A Study on Determining the Physical Workload of the Forest Harvesting and Nursery-Afforestation Workers

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ABSTRACT This study examines the physical workload, isometric strength and body composition values of workers working in the forestry industry. Researches in 10 different test areas in total were carried out, including 31 workers of forest harvesting and 30 workers of forest nursery-afforestation in The Regional Directorate of Forestry, Artvin (RDF). As the result of the workload measurement conducted on the workers, the physiological workload (%HRR) of harvesting and nursery-afforestation workers was found as 40.9 percent and 32.4 percent on average, respectively. This finding leads to the conclusion that nursing-afforestation workers can be classified as "light-work" workers, whereas harvesting workers must be classified as "medium-weight work" workers. Heartbeat rates for both worker groups during resting (HRrest) were almost identical; however, the heartbeat rates while at work (HRmax) were found to be higher in harvesting workers than in nursing-afforestation workers, which suggests that harvesting workers are more challenged at some periods of their work activity.

INTRODUCTION

Forestry activities form an organization involving various practices which are mostly performed in outdoor working conditions, including hard work (Apud and Valdez 1995; Apud et al. 2014). This organization includes afforestation, maintenance, protection, harvesting/production, construction, tree nursery, and erosion control (Eroglu et al. 2008; Eroglu et al. 2015). When forestry work is evaluated in general, it differs from other fields of operation due to such factors such as the working conditions, and the place and time of the operation (Erdas and Acar 1995; Zhao and Jackson 2014).

As is the case in several fields of operation, it is also required in the forestry operations that there be some harmony between the worker and the job done in order for the human body to work more efficiently. It is necessary that a worker has a proper physical body to show his physiologi-

*Address for correspondence: Dr. Habip Eroglu Karadeniz Technical University, Faculty of Forestry, 61080, Trabzon, Turkey Telephone: + 90 462 377 34 97 Fax: + 90 462 325 74 99 E-mail: habip@ktu.edu.tr cal capacity at work. A worker cannot expect to reach the highest performance in his work unless the features of his physical body are able to meet the workload he is exposed to. The relationship between the human body at work and the job being done is of great importance.

Physiological workload is a parameter which shows the pressure a worker is exposed to at work is based on his heart rate during his work activities. Heart rate is related to oxygen consumption and can be used to determine the physical workload under certain conditions.

The devices used to measure the heartbeat values consist of the analogue components needed to record the electrocardiography signals and contain different digital components to record the number of heartbeats. Thanks to this method, the load intensity the worker is exposed to during his activities at work can be calculated through formulas (Vitalis 1987; Kirk and Sulmann 2001; Shemwetta et al. 2002; Samsuddin et al. 2015). The physiological workloads of the workers are affected by such physical attributes such as body composition, body mass index (BMI) and strength (Diament et al. 1968; Wortman et al. 2015). The body composition is generally made up of a proportional collection of fat, bones, muscle cells, other organic substances and ex-

tracellular fluids (Going et al. 1995: Bangsbo et al. 2015). Today the most valid measurement is the body mass index (BMI). The BMI is calculated by dividing the body weight (kg) by the square of the height (m). The ideal weight for a person can be determined by calculating his/her BMI (Sonmez 2003). Another factor associated with physical structure which affects the performance of a person is the concept of "strength". Strength is the ability of the muscles to contract against any resistance they meet or to endure against it for a given period. As another definition, strength is described as the ability to apply a force with short-term maximal efforts and to repeat the submaximal efforts.

In this study, the load intensity at work which the workers, all of whom were male and in charge of harvesting and nursery-afforestation, were exposed to as well as their body compositions and some of their isometric strengths were determined.

MATERIAL AND METHODS

Study Area

Within the scope of this research, studies were conducted in 10 places in total, all of which were located within the boundaries of the RDF (Regional Directorate of Forestry), Artvin (Fig. 1).

Studies were performed at one location in the Ardanuc Forest Nursery, the Seyitler Nursery, Acisu, Natangev, Erenler and Sitimsara, respectively and at 2 location in Varlik and Bogaboynu, respectively (Table 1). The study was conducted on 61 forestry workers, all of whom were males aged between 18 and 61. Of these workers, 31 of them were employed in the harvesting area, while 30 were employed in the nursery-afforestation.

The workers in charge of the areas where harvesting was done performed such tasks such as tree-cutting, branch-collecting, peeling, log-

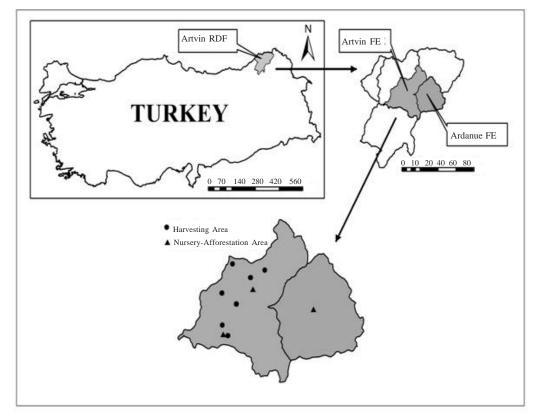


Fig.1. The location of the study points

Study location	Work	Number of workers	Division No.	Aspect	Elevation (m)	Slope (%)	Tree type
Acisu	Harvesting	5	30	NE	1100	80	Spruce
Natangev	C	8	114	SE	1600	50	Spruce
Varlik		2	137	SE	1900	70	Spruce
Erenler (1)		3	150	SE	1900	70	Spruce, Abies
Erenler (2)		3	3	SE	1900	70	Spruce
Sitimsara		7	241	S	1800	60	Spruce
Bogaboynu (1)		3	72	NE	1950	70	Scotch pine
0.0	Total	31					ľ
Bogaboynu (2)	Nursery- Afforestation	8	71	S	1900	70	
Seyitler nursery		7		S	536	1-2	
Ardanuc nursery		15		W	760	1-2	
,	Total	30					

 Table 1: Information about study locations

ging, cabling to the nearest roadside and wood extraction with cabled overhead lines. The workers in charge of the nursery-afforestation, on the other hand, performed activities such as preparing seedbeds, filling tubes and placing them in harvesting parcels, disinfecting them from pests, shelling, harvesting, sapling-packaging, and sowing. The afforestation workers performed their tasks as part of afforestation activities connected to slope stabilization.

Determining the Strength Values

A back and knee dynamometer was used for measuring the maximal strength of the workers. When knee strength was being measured, the workers were made to place their feet on the dynamometer scaffold with their knees in a bent position and to keep their arms stretched, their back upright, and their chests slightly bent forward. When measuring back strength, the workers were made to sit on the dynamometer scaffold and to keep their legs straight and their back slightly bent, so that they were prevented from moving their legs. The workers were then asked to pull the dynamometer chain with the help of a handle using their maximum strength. These measurements were repeated twice on the workers, and the highest values were taken into consideration.

Determining Body Compositions

The skinfold thickness method was used for measuring body composition. A Holtain-brand skinfold caliper was used for measuring the skin fold thickness. Measurements related to determining the body composition were made in 7 areas, namely the abdominal area, the thigh, the biceps, the triceps, the suprailiac and subscapular areas, and the calf (Zorba and Ziyagil 1995).

The measurements were repeated three times, and their average was recorded in "mm". Later on, the formulas 1, 2, 3 and 4 were used for determining the body fat ratios of the forest workers (Jackson and Pullock 1978; Siri 1956).

$DB = 1.112 - 0.00043499(\Sigma 7 \text{SKF}) + 0.00000055$	(1)
$BM_{(\Sigma TSKF)^2} - 0.0002826 \text{ (age)}$	()

Fat
$$(\%) = |(4.95/dB) - 4.50| \times 100$$
 (2)

$$FM = \frac{BM \times Fat\%}{100}$$
(3)

(4)

dB, Body density

SKF, Biceps, Triceps, Subscapular and Suprailiac areas, the Abdominal area, the thigh, Calf skin thickness in "mm".

Fat (%),	Body fat percentage
FM (kg),	Body Fat mass
BM (kg),	Body mass
NFM(kg),	Non-fat mass

Determining the Physiological Workload

The GPSport system was used in order to measure the physiological workloads of the workers in the forest. Afterwards, the GPSport system data were recorded throughout the study, and the obtained data were transferred to the computer environment with the help of Team AMS R1 2011 software. Formula 5 was used to determine the physiological workload (Smith et al. 1985; Trites et al. 1993; Apud and Valdes 1995; Kirk and Parker 1996; Sullman and Byers 2000; Kirk and Sullman 2001; Astrand et al. 2003). Formula 6 below was used for the purpose of determining half of the heartbeat reserves of the workers (Lammert 1972). The heart rates of the workers at rest and their heart rates during working hours were obtained using Formula 7 (Diament et al. 1968).

$$\begin{array}{ll} \text{\%HRR} = \times 100 & (5) \\ 50\% \text{ I} = + & \underline{HR_{max} - HR_{res}} & (6) \\ \text{Ratio} = & \frac{HR_{wart}}{HR_{res}} & 2 & (7) \end{array}$$

%HRR, The number of physical workload

HR_{work} (beat/min), The number of heartbeats during working hours

 $H\bar{R}_{rest}$ (beat/min), The number of heartbeats during resting

 HR_{max} (beat/min), The number of maximal heartbeat (= 220 – age)

50% Level, Half of the heartbeat reserves

RESULTS AND DISCUSSION

The values obtained from the measurements performed on the harvesting and sapling-afforestation workers in the study are given in Tables 2 and 3.

