was determined with a standard adjustable-handle jamar dynamometer (Boyeet al., 2002; Schlusselet al., 2008; Rauch et al., 2002). The subject was told to put maximum force on the dynamometer. The grip force was expressed in Newtons (N) by multiplying the dynamometer reading in kilograms by a factor of 9.81.

2.4 Physiological Measurements:
Systolic (SBP) and diastolic (DBP) blood pressure were measured with the help of sphygmomanometer and stethoscope. Resting heart rate (HR) and respiratory rate (RR) were taken respectively by measuring the pulse rate at the left radial artery by palpating for 1 min (Agrawal et al., 2013) and visual observation of breathing per minute (Walker et al., 1990) with a stop watch.

2.5 Collection of Blood Samples and Analysis:
Blood samples were taken by professional phlebotomist from each subject between 8 am and 10 am after the subjects had fasted overnight. For estimation of liver function test a total of 5mL fasting venous blood was collected into an evacuated tube containing no anticoagulant. Analysis of serum alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), total proteins, albumin, total bilirubin, and direct bilirubin were performed by using biochemical kit (Coral Clinical Systems, Tulip Diagnostics (P) Ltd., India) by using a Semi Auto Analyzer (ERBA Diagnostics Mannheim GmbH, Germany).

The data of liver function enzymes were further analyzed by the cut-off points in accordance to the kit specific laboratory’s instructions. For the different liver tests cut off points were 37U/L for AST in male and 31U/L for AST in female, 5–35U/L for ALT, 80–290U/L for ALP. The percentage of elevated liver tests in the studied population was determined according to the cut-off points as mentioned in the laboratory protocol (Verrijken et al., 2010). When one or more of the abovementioned liver tests were above the upper limit value of normal we labeled them as disturbed (AST> 37 U/L in male &>31 U/L in female or ALT > 35 U/L or ALP> 290 U/L).

Furthermore, the assessment of the severity of liver function damage was then performed by using albumin-bilirubin (ALBI) score, a newly developed scoring system. The ALBI score was calculated as: ALBI = [Log10TBil (µmol/L) x 0.66] + [Alb (g/L) x -0.085], wherein the ALBI grades included grades 1 (ALBI score ≤-2.6), 2 (-2.59 <ALBI score <-1.39), and 3 (ALBI score ≥-1.39) (Johnson et al., 2015; Wang et al., 2016). Where ‘TBil’ is total bilirubin and ‘Alb’ is albumin.

2.6 Statistical Analysis:
All statistical tests were performed following standard techniques. Descriptive data were presented as mean ± SD. Unpaired t-tests were performed to check for differences in between the groups. Statistical analyses were performed with SPSS, version 17.0. P<0.05 was considered to indicate statistical significance.

3. RESULTS
Mean values for age, physical and physiological characteristics of the two groups are presented in table 1. Results revealed that there were significant differences in height (cm), weight (kg), systolic and diastolic blood pressure was found in between the male and female tea garden workers. These characteristics were found significantly higher for males as compared to female. No significant differences were found in BMI (kg/m²) and heart rate between males and females workers. Also there were no significant differences in their average age.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Male (Group A) (n=190)</th>
<th>Female (Group B) (n=215)</th>
<th>P Value * (Gr. A Vs Gr. B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (Years)</td>
<td>38.54 ± 10.74</td>
<td>36.39 ± 11.46</td>
<td>0.053</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>159.50 ± 7.36</td>
<td>152.11 ± 6.13</td>
<td>0.000</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>49.74 ± 8.77</td>
<td>44.23 ± 8.07</td>
<td>0.000</td>
</tr>
<tr>
<td>Systolic Blood Pressure (mm of Hg)</td>
<td>122.17 ± 18.65</td>
<td>117.58 ± 19.98</td>
<td>0.017</td>
</tr>
</tbody>
</table>
Among all these studied population, 50 male and 75 female workers were randomly selected for the detail anthropometric study (Table 2). Results revealed that there were significant differences in MUAC (P<0.05) and UAMA (P<0.01) and males are having higher values than the females. Although males are having significantly higher level FFM but there was no significant difference (P>0.05) in FFMI of male and female workers. No significant differences were found in skeletal mass (P > 0.5) and percentage of skeletal mass (P>0.05) between the male and female workers. Results also revealed that male workers are having significantly higher muscle mass (MM) (P<0.05) and higher percentage of muscle mass (%MM) (P<0.001). Results of hand grip force of the non-dominant hand male workers are having significantly higher grip force (P<0.001) than the female.