As can be seen in Tables 2 and 3, the average ages of the harvesting and nursery-afforestation workers were 43.1 and 44.9, respectively. Their average body weights were determined to be 79.2 kg and 80.4 kg, respectively, whereas their average height was found to be 1.70 m. in both groups. The average body mass index values of the harvesting and nursery-afforestation workers were found to be 26.6 kg/m² and 27.1 kg/m², respectively. From these results, it is seen that both groups of workers were in the "obese" class. A detailed examination shows that 43 percent of the harvesting workers fall into the "normal" class, whereas 57 percent were in the "obese" class, and that 33 percent of the nursery-afforestation workers were in the "normal" class, while 67 percent were in the "obese" class. In this classification, the criteria used for the BMI were as follows: 20=slim, 20-25=normal, 25-30=obese (Kirk and Sullman 2001: Ramesh 2015).

While the difference between the harvesting workers and the nursery afforestation workers was more prominent due to the fact that the workload of the harvesting workers was far more challenging during the working hours, the fact that the values were proximate to each other may result from the differences in nutritional means. Similar to the obtained valuess, the studies conducted showed that in chainsaw operators the BMI value was found to be 25.1 kg/m^2 (obese) (Caliskan and Caglar, 2010), whereas this value in overhead line workers was 24.9 kg/m² (normal) (Kirk and Sullman 2001) in forest workers 22.6 kg/m² (normal) (Dube et al. 2015) and 24.4 kg/m² (normal) in the loader tractor drivers (Melemez and Tunay 2010).

Whereas the body density values in both groups of workers were almost identical, it was determined to be 1.059 in the harvesting workers and 1.055 in the nursery-afforestation workers. The body fat percentage of the harvesting workers was 16.77 percent, whereas it was measured as 19.10 percent in the nursery-afforestation workers.

On considering the body fat percentage values and average ages (43.1 in the harvesting workers and 44.9 in the nursery-afforestation workers) of the harvesting and nursery-afforestation workers by using Table 4, the workers are seen to be in the "medium" group (Robers and Roberts 1997: Arora et al. 2015).

Table 4: Classification of body compositions

Group-age	20-29	30-39	40-49	50-59	<i>60</i> ≤
Medium Overweight	11-13 14-20 21-23		14-16 17-23 24-26	15-17	16-18 19-25 26-28

A detailed look at the body compositions of the workers reveals that 30 percent of the harvesting workers were "perfect", while 3 percent of them were "good", 57 percent were "medium" and 10 percent were "overweight"; and that no "obese" worker was found in this group of workers. On the other hand, it was determined that 24 percent of nursery-afforestation workers were 'perfect", 20 percent were "good", and again 20 percent of them were in the "medium" class, while 6 percent were "overweight", and 30 percent were "obese". From these values, it follows that the majority of the nursery-afforestation workers fall into the class of the "obese" class; however, when the general averages are examined, both groups of workers seem to fall into the "medium" class. There is no way of directly measuring the body composition of a living person (Swenor et al. 2015).

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Table 2: Parameters of the harvesting workers

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$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	49601.6023.41.0714.0 8.4 51.6 51951.7530.11.04 26.3 23.6 66.4 52951.7730.31.04 29.6 23.81 66.9 52951.7730.31.04 29.6 23.81 66.9 52951.7730.31.03 29.2 27.7 67.3 54701.76 22.6 1.07 11.5 8.0 62.0 551051.79 32.8 1.07 11.5 8.0 62.0 551051.79 32.8 1.04 26.7 57.5 57571.79 32.8 1.04 26.7 57.5 5660 1.73 26.1 1.07 14.1 8.4 51.6 58108 1.75 35.3 1.03 32.1 34.7 73.3 59108 1.73 32.4 1.05 21.1 16.9 63.1 5980.4 1.73 33.4 1.03 32.1 34.7 73.3 59100 1.73 26.4 1.05 21.1 16.9 64.25 58 1.67 1.07 27.1 1.055 9.7 70.4 59 115 1.72 27.1 1.055 9.7 70.4 59 115 1.93 32.1 34.7 73.3 59 115 1.72 27.1 1.055 97.2 <td>60 23.4 1.07 14.0 8.4 51.6 60 80 67 120 89 26.1 1.48 116 0 65 32.7 1.04 26.3 23.6 66.4 85 90 60 127 100 39.2 1.66 111 0 65 30.1 1.04 25.3 23.6 66.4 85 95 65 132 107 43.5 1.78 114 0 77 30.3 1.03 29.2 27.7 67.3 35 40 60 152 106 42.6 1.77 114 0 78 30.1 1.04 26.3 20.5 57.5 55 60 99 72 12.1 1.22 113 0 79 32.8 10.4 24.7 25.9 79.1 80 65 113 80 19.0 1.33 113 0 75 21.2 1.05 19.4 12.6 52.4 40 35 61 128 101 39.0 1.68 113 0 75 23.7 1.07 14.1 8.4 51.6 50 40 67 119 93 31.7 1.55 112 0 75 23.7 1.07 14.1 8.4 51.6 50 40 67 119 93 31.7 1.55 112 0 78 33.4 1.03 28.9 28.9 71.1 86 710 39.2 1.66 111 0 78 33.4 1.03 28.9 28.9 71.1 86 71 0 78 33.4 1.03 28.9 28.9 71.1 86 71 0 78 33.4 1.03 28.9 28.9 71.1 86 71 0 79 35.3 1.03 32.1 34.7 73.3 60 50 64 127 100 39.2 1.66 111 0 78 33.4 1.03 28.9 28.9 71.1 86 71 0 79 35.3 1.03 32.1 34.7 73.3 60 50 64 127 100 39.2 1.66 111 0 78 33.4 1.03 28.9 28.9 71.1 86 71 0 79 35.3 1.03 32.1 34.7 73.3 60 50 64 127 100 39.2 1.66 111 0 78 24.6 1.08 9.7 7 6 70.4 160 130 65 129 97 32.4 1.0 1.67 111 0 78 24.6 1.08 9.7 7 6 70.4 160 130 65 125 105 41.2 1.91 108 0 70 95 125 105 125 105 112 51.2 133 1 70 11.8 7 7 118 87 75 125 105 105 44.2 1.00 105 110 108 0 70 165 70 188 127 53.2 2.12 133 1 71 1.055 19.10 16.15 64.25 70 64.8 64 129 97 32.4 1.62 117.2 0 70 39.2 1.08 02.1 108 0 70 165 70 188 127 53.2 2.12 133 1 80 40 Density, Fat%= Body Fat Percentage, KS= Knee Strength, BS= Back Strength, HR_{tot}(beats/min)= Heartbeat during rehated throw the the the the the the the the the the</td> <td>49</td> <td></td> <td>1.67</td> <td>25.8</td> <td>1.04</td> <td>24.9</td> <td>17.9</td> <td>54.1</td> <td>35</td> <td>35</td> <td>60</td> <td>112</td> <td>87</td> <td>24.3</td> <td>1.45</td> <td></td> <td></td>	60 23.4 1.07 14.0 8.4 51.6 60 80 67 120 89 26.1 1.48 116 0 65 32.7 1.04 26.3 23.6 66.4 85 90 60 127 100 39.2 1.66 111 0 65 30.1 1.04 25.3 23.6 66.4 85 95 65 132 107 43.5 1.78 114 0 77 30.3 1.03 29.2 27.7 67.3 35 40 60 152 106 42.6 1.77 114 0 78 30.1 1.04 26.3 20.5 57.5 55 60 99 72 12.1 1.22 113 0 79 32.8 10.4 24.7 25.9 79.1 80 65 113 80 19.0 1.33 113 0 75 21.2 1.05 19.4 12.6 52.4 40 35 61 128 101 39.0 1.68 113 0 75 23.7 1.07 14.1 8.4 51.6 50 40 67 119 93 31.7 1.55 112 0 75 23.7 1.07 14.1 8.4 51.6 50 40 67 119 93 31.7 1.55 112 0 78 33.4 1.03 28.9 28.9 71.1 86 710 39.2 1.66 111 0 78 33.4 1.03 28.9 28.9 71.1 86 71 0 78 33.4 1.03 28.9 28.9 71.1 86 71 0 78 33.4 1.03 28.9 28.9 71.1 86 71 0 79 35.3 1.03 32.1 34.7 73.3 60 50 64 127 100 39.2 1.66 111 0 78 33.4 1.03 28.9 28.9 71.1 86 71 0 79 35.3 1.03 32.1 34.7 73.3 60 50 64 127 100 39.2 1.66 111 0 78 33.4 1.03 28.9 28.9 71.1 86 71 0 79 35.3 1.03 32.1 34.7 73.3 60 50 64 127 100 39.2 1.66 111 0 78 24.6 1.08 9.7 7 6 70.4 160 130 65 129 97 32.4 1.0 1.67 111 0 78 24.6 1.08 9.7 7 6 70.4 160 130 65 125 105 41.2 1.91 108 0 70 95 125 105 125 105 112 51.2 133 1 70 11.8 7 7 118 87 75 125 105 105 44.2 1.00 105 110 108 0 70 165 70 188 127 53.2 2.12 133 1 71 1.055 19.10 16.15 64.25 70 64.8 64 129 97 32.4 1.62 117.2 0 70 39.2 1.08 02.1 108 0 70 165 70 188 127 53.2 2.12 133 1 80 40 Density, Fat%= Body Fat Percentage, KS= Knee Strength, BS= Back Strength, HR _{tot} (beats/min)= Heartbeat during rehated throw the	49		1.67	25.8	1.04	24.9	17.9	54.1	35	35	60	112	87	24.3	1.45		
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	50901.66 32.7 1.04 26.3 23.6 66.4 51951.75 31.0 1.03 29.6 28.1 66.9 52951.77 30.3 1.03 29.2 27.7 67.3 5470 1.76 30.3 1.03 29.2 27.7 67.3 5578 1.77 30.3 1.04 26.3 20.5 57.5 55105 1.77 32.8 1.04 26.3 20.5 57.5 55105 1.79 32.8 1.04 26.3 20.5 57.5 57105 1.79 32.8 1.04 24.7 25.9 79.1 55105 1.77 32.3 1.03 32.1 34.7 73.3 59108 1.75 35.3 1.03 32.1 34.7 73.3 59108 1.77 33.4 1.03 32.1 34.7 73.3 59100 1.74 26.4 1.05 21.1 16.9 63.1 59100 1.74 26.4 1.05 21.1 16.9 63.1 59108 1.77 27.1 1.055 97.9 70.4 58 47.9 33.2 1.03 32.1 34.7 73.3 59 115 1.9 1.055 19.10 16.15 64.25 59 115 1.97 33.1 34.7 30.3 34.7 59 115 <td>66 32.7 1.04 26.3 23.6 66.4 85 96 33.0 1.66 111 06 75 31.0 1.03 29.6 28.1 66.9 55 65 136 96 33.0 1.60 115 0115 0115 0115 0107 115 8.0 62.0 35 56 66 113 80 190 133 114 02 76 22.6 1.07 11.5 8.0 62.0 35 66 96 33.0 114 07 113 80 190 133 114 02 75 21.2 107 14.1 8.4 51.6 50 66 112 80 127 103 32.1 134.7 733 31.7 1.55 112 02 05 66 111 96 010 016 010 016 0111 02 035 1112 02 1127 1127 1101</td> <td>49</td> <td></td> <td>1.60</td> <td>23.4</td> <td>1.07</td> <td>14.0</td> <td>8.4</td> <td>51.6</td> <td>60</td> <td>80</td> <td>67</td> <td>120</td> <td>89</td> <td>26.1</td> <td>1.48</td> <td></td> <td></td>	66 32.7 1.04 26.3 23.6 66.4 85 96 33.0 1.66 111 06 75 31.0 1.03 29.6 28.1 66.9 55 65 136 96 33.0 1.60 115 0115 0115 0115 0107 115 8.0 62.0 35 56 66 113 80 190 133 114 02 76 22.6 1.07 11.5 8.0 62.0 35 66 96 33.0 114 07 113 80 190 133 114 02 75 21.2 107 14.1 8.4 51.6 50 66 112 80 127 103 32.1 134.7 733 31.7 1.55 112 02 05 66 111 96 010 016 010 016 0111 02 035 1112 02 1127 1127 1101	49		1.60	23.4	1.07	14.0	8.4	51.6	60	80	67	120	89	26.1	1.48		