Table 2: Details of anthropometric study of the male and female tea garden workers.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Male (Group A) (n=50)</th>
<th>Female (Group B) (n=75)</th>
<th>P Value * (Gr. A Vs Gr. B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MUAC (cm)</td>
<td>23.84 ± 4.35</td>
<td>22.15 ± 3.42</td>
<td>0.025</td>
</tr>
<tr>
<td>UAMA (cm²)</td>
<td>45.36 ± 19.34</td>
<td>34.33 ± 14.37</td>
<td>0.001</td>
</tr>
<tr>
<td>FFM (kg)</td>
<td>50.42 ± 7.97</td>
<td>42.48 ± 6.30</td>
<td>0.000</td>
</tr>
<tr>
<td>FFMI</td>
<td>19.12 ± 2.32</td>
<td>18.99 ± 2.56</td>
<td>0.767</td>
</tr>
<tr>
<td>SM (kg)</td>
<td>8.65 ± 2.54</td>
<td>7.81 ± 1.92</td>
<td>0.055</td>
</tr>
<tr>
<td>% SM</td>
<td>17.10 ± 4.77</td>
<td>18.06 ± 4.18</td>
<td>0.253</td>
</tr>
<tr>
<td>MM (kg)</td>
<td>20.50 ± 7.53</td>
<td>17.68 ± 4.99</td>
<td>0.025</td>
</tr>
<tr>
<td>% MM</td>
<td>36.38 ± 13.65</td>
<td>23.01 ± 13.76</td>
<td>0.000</td>
</tr>
<tr>
<td>Grip force (N)</td>
<td>184.04 ± 60.73</td>
<td>54.65 ± 41.65</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Values are expressed as mean ± SD. * denotes P value based on the unpaired t-test.

Table 3 depicts the levels of serum proteins. Result revealed that there was no significant differences (P>0.5) in total serum protein and globulin between the male and female workers. However, male workers showed significantly higher level of serum albumin (P<0.05) than the females. Table 3 also depicts the levels of total bilirubin and direct bilirubin of the tea garden workers. Significantly higher levels of total bilirubin (P<0.001) and direct bilirubin (P<0.001) were found in male workers than the females. It was also found that all the enzymes of liver function test (AST, ALT and ALP) were significantly higher (P<0.001) in male workers than the females.

Table 3: Levels of serum proteins and indices of liver function test (LFT) of the male and female of the tea garden workers.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Male (Group A) (n=190)</th>
<th>Female (Group B) (n=215)</th>
<th>P Value * (Gr. A Vs Gr. B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Protein (g/dL)</td>
<td>6.90 ± 1.12</td>
<td>6.80 ± 1.06</td>
<td>0.376</td>
</tr>
<tr>
<td>Albumin (g/dL)</td>
<td>3.67 ± 0.49</td>
<td>3.55 ± 0.55</td>
<td>0.022</td>
</tr>
<tr>
<td>Globulin (g/dL)</td>
<td>3.23 ± 0.97</td>
<td>3.25 ± 0.92</td>
<td>0.784</td>
</tr>
<tr>
<td>Total Bilirubin (mg/dL)</td>
<td>1.06 ± 0.46</td>
<td>0.89 ± 0.37</td>
<td>0.000</td>
</tr>
<tr>
<td>Direct Bilirubin (mg/dL)</td>
<td>0.73 ± 0.26</td>
<td>0.62 ± 0.24</td>
<td>0.000</td>
</tr>
<tr>
<td>AST (U/L)</td>
<td>45.17 ± 22.52</td>
<td>34.11 ± 16.90</td>
<td>0.000</td>
</tr>
<tr>
<td>ALT (U/L)</td>
<td>33.07 ± 14.07</td>
<td>25.52±13.66</td>
<td>0.000</td>
</tr>
</tbody>
</table>
4. DISCUSSION