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	5195 1.75 31.0 1.03 29.6 28.1 66.9 5283 1.66 30.1 1.04 27.0 22.4 60.6 5378 1.76 22.6 1.07 11.5 8.0 62.0 5578 1.77 30.3 1.04 26.3 20.5 57.5 55105 1.79 32.8 1.04 26.3 20.5 57.5 5565 1.79 32.8 1.04 24.7 25.9 79.1 5660 1.59 32.1 1.07 14.1 8.4 57.5 5758 108 1.77 23.2 1.07 14.1 8.4 57.4 59 100 1.74 26.4 1.05 21.1 16.9 63.1 59 100 1.74 26.4 1.05 21.1 16.9 63.1 51 100 1.74 26.4 1.05 21.1 16.9 63.1 59 100 1.74 26.4 1.05 21.1 16.9 63.1 59 103 1.78 24.6 1.08 28.9 70.4 58 1.59 19.8 1.03 28.9 70.4 59 115 1.93 32.1 34.7 73.3 59 115 1.93 32.1 34.7 73.3 59 115 1.93 32.1 34.7 73.3 50 35.3 1.05 93.1 <td>75 31.0 1.03 29.6 28.1 66.9 55 65 136 96 33.0 1.60 115 0 77 30.3 1.04 27.0 22.4 60.6 35 30 60 132 107 43.5 1.77 114 0 77 30.3 1.03 29.2 27.7 67.3 35 30 60 113 80 19.0 1.33 113 0 78 22.6 1.07 11.5 8.0 62.0 30 25 60 99 72 12.1 1.22 113 0 78 21.1 104 26.3 20.5 57.5 55 60 60 113 80 19.0 1.33 113 0 78 21.2 105 19.4 12.6 52.4 40 35 61 128 101 39.0 1.68 113 0 78 23.7 107 14.1 8.4 51.6 50 64 127 100 39.2 1.66 111 0 78 35.3 1.03 32.1 34.7 73.3 60 50 64 127 100 39.2 1.66 111 0 78 23.6 1.03 22.1 16.9 63.1 80 70 65 129 102 41.0 1.67 111 0 78 24.6 1.05 21.1 16.9 63.1 80 70 65 129 102 41.0 1.67 111 0 78 24.6 1.03 29.1 0.615 64.25 70 64.8 64 127 100 39.2 1.66 111 0 78 24.6 1.03 29.1 0.615 64.25 70 64.8 64 129 97 32.4 1.62 117.2 0 70 10.8 1.03 5.1 3.4.7 80.3 170 165 70 188 127 53.2 2.12 123 1 70 10.8 1.03 5.1 3.4.7 80.3 170 165 70 188 127 53.2 2.12 133 1 70 1.67 111 0 71 25 105 19.1 0 16.15 64.25 70 64.8 64 129 97 32.4 1.62 117.2 0 70 19.8 1.03 5.1 3.4.7 80.3 170 165 70 188 127 53.2 2.12 133 1 80dy Density, Fat%= Body Fat Percentage, KS= Knee Strength, BS= Back Strength, HR_{ret}(beats/min)= Heartbeat during re heartbeat during working.</td> <td>50</td> <td></td> <td>1.66</td> <td>32.7</td> <td>1.04</td> <td>26.3</td> <td>23.6</td> <td>66.4</td> <td>85</td> <td>90</td> <td>60</td> <td>127</td> <td>100</td> <td>39.2</td> <td>1.66</td> <td></td> <td></td>	75 31.0 1.03 29.6 28.1 66.9 55 65 136 96 33.0 1.60 115 0 77 30.3 1.04 27.0 22.4 60.6 35 30 60 132 107 43.5 1.77 114 0 77 30.3 1.03 29.2 27.7 67.3 35 30 60 113 80 19.0 1.33 113 0 78 22.6 1.07 11.5 8.0 62.0 30 25 60 99 72 12.1 1.22 113 0 78 21.1 104 26.3 20.5 57.5 55 60 60 113 80 19.0 1.33 113 0 78 21.2 105 19.4 12.6 52.4 40 35 61 128 101 39.0 1.68 113 0 78 23.7 107 14.1 8.4 51.6 50 64 127 100 39.2 1.66 111 0 78 35.3 1.03 32.1 34.7 73.3 60 50 64 127 100 39.2 1.66 111 0 78 23.6 1.03 22.1 16.9 63.1 80 70 65 129 102 41.0 1.67 111 0 78 24.6 1.05 21.1 16.9 63.1 80 70 65 129 102 41.0 1.67 111 0 78 24.6 1.03 29.1 0.615 64.25 70 64.8 64 127 100 39.2 1.66 111 0 78 24.6 1.03 29.1 0.615 64.25 70 64.8 64 129 97 32.4 1.62 117.2 0 70 10.8 1.03 5.1 3.4.7 80.3 170 165 70 188 127 53.2 2.12 123 1 70 10.8 1.03 5.1 3.4.7 80.3 170 165 70 188 127 53.2 2.12 133 1 70 1.67 111 0 71 25 105 19.1 0 16.15 64.25 70 64.8 64 129 97 32.4 1.62 117.2 0 70 19.8 1.03 5.1 3.4.7 80.3 170 165 70 188 127 53.2 2.12 133 1 80dy Density, Fat%= Body Fat Percentage, KS= Knee Strength, BS= Back Strength, HR _{ret} (beats/min)= Heartbeat during re heartbeat during working.	50		1.66	32.7	1.04	26.3	23.6	66.4	85	90	60	127	100	39.2	1.66		
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	52831.6630.11.04 27.0 22.4 60.6 54701.7730.31.03 29.2 27.7 67.3 55781.7730.31.03 29.2 27.7 67.3 551051.7922.61.0711.5 80.6 62.0 55651.7932.81.04 24.7 25.9 79.1 56601.5923.71.0714.1 84 51.6 581081.7733.41.0714.1 84 51.6 59801.7426.41.0523.114.1 84 51.6 59801.7426.41.0523.116.9 63.1 591001.7333.41.0322.116.9 63.1 591001.7325.41.0519.971.1591001.7325.41.0528.971.1591001.7325.11.0516.9 64.25 18581.5919.81.036.33.8 54.25 591151.93.5.31.083.2.1 34.7 73.3 591151.91.03 6.3 3.8 54.25 505857.11.05519.1016.15 64.25 585857.33.2.1 1.055 19.10 16.15 64.25 505857.33.08 </td <td>66 30.1 1.04 27.0 22.4 60.6 35 30 60 132 107 43.5 1.78 114 0 77 30.3 1.03 29.2 27.7 67.3 35 40 60 152 106 42.6 1.77 114 0 78 22.6 1.07 11.5 8.0 62.0 30 55 65 97 81 20.8 1.37 112 0 73 26.1 1.04 24.7 25.9 79.1 80 65 65 97 81 20.8 113 0 75 21.2 1.05 19.4 12.6 52.4 40 35 61 128 101 39.0 1.68 113 0 75 21.2 1.05 19.4 12.6 52.4 40 35 61 128 101 39.0 1.68 113 0 75 35.3 1.07 14.1 8.4 73.3 60 50 67 119 93 31.7 1.55 112 0 78 26.4 1.05 21.1 16.9 63.1 80 70 65 129 102 41.0 1.67 111 0 78 26.4 1.05 21.1 16.9 63.1 80 70 65 129 102 41.0 1.67 111 0 78 24.6 1.08 9.7 7.6 13.0 39.2 1.66 111 0 78 25.1 9.10 16.15 64.25 70 64.8 64 127 100 39.2 1.66 111 0 78 27.1 1.055 19.10 16.15 64.25 70 64.8 67 129 97 32.4 1.62 117.2 0 79 35.3 1.03 32.1 34.7 80.3 170 165 70 188 127 53.2 2.12 133 1 80dy Density, Fat%= Body Fat Percentage, KS= Knee Strength, BS= Back Strength, HR_{ret}(beats/min)= Heartbeat during re heartbeat during working, to heartbeat during returng resting; 50%I = Heartbeat half-reserve; HR_{wite} = 0 64 Ratio = The ratio of heartbeat during working to heartbeat during resting; 50%I = Heartbeat half-reserve; HR_{wite} $M_w^{50I} = 0$</td> <td>51</td> <td></td> <td>1.75</td> <td>31.0</td> <td>1.03</td> <td>29.6</td> <td>28.1</td> <td>60.9</td> <td>55</td> <td>65</td> <td>65</td> <td>136</td> <td>96</td> <td>33.0</td> <td>1.60</td> <td></td> <td></td>	66 30.1 1.04 27.0 22.4 60.6 35 30 60 132 107 43.5 1.78 114 0 77 30.3 1.03 29.2 27.7 67.3 35 40 60 152 106 42.6 1.77 114 0 78 22.6 1.07 11.5 8.0 62.0 30 55 65 97 81 20.8 1.37 112 0 73 26.1 1.04 24.7 25.9 79.1 80 65 65 97 81 20.8 113 0 75 21.2 1.05 19.4 12.6 52.4 40 35 61 128 101 39.0 1.68 113 0 75 21.2 1.05 19.4 12.6 52.4 40 35 61 128 101 39.0 1.68 113 0 75 35.3 1.07 14.1 8.4 73.3 60 50 67 119 93 31.7 1.55 112 0 78 26.4 1.05 21.1 16.9 63.1 80 70 65 129 102 41.0 1.67 111 0 78 26.4 1.05 21.1 16.9 63.1 80 70 65 129 102 41.0 1.67 111 0 78 24.6 1.08 9.7 7.6 13.0 39.2 1.66 111 0 78 25.1 9.10 16.15 64.25 70 64.8 64 127 100 39.2 1.66 111 0 78 27.1 1.055 19.10 16.15 64.25 70 64.8 67 129 97 32.4 1.62 117.2 0 79 35.3 1.03 32.1 34.7 80.3 170 165 70 188 127 53.2 2.12 133 1 80dy Density, Fat%= Body Fat Percentage, KS= Knee Strength, BS= Back Strength, HR _{ret} (beats/min)= Heartbeat during re heartbeat during working, to heartbeat during returng resting; 50%I = Heartbeat half-reserve; HR _{wite} = 0 64 Ratio = The ratio of heartbeat during working to heartbeat during resting; 50%I = Heartbeat half-reserve; HR _{wite} $M_w^{50I} = 0$	51		1.75	31.0	1.03	29.6	28.1	60.9	55	65	65	136	96	33.0	1.60		
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	5295 1.77 30.3 1.03 29.2 27.7 67.3 5578 1.76 22.6 1.07 11.5 8.0 62.0 55105 1.79 26.1 1.07 11.5 8.0 62.0 55105 1.77 32.8 1.04 24.7 25.9 57.5 56 60 1.59 23.7 1.07 14.1 8.4 51.6 58 108 1.77 33.3 1.03 32.1 34.7 73.3 59 80 1.77 23.3 1.03 22.11 16.9 63.1 59 80.4 1.73 33.4 1.03 28.9 71.1 34 78 1.78 24.6 1.08 9.7 7.6 70.4 59 80.4 1.72 27.1 1.055 19.10 16.15 64.25 18 58 1.03 6.3 3.8 54.25 59 115 1.9 1.055 19.10 16.15 64.25 18 58 1.59 19.8 1.03 6.3 38.5 54.25 59 115 1.9 35.3 1.08 32.1 34.7 80.3 59 115 1.9 35.3 1.08 32.1 34.7 80.3 59 115 1.9 35.3 1.08 32.1 34.7 80.3 59 115 1.9 80.4 1.72 27.1 10.8 3	77 30.3 1.03 29.2 27.7 67.3 35 40 60 152 106 42.6 1.77 114 C 73 22.6 1.07 11.5 8.0 62.0 30 25 60 99 72 12.1 1.22 113 C 73 22.1 1.04 26.3 20.5 57.5 55 65 97 81 20.8 1.33 113 C 75 23.2 1.07 14.1 8.4 51.6 50 40 67 119 93 31.7 1.55 112 C 75 23.3 1.03 32.1 34.7 73.3 60 50 64 127 100 39.2 1.66 111 C 74 26.4 103 22.1 16.9 71.1 88 75 65 129 93 31.7 1.55 112 C 73 33.4 103 22.1 16.9 71.1 88 77 65 129 102 41.0 1.67 111 C 73 33.4 103 22.1 16.9 71.1 85 77 125 102 41.0 1.67 111 C 73 33.4 103 22.1 16.9 71.1 85 70 65 129 97 32.4 1.0 1.67 111 C 73 33.4 103 2.1 16.9 51 70 64.8 64 129 97 32.4 1.0 1.67 111 C 73 33.4 103 2.1 16.9 51 160 127 53.2 2.12 123 1 73 33.4 103 5.1 3.1 85 70 64.8 64 129 97 32.4 1.62 117.2 C 59 19.8 103 6.3 170 16.15 64.25 70 64.8 64 129 97 32.4 1.62 117.2 C 50 35.3 1.08 32.1 34.7 80.3 170 165 70 188 127 53.2 2.12 123 1 80dy Density, Fat%= Body Fat Percentage, KS= Knee Strength, BS= Back Strength, HR _{tok} (beats/min)= Heartbeat during re heartbeat during working.	52		1.66	30.1	1.04	27.0	22.4	60.6	35	30	60	132	107	43.5	1.78		
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	54701.7622.61.0711.58.062.0551051.7926.11.0426.320.557.5551051.7926.11.0426.320.557.555651.7723.71.0714.18.451.6581081.7535.31.0332.134.773.359801.7426.41.0521.116.963.159801.7333.41.0332.134.773.3591001.7324.41.0521.116.963.15980.41.7827.11.05519.1016.1564.2518581.5919.81.036.33.854.25591151.935.31.0832.134.778.4501333.21.0332.99.77.670.4591151.935.31.0823.134.780.3591151.935.31.0832.134.780.380dy Mass Index, dB=Body Density, Fat%= Body Fat Percentage, KS=	76 22.6 1.07 11.5 8.0 62.0 30 25 60 99 72 12.1 1.22 113 0 73 26.1 1.04 26.3 20.5 57.5 55 60 60 113 80 19.0 1.33 113 0 75 21.2 1.05 19.4 12.6 52.4 40 35 61 128 101 39.0 1.68 113 0 75 23.7 1.07 14.1 8.4 51.6 50 40 67 119 93 31.7 1.55 112 0 74 26.4 1.03 32.1 34.7 73.3 60 50 64 127 100 39.2 1.66 111 0 73 33.4 1.03 28.9 28.9 71.1 85 75 70 65 129 102 41.0 1.67 111 0 73 33.4 1.03 28.9 28.9 71.1 85 75 70 65 129 105 47.2 1.91 108 0 73 24.6 1.03 28.9 28.9 71.1 85 77 125 129 105 47.2 1.91 108 0 73 33.4 1.03 28.9 28.9 71.1 85 77 125 129 105 47.2 1.91 108 0 73 33.4 1.03 28.9 28.9 71.1 85 77 67 10 93 2.4 1.0 1.67 111 0 73 33.4 1.03 28.9 28.9 71.1 85 77 67 125 105 47.2 1.91 108 0 78 24.6 1.08 9.7 7.6 70.4 160 130 65 129 97 32.4 1.62 117.2 0 79 35.3 1.08 32.1 34.7 80.3 170 165 70 188 127 53.2 2.12 123 1 80dy Density, Fat%= Body Fat Percentage, KS= Knee Strength, BS= Back Strength, HR _{tot} (beats/min)= Heartbeat during re heartbeat during working, the theorem of the meature at the theorem of the meature at the theorem of the total of	52		1.77	30.3	1.03	29.2	27.7	67.3	35	40	60	152	106	42.6	1.77		
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	5578 1.73 26.1 1.04 26.3 20.5 57.5 55105 1.79 32.8 1.04 24.7 25.9 79.1 5660 1.59 32.1 1.07 14.1 8.4 55.4 58108 1.75 35.3 1.07 14.1 8.4 55.4 59108 1.75 35.3 1.07 14.1 8.4 55.4 59100 1.74 26.4 1.05 21.1 16.9 63.1 34 78 1.73 32.4 1.03 28.9 71.1 59 100 1.74 26.4 1.03 28.9 71.1 59 100 1.77 27.1 1.055 19.10 16.15 64.25 18 58 1.59 19.8 1.03 6.3 $38.64.25$ 59 115 1.9 32.1 34.7 80.3 50 35.3 1.03 6.3 $38.64.25$ 59 115 1.9 32.1 34.7 80.3 50 115 1.9 32.1 34.7 80.3 50 115 1.9 32.1 34.7 80.3 50 115 1.9 80.3 32.1 34.7 80.3 800 1886 1088 1008 32.1 34.7 80.3 800 1088 1008 32.1 34.7 80.3	73 26.1 1.04 26.3 20.5 57.5 55 60 60 113 80 19.0 1.33 113 0 75 21.2 1.07 19.4 12.6 50 50 65 97 81 20.8 1.37 112 00 1.33 113 0 75 23.7 1.07 14.1 8.4 51.6 50 66 67 119 93 31.7 1.55 112 05 111 05 111 06 51.6 61 127 100 39.2 1.66 111 06 111 06 50 64 127 100 39.2 116 111 06 111 06 50 66 51 64 127 100 32.1 111 06 111 06 111 06 111 06 111 06 127 100 39.2 110 161 101 30.6 109 121	54		1.76	22.6	1.07	11.5	8.0	62.0	30	25	60	66	72	12.1	1.22		
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	55 105 1.79 32.8 1.04 24.7 25.9 79.1 55 65 1.75 21.2 1.05 19.4 12.6 52.4 56 60 1.59 23.7 1.07 14.1 8.4 51.6 58 108 1.75 21.2 1.05 21.1 16.9 63.1 59 80 1.74 26.4 1.05 21.1 16.9 63.1 59 100 1.74 26.4 1.05 21.1 16.9 63.1 34 7 1.72 27.1 1.05 21.1 16.9 63.1 34 7 8.0.4 1.72 27.1 1.05 19.1 7.6 70.4 37 7.8 9.7 7.6 70.4 24.25 11 105 64.25 18 58 1.59 19.8 1.08 32.1 34.7 80.3 59 115 1.9 35.3 1.08 32.1 34.7 80.3 59 115 1.9	79 32.8 1.04 24.7 25.9 79.1 80 65 65 97 81 20.8 1.37 112 00 75 21.2 1.05 92.4 12.6 52.4 40 35 61 112 90 1.68 113 05 112 119 93 31.7 1.55 112 05 111 05 111 05 111 06 111 05 111 05 111 05 111 05 111 05 111 05 127 100 39.2 106 111 05 102 41.0 166 111 05 111 05 102 41.0 167 111 05 127 100 39.2 101 108 05 106 105 64.2 67 105 47.2 101 108 05 102 41.0 108 102 101 108 05 06 102 <t< td=""><td>55</td><td></td><td>1.73</td><td>26.1</td><td>1.04</td><td>26.3</td><td>20.5</td><td>57.5</td><td>55</td><td>60</td><td>60</td><td>113</td><td>80</td><td>19.0</td><td>1.33</td><td></td><td></td></t<>	55		1.73	26.1	1.04	26.3	20.5	57.5	55	60	60	113	80	19.0	1.33		
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	55 65 1.75 21.2 1.05 19.4 12.6 52.4 56 60 1.59 23.7 1.07 14.1 8.4 51.6 58 108 1.75 25.4 1.03 32.1 34.7 73.3 59 108 1.75 25.4 1.03 32.1 34.7 73.3 59 100 1.74 25.4 1.03 28.9 71.1 34 78 1.78 24.6 1.08 9.7 7.6 70.4 34 78 1.77 27.1 1.055 19.10 16.15 64.25 34 78 1.72 27.1 1.055 19.0 16.15 64.25 18 58 1.59 19.8 1.03 6.3 3.8 54.25 19 15 1.9 35.3 1.08 32.1 34.7 80.3 59 115 1.9 35.3 1.08 32.1 34.7 80.3 80dy Mass Index, dB=Body Density, Fat%= Body Fat Percentage, KS= 54.2 54.2<	75 21.2 1.05 19.4 12.6 52.4 40 35 61 128 101 39.0 1.68 113 0 75 35.3 1.07 14.1 8.4 51.6 50 40 67 119 93 31.7 1.55 112 0 74 26.4 1.05 21.1 16.9 63.1 80 70 65 129 102 41.0 1.67 111 0 73 33.4 1.03 22.1 16.9 71.1 85 75 70 125 105 47.2 1.91 108 0 73 24.6 1.08 9.7 7.6 70.4 160 130 67 160 127 53.2 2.12 123 1 79 25.3 1.03 6.3 3.8 54.2 5 70 64.8 64 129 97 32.4 1.62 117.2 0 70 35.3 1.08 32.1 34.7 80.3 170 165 70 188 127 53.2 2.12 123 1 80 dy Density, Fat%= Body Fat Percentage, KS= Knee Strength, BS= Back Strength, HR _{test} (beats/min)= Heartbeat during working, 12. The string of the set to the set	55	-	1.79	32.8	1.04	24.7	25.9	79.1	80	65	65	67	81	20.8	1.37		
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	56 60 1.59 23.7 1.07 14.1 8.4 51.6 58 108 1.75 35.3 1.03 32.1 34.7 73.3 59 80 1.74 26.4 1.03 28.9 71.1 59 100 1.74 26.4 1.03 28.9 71.1 34 78 1.77 26.4 1.03 28.9 71.1 34 78 1.77 27.1 1.055 19.10 16.15 64.25 18 58 1.59 19.8 1.03 56.3 3.4.2 59 115 1.9 35.3 1.08 32.1 34.7 80.3 60dy Mass Index, dB=Body Density, Fat%= Body Fat Percentage, KS=	59 23.7 1.07 14.1 8.4 51.6 50 40 67 119 93 31.7 1.55 112 00 74 26.4 1.03 21.1 16.9 63.1 80 70 65 127 100 39.2 1.66 111 00 73 $33.4.7$ 73.3 60 50 64 127 100 39.2 1.66 111 00 73 33.4 1.03 28.9 71.1 85 75 70 127 53.2 2.12 103 00 </td <td>55</td> <td></td> <td>1.75</td> <td>21.2</td> <td>1.05</td> <td>19.4</td> <td>12.6</td> <td>52.4</td> <td>40</td> <td>35</td> <td>61</td> <td>128</td> <td>101</td> <td>39.0</td> <td>1.68</td> <td></td> <td></td>	55		1.75	21.2	1.05	19.4	12.6	52.4	40	35	61	128	101	39.0	1.68		