It is well known that nutritional screening with anthropometric measurements is an important first step in the early identification of malnutrition in any population. It initiates the whole nutrition care process of any population. Our previous study with tea garden workers of West Tripura District (Nath et al., 2018) revealed that both male and female workers are suffering from chronic energy deficiency. In this context, this study was undertaken to analyse the nutritional status based on anthropometric indices and also to study of the functional status of the liver in these male and female tea garden worker.

Detailed anthropometric study revealed that female tea garden workers are having lower MUAC and UAMA. As expected, males are having significantly higher FFM and MM compared to female workers. Muscle strength has been shown to be positively associated to muscle mass (Pham et al., 2007). Results of grips force revealed that males are having greater hand grip strength than the female workers. Grip strength represents a well-established measure of muscle function indicating fairly well the nutritional status of an individual (Heimburger et al., 2000). However, FFMI and skeletal mass did not showed any gender variation.

To identify the physiologic functions of liver, some liver function tests (LFT) measure are widely used in epidemiological study. LFT is used to determine any liver disorder. These usually include total protein, albumin, alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), total bilirubin and direct bilirubin (Burke, 2002). AST and ALT have been used as noninvasive surrogate markers of liver damage in epidemiological studies (Clark and Diehl, 2003; Clark et al., 2003). In other studies with the people of different ethnic origins, serum AST-to-ALT ratio was found to be
independently associated with metabolic syndrome (Hanley et al., 2005; Tzimaet al., 2009). The higher levels of ALT-to-AST indicate that the liver is either injured or inflamed (Sherlock and Dooley, 1997). Our study revealed that except total protein and globulin, all other parameters related to LFT were significantly higher in males than the female tea garden workers. When the result was further analyzed for elevated liver function state (Verrijken et al., 2010) based on the cutoff values of the hepatic enzymes, it was found that male population (60.73%) was having more elevated liver function test measures than the female tea garden workers.

The albumin-bilirubin (ALBI) score is a newly developed, simple, and objective scoring system for assessing the severity of liver function damage via only two indicators: albumin and bilirubin. The ALBI score may be used to evaluate the liver function damage and prognosis of patients with liver diseases and cancer (Johnson et al., 2015; Toyoda et al., 2016). Our result of ALBI score revealed that 72.63% of the male and 70.70% of the female workers are having less good liver function (Grade 2) whereas 27.37% of the male and 29.30% of the female population are having good liver function (Grade 1). However, no candidate was found with worst liver function (Grade 3). When overall population was considered, about 71.60% are having Grade 2 level of functional status of liver. This finding along with the elevated level of liver function test revealed that the physiologic function of liver of the tea garden workers is in alarming condition and males are more affected than the female tea garden worker.

Despite some limitations (no data on different clinical conditions of liver due to different liver diseases), we assumed that the elevated concentrations of liver enzymes were might be due to their poor living condition and nutritional status. It is well-known that the verifying of alcohol intake is not possible. However, to avoid this we rejected the candidates having record of alcohol consumption. As we used rather strict criteria for alcohol consumption, we assume that the liver disturbances in our studied population were minimally influenced by alcohol.

In conclusion, this study revealed that the functional status of liver of the tea garden workers of West Tripura District, Tripura is in alarming condition and need more attention to develop their health and physiological conditions.

5. ACKNOWLEDGEMENT
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REFERENCES