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	 28 108 1.75 35.3 1.03 32.1 34.7 73.3 59 80 1.74 26.4 1.05 21.1 16.9 63.1 59 100 1.73 23.4 1.03 28.9 77.1 1.6 34 78 1.78 24.6 1.08 9.7 7.6 70.4 34 1.8 58 1.59 19.8 1.03 6.3 3.8 54.25 59 115 1.9 35.3 1.08 32.1 34.7 80.3 Body Mass Index, dB=Body Density, Fat%= Body Fat Percentage, KS= 	75 35.3 1.03 32.1 34.7 73.3 60 50 64 127 100 39.2 1.66 111 0 74 26.4 1.05 21.1 16.9 63.1 80 70 65 129 102 14.0 1.67 111 0 73 33.4 1.03 28.9 7.0.4 160 130 67 160 127 53.2 2.12 108 0 72 27.1 1.055 19.10 16.15 64.25 70 64.8 64 129 97 32.4 1.62 117.2 0 59 19.8 1.03 6.3 38 54.2 20 55.0 60 93 70 11.8 107.2 108 0 59 19.8 1.08 32.1 34.7 80.3 170 165 70 188 127 53.2 2.12 135 0 50 35.3 1.08 32.1 34.7 80.3 170 165 70 188 1	56		1.59	23.7	1.07	14.1	8.4	51.6	50	40	67	119	93	31.7	1.55		
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	59 80 1.74 26.4 1.05 21.1 16.9 63.1 59 100 1.73 33.4 1.03 28.9 28.9 71.1 34 78 1.73 33.4 1.03 28.9 76.6 70.4 34 78 1.72 27.1 1.05 9.7 7.6 70.4 35 44.9 80.4 1.72 27.1 1.055 19.10 16.15 64.25 18 58 1.59 19.8 1.03 35.3 3.8 54.2 59 115 1.9 35.3 1.08 32.1 34.7 80.3 63 155 19.8 1.03 32.1 34.7 80.3 64 25 1.08 32.1 34.7 86.2 704 35.3 1.08 32.1 34.7 80.3 80dy Mass Index, dB=Body Density, Fat%= Body Fat Percentage, KS= 86.4 86.4 86.4 86.4	74 26.4 1.05 21.1 16.9 63.1 80 70 65 129 102 41.0 1.67 111 0.7 73 33.4 1.03 28.9 71.1 85 75 70 125 105 47.2 1.91 108 0.7 72 27.1 1.055 9.7 7.6 70.4 160 87 53.2 2.12 123 0.5 23.2 1.91 0.6 0.7 0.5 0.7 $0.53.2$ 2.12 123 0.5 0.7 $0.52.0$ 60 93 70 11.8 1.22 108 0.7	58	-	1.75	35.3	1.03	32.1	34.7	73.3	60	50	64	127	100	39.2	1.66		
59 100 1.73 33.4 1.03 28.9 71.1 85 75 70 125 105 47.2 1.91 108 34 78 1.78 9.7 7.6 70.4 160 130 67 160 127 53.2 2.12 123 5e 44.9 80.4 1.72 27.1 1055 19.10 16.15 64.25 70 64 129 97 32.4 1.62 117.2 18 80.4 1.72 27.1 1055 9.10 16.15 64.25 70 64 129 97 32.4 1.62 117.2 59 115 1.9 35.3 1.08 32.1 34.7 80.3 170 165 70 188 127 53.2 2.12 135	59 100 1.73 33.4 1.03 28.9 71.1 34 78 1.78 24.6 1.08 9.7 7.6 70.4 se 44.9 80.4 1.72 27.1 10.55 19.10 16.15 64.25 18 58 1.59 19.8 1.03 6.3 3.8 54.2 59 115 1.9 35.3 1.08 32.1 34.7 80.3 Body Mass Index, dB=Body Density, Fat%= Body Fat Percentage, KS=	73 33.4 1.03 28.9 28.9 71.1 85 75 70 125 105 47.2 1.91 108 0 78 24.6 1.08 9.7 7.6 70.4 160 130 67 160 127 53.2 2.12 123 1 72 27.1 1.055 19.10 16.15 64.25 70 64.8 64 129 97 32.4 1.62 117.2 0 93 5.3 1.08 32.1 34.7 80.3 170 165 70 188 127 53.2 2.12 135 1 80dy Density, Fat%= Body Fat Percentage, KS= Knee Strength, BS= Back Strength, HR _{rest} (beats/min)= Heartbeat during re heartbeat, HR _{work} = Heartbeat during working, to heartbeat during resting; 50%I = Heartbeat half-reserve; HR _w /%50I =	59		1.74	26.4	1.05	21.1	16.9	63.1	80	70	65	129	102	41.0	1.67		
34 78 1.78 24.6 1.08 9.7 7.6 70.4 160 130 67 160 127 53.2 2.12 123 5e 44.9 80.4 1.72 27.1 1.055 19.10 16.15 64.25 70 64.8 64 129 97 32.4 1.62 117.2 18 58 1.59 19.8 1.03 6.3 3.8 54.2 20 25.0 60 93 70 11.8 1.22 108 59 115 1.9 35.3 1.08 32.1 34.7 80.3 170 165 70 188 127 53.2 2.12 135	34 78 1.78 24.6 1.08 9.7 7.6 70.4 se 44.9 80.4 1.72 27.1 1.055 19.10 16.15 64.25 18 58 1.59 19.8 1.03 6.3 3.8 54.2 59 115 1.9 35.3 1.08 32.1 34.7 80.3 Body Mass Index, dB=Body Density, Fat%= Body Fat Percentage, KS=	78 24.6 1.08 9.7 7.6 70.4 160 130 67 160 127 53.2 2.12 123 117.2 72 27.1 1.055 19.10 16.15 64.25 70 64.8 64 129 97 32.4 1.62 117.2 00 59 19.8 1.03 6.3 3.8 54.2 20 25.0 60 93 70 11.8 1.22 108 00 00 00 00 00 11.2 108 127 53.2 2.12 135 1 804y Density, Fat%= Body Fat Percentage, KS= Knee Strength, BS= Back Strength, HR _{rest} (beats/min)= Heartbeat during restring restring; 50% I = Heartbeat half-reserve; HR _w /% 50I =	59	-	1.73	33.4	1.03	28.9	28.9	71.1	85	75	70	125	105	47.2	1.91		
ge 44.9 80.4 1.72 27.1 1.055 19.10 16.15 64.25 70 64.8 64 129 97 32.4 1.62 117.2 18 58 1.59 19.8 1.03 6.3 3.8 54.2 20 25.0 60 93 70 11.8 1.22 108 59 115 1.9 35.3 1.08 32.1 34.7 80.3 170 165 70 188 127 53.2 2.12 135	ge 44.9 80.4 1.72 27.1 1.055 19.10 16.15 64.25 18 58 1.59 19.8 1.03 6.3 3.8 54.25 59 115 1.9 35.3 1.08 32.1 34.7 80.3 Body Mass Index, dB=Body Density, Fat%= Body Fat Percentage, KS=	72 27.1 1.055 19.10 16.15 64.25 70 64.8 64 129 97 32.4 1.62 117.2 0 59 19.8 1.03 6.3 3.8 54.2 20 25.0 60 93 70 11.8 1.22 108 0 9 35.3 1.08 32.1 34.7 80.3 170 165 70 188 127 53.2 2.12 135 1 Body Density, Fat%= Body Fat Percentage, KS= Knee Strength, BS= Back Strength, HR _{rest} (beats/min)= Heartbeat during re heartbeat, HR _{wake} = Heartbeat during working, at resting; 50%1 = Heartbeat huring working,			1.78	24.6	1.08	9.7	7.6	70.4	160	130	67	160	127	53.2	2.12		
18 58 1.59 19.8 1.03 6.3 3.8 54.2 20 25.0 60 93 70 11.8 1.22 108 59 115 1.9 35.3 1.08 32.1 34.7 80.3 170 165 70 188 127 53.2 2.12 135	18 58 1.59 19.8 1.03 6.3 3.8 54.2 59 115 1.9 35.3 1.08 32.1 34.7 80.3 Body Mass Index, dB=Body Density, Fat%= Body Fat Percentage, KS=	59 19.8 1.03 6.3 3.8 54.2 20 25.0 60 93 70 11.8 1.22 108 0.3 170 165 70 188 127 53.2 2.12 135 112 136 0.3 170 165 70 188 127 53.2 2.12 135 112 136 118 127 53.2 2.12 135 116 118 127 53.2 2.12 135 116 118 116 112	50		1.72	27.1	1.055	19.10	16.15	64.25	70	64.8	64	129	97	32.4	1.62		
115 1.9 35.3 1.08 32.1 34.7 80.3 170 165 70 188 127 53.2 2.12 135	59 115 1.9 35.3 1.08 32.1 34.7 80.3 Body Mass Index, dB=Body Density, Fat%= Body Fat Percentage, KS=	9 35.3 1.08 32.1 34.7 80.3 170 165 70 188 127 53.2 2.12 135 1 Body Density, Fat%= Body Fat Percentage, KS= Knee Strength, BS= Back Strength, HR_{rest} (beats/min)= Heartbeat during re heartbeat, HR_{rest} = Heartbeat during working, d. Ratio = The ratio of heartbeat during working to heartbeat during resting; 50%I = Heartbeat half-reserve; $HR_w/\%50I =$	-	58	1.59	19.8	1.03	6.3	3.8	54.2	20	25.0	60	93	70	11.8	1.22		
	Body Mass Index, dB=Body Density, Fat%= Body Fat Percentage, KS=	Body Density, Fat%= Body Fat Percentage, KS= Knee Strength, BS= Back Strength, HR _{rest} (beats/min)= Heartbeat during re heartbeat, HR _{rest} (beats/min)= Heartbeat during working, ad: Ratio = The ratio of heartbeat during working to heartbeat during resting; 50%I = Heartbeat half-reserve; $HR_w/\%50I = 1000$	59	115	1.9	35.3	1.08	32.1	34.7	80.3	170	165	70	188	127	53.2	2.12		
heartbeat, HR work = Heartbeat during working,			KK= Phys	iological wi		11 3	le ratio o	of hearth	beat durn	ng workn	ng to hea	urtbeat di	Iring rest	ing; 50%	h I = Hea	rtbeat ha	lf-reserve	; HK /%	П
heartbeat, HR $_{work}$ = Heartbeat during working, ad; Ratio = The ratio of heartbeat during working to heartbeat during resting; 50%I = Heartbeat half-reserve; HR $_{w}$ /%50I = o heartbeat half-reserve	ad; Katio = 1 ne ratio of heartbeat during working to heartbeat during resting; $50\%1 =$ Heartbeat half-reserve; $HK_w/\%501 =$ o heartbeat half-reserve		ווכמו וחכמו ח	AUUW BIITU.	-	כמו ווייסמו זוו	10001-111	e A											

Table 3: Parameters of the nursery-afforestation workers

PHYSICAL WORKLOAD OF FOREST WORKERS

However, this value can be determined through a number of calculations. In this paper, starting from the body fat percentages of the forestry workers, the fat-mass and non-fat mass values were obtained. It is important to estimate the fat mass value, since this value represents the energy reserve of the body; on the other hand, the non-fat mass value is an important indicator of the muscle and skeleton structure of the body, and for this reason it is related to the body's state of fitness (Apud and Valdes 1995; Schoenfeld et al. 2015).

While the body weight average of the harvesting workers was 79.2 kg, this value in the nursery-afforestation workers was 80.4 kg. As a result of the calculations made, the fat-mass ratios of the harvesting and nursery-afforestation workers were calculated as 13.51 kg and 16.15 kg, respectively. The non-fat mass values in the harvesting and nursery-afforestation workers were determined to be 65.69 kg and 64.25 kg, respectively. From these results, it can be concluded that the nursery-afforestation workers are heavier than the harvesting workers. The average fat-mass of the nursery-afforestation workers is higher than that of the harvesting workers; however, there is no significant difference in terms of their non-fat mass. In other words, it can be said that the energy reserves of the nursery-afforestation workers are at higher levels, whereas the muscular and skeletal development of the harvesting workers is in better condition. In a study conducted in Chile, the average weight value of forestry workers was calculated as 63.4 kg, while their body fat-mass was 16.8 kg and their non-fat mass was 52.7 kg (Apud and Valdes 1995). In the other study conducted in Turkey, the average weigth values of forestry workers were determined as 73.1 kg (Enez et al. 2014).

From the obtained values, it follows that 20 percent of the weight values of the nursery-afforestation workers were made up of fat masses, whereas this ratio for the harvesting workers was 16 percent. This ratio in the forestry workers in Chile, on the other hand, was found to be 26 percent, which shows that the energy reserves of the forestry workers in Chile are higher than those of the forestry workers in this study (Apud and Valdes 1995). On the other hand, on considering their non-fat masses, 76 percent of the weight values of the nursery-afforestation workers in this study were calculated as non-fat mass, whereas this ratio was 79 percent in the harvesting workers. This ratio in the forestry workers in Chile, however, was calculated to be 83 percent (Apud and Valdes 1995). Both of the values are seen to be lower in comparison to those of the Chilean forestry workers. The reason for such an outcome may be considered to be the fact that the Chilean forestry workers are better trained in terms of nutritional means.

The knee strength values of the harvesting and nursery-afforestation workers were found to be 82.8 kg and 70 kg, respectively. The back strength values of the harvesting and nurseryafforestation workers were determined to be 70.5 kg and 64.8 kg, respectively. As will be understood, the measured values in the harvesting workers proved to be higher, which can be evaluated as an indicator of the fact that the harvesting workers have a greater endurance for such conditions. If we considering the forestry tasks to be the same as the exercises that athletes do, it is normal that the harvesting workers become more resilient towards these tasks as they are challenged more due to the activities they perform.

Apart from the forestry sector, in some studies aiming at finding out the isometric strength values, the knee strength value of mountaineers was found to be 88.4 kg (Ozkan and Sarol 2008), whereas in another study, the back strength values of soccer players, basketball and volleyball players were determined to be 70.08 kg, 65 kg and 62.36 kg, respectively (Aydos et al. 2004). It follows from these values that forestry workers and the individuals taking part in certain sports have very similar strength values to each other.

Some heartbeat values were used in determining the workload level of the workers. These values are Physiological Workload (Vitalis 1987; Minard 1971; Saha 1978; Singh 2015), the ratio of the heartbeat value during working hours to the heartbeat ratio during resting (Diament et al. 1968; Fordham et al. 1978; Goldsmith et al. 1978: Böhm et al. 2015) and the 50 percent level (Lammert 1972) values. In addition, starting from the average heartbeat value during working hours, the intensity value of the work was identified (Grandjean 1980).

When the physiological workloads were compared, it was determined that the physiological workload (% HRR) values of the harvesting workers were 40.9 percent on average, while the physiological workload (% HRR) values of the nurs-

ery-afforestation workers were 32.4 percent on average (Fig. 2).

Table 5 shows what class the work performed according to heartbeat measurements and physiological workload level (Vitalis 1987; Kirk and Sullman 2001; Shemwetta et al. 2002; Grandjean 1980; Parker et al. 1999) is in. From this point, considering the workload levels of the harvesting workers during working hours, it follows that while 33 percent of the workers fall into the "light" work group and 67 percent into the "medium" work group, they are generally considered within the "medium" work group; and while 51percent of them fall into the "light" work group and 49 percent into the "medium" work group, they are generally considered to be within the "light" work group.

Table 5: Workload levels

Work level (beats/min	Heartbeat (beats/min)	Physiologi- cal work- load (%)	Energy consum- ption (Kcal/min)
Light	70-90	0-36	< 0.5
Medium	90-110	36-78	2.5-5.0
Heavy	110-130	78-114	5.0-7.5
Very heavy	130-150	114-150	7.5-10.0
Extremely heavy	150-170	>150	>10.0

As the result of the measurements performed during the chainsaw and branch pruning studies carried out in New Zealand, the physiological workload values of the workers were determined to have varied between 30 percent and 37 percent (Parker et al. 1999). It was also determined that this value had varied between 31percent and 60percent during chainsaw cutting, logging and ground-skidding activities (Kirk and Parker 1996). Kirk and Sullman (2001) found the physiological workload of the workers to be 36.4 percent while working on the forest skyline. In another study conducted in New Zealand, Kirk and Parker (1996) determined that the physiological workload of those in charge of the pruning was 29 percent. As the result of the measurements performed during forestry harvesting practices in Tanzania, the physiological workload value was found to be 49 percent (Abeli and Malisa 1994) whereas Shemwetta et al. (2002) found this value to be 67 percent in forestry harvesting activities.

On the other hand, in another study conducted in Turkey, it was found that the physiological workload of forestry workers using chainsaws at work was 44.79 percent (Caliskan and Caglar 2010). However, in another study performed by Melemez et al. in Turkey (2011), it was determined that the physiological workload value of the

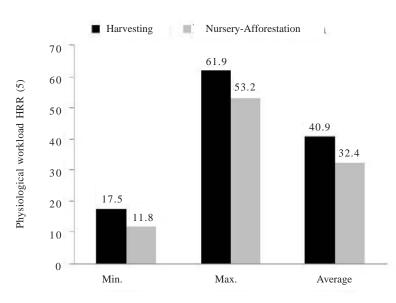


Fig. 2. Physiological workload of the harvesting and nursery-afforestation workers (% HRR)

chainsaw workers was 36.59 percent. In this study, this value was determined to be 20.17 percent for the tractor workers. Separately, Melemez and Tunay (2010), in the study they conducted, found that the workers using loading machines had a physiological workload value of 49 percent. It was seen through these conducted studies that the physiological workload value was affected by the type of work and the challenges experienced by the workers during their activities. Likewise, due to the same kind of reasons within the scope of this study, it is likely that the physiological workload value of the harvesting workers proved to be higher than the physiological workload of the nursery-afforestation workers, considering the degree of hardship they are faced with.

The heart rates at the time of resting (HR_{rest}) were assessed as 61.2 beats/min in the harvesting workers and 60 beats/min in the nursery-afforestation workers on average, while the maximum heart rates during working hours (HR_{max}) were 142.5 beats/min in the harvesting workers and 128.4 beats/min in the nursery-afforestation workers. The average heart rates during working hours (HR_{work}) were 108.1 beats/min in the harvesting workers and 96.9 beats/min in the nursery-afforestation workers on average (Fig. 3).

Within the scope of the study, the heartbeat values of the workers during resting were found to be between 60 and 80 beats/min, which were accepted as normal values (Sonmez 2003). These values suggest that the HR_{rest} values of both the harvesting and nursery-afforestation workers were within normal limits. The fact that the HR. values of the harvesting workers proved to be lower than those of the nursery-afforestation workers can be said to be due to the fact that the harvesting workers are accustomed to performing heavier tasks. In a study conducted in New Zealand, it was found that the HR_{rest} value of forestry workers was 79 beats/min (Kirk and Parker 1996). However, in a study conducted in Turkey on forestry workers using chainsaws, it was found that the HR_{rest} values of the workers was 70.5 beats/min (Grandjean 1980). In another study conducted in our country, it was determined that the HR $_{work}$ values of chainsaw operators was 72.7 beats/min (Melemez et al. 2011). The heartbeat values of forestry workers in Tanzania and Australia during their resting hours was found to be 68 beats/min (Abeli and Malisa 1994).

The HR_{max} value was found to be 165 beats/ min for forestry workers in Tanzania (Abeli and Malisa 1994). Another study conducted in Italy suggests that the HR_{max} value for skidding activities performed with a tractor proved to be 127 beats/min (Cristofolini et al. 1990). Another study conducted on young swimmers determined this value to be 186 beats/min. In this study, the low level of HR_{max} values in forestry workers can be attributed to their high average age (43.1 in the harvesting workers).

Taking these values into account, it is seen that both jobs can be classified as "medium-weight work". The reason for which the HR_{work} values of the harvesting workers were higher compared to the nursing-afforestation workers was that the workload level of the harvesting workers during activity was higher, which can be said to cause an increase in the heart rate (Fig. 3).

Heartbeat is a reliable tool for displaying the physiological workload (Roja 2005). In a study conducted in Tanzania, the heart rate of workers while doing manual loading was found to be 178 beats/min. In the same study, this value during logging activities was determined to be 133 beats/min (Shemwetta et al. 2002).

A study conducted in Turkey suggests that the heart rate of chainsaw workers during working hours was found to be 122.8 beats/min (Caliskan and Caglar 2010). In another study conducted in Turkey, it was found that the heart rate in tractor operators was 94 beats/min, while in chainsaw workers it was 108 beats/min (Melemez et al. 2011). In New Zealand in 1996, Kirk and Parker found that the average heart rate of pruning workers was 112 beats/min. The heart rate during cutting-down and peeling activities proved to be 112 and 120 beats/min, respectively (Abeli and Melisa 1994). In New Zealand, the heart rate of overhead line workers during working hours was determined to be 106 beats/min (Kirk and Sullman 2001). In a study conducted in Chile, however, it was determined that the average heart rate of afforestation workers was 106 beats/min. The same study showed that the heartbeat rate during pruning was 120.9 beats/min (Apud and Valdes 1995).

When these studies are analyzed, it can once again be seen that the heart rates and the degree of the strength needed for the work to be done were directly proportionate. One cannot ignore the possibility that environmental conditions can have an effect on the heart rate during working

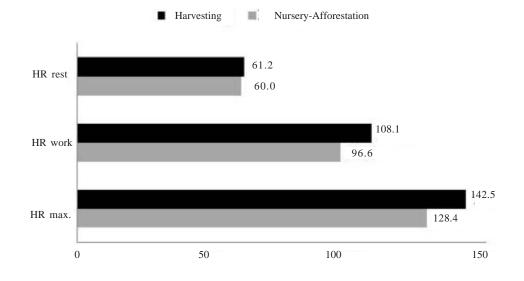


Fig.3. Maximum (HR_{max}) and average (HR_{rest}) heart rate values of the harvesting and nursery-afforestaton workers during resting

hours. It is true that with the an increase in temperature and humidity, the body's system will be more challenged, and the heart rates of the workers will therefore also increase. Moreover, the tools used for work can also be considered as an important factor in terms of the change in the average heart rate. The ratio of the heart rates of workers at work to the ratio of the heart rates during resting was determined to be 1.75 in the harvesting workers and 1.61 in the nursing-afforestation workers on average, respectively (Fig. 4). This value was found to be 1.45 in the pruning workers (Kirk and Parker 1996). A study conducted in Turkey

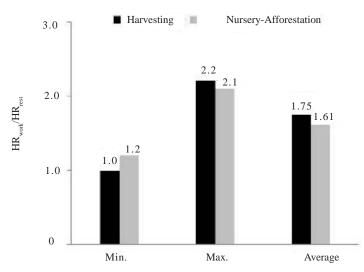


Fig. 4. Ratio of heart rates of the harvesting and nursing-afforestation workers to heartbeat rates durng resting (HR_{work}/HR_{rest})

found the HRwork/HRrest value in chainsaw workers to be 1.74 (Caliskan and Caglar 2010). In addition, Goldsmith et al. (1978) found this value to be 1.45 in car body workers. However, another study showed this value to be 1.37 in steel workers (Vitalis 1987).

The heartbeat half-reserve values of the workers was found to be 115.4 in the harvesting

workers and 116.9 in the nursery-afforestation workers on average (Fig. 5).

Considering the $HR_{work}/50\%$ I value, the last of the physiological parameters showing the ratio of the heart rate during working hours to the heartbeat half-reserve rate, it was seen that this value was 0.9 in the harvesting workers and 0.8 in the nursing-afforestation workers on average, respectively (Fig. 6).

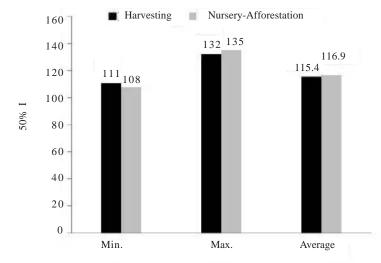


Fig. 5. Half-reserve heart reat values of the harvesting and nursing-afforestation workers (% 50)

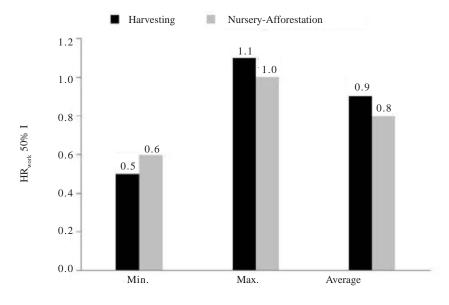


Fig. 6. $HR_{work}/50\%$ I values of the harvesting and nursing-afforestation workers

Put forward by Lammert (1972) and used by Vitalis et al. (1987) the $HR_{work}/50\%$ I value obtained by dividing the heart rate during working hours (HR_{work}) by the heartbeat half-reserve rate (%50 I) is a simple and effective method in minimizing the workload of the workers. If this value during activity/working hours is "1", then the work is regarded as a "Continuous Heavy Duty" (Lammert 1972). In this paper, this value was found to be 0.90 in the harvesting workers and 0.82 in the nursing-afforestation workers, which, when examined, suggests that the workload level in the groups of workers does not fall into the "Continuous Heavy Duty" class owing to the fact that the value in both of the groups of workers is lower than "1", although these are proximate values. In a study conducted in our country, this value was found to be 0.97 in chainsaw operators (Caliskan and Caglar 2010). In another study conducted in New Zealand, it was found that this value was 0.82 in pruning workers (Kirk and Parker 1996).

CONCLUSION

The resting and working periods of the forestry workers should be periodically controlled during operational activities. In particular, occasional abnormal changes that may occur in the heart rates of workers can have negative impacts on their health status. Considering that their heart rates are affected by factors such as age, weight and height, the workers must be equipped with tools that are most suitable for them so that their workload pressure can be mitigated.

In particular, since the harvesting workers do various jobs with different levels of intensity, and thus it becomes hard for them to concentrate on a single activity, the workload and heartbeat rate values of the workers during the working hours cannot be brought under control. This issue can be improved by means of a decent work plan and a resulting action plan.

As harvesting activities are far more challenging when compared to nursing-afforestation activities, it should be decided as to what jobs the workers should be assigned to by considering their bodily strength and body composition values.

The real performance values (aerobic capacities) to be exhibited by the would-be workers during activity should be determined, and the workers must be selected and employed accordingly.

RECOMMENDATIONS

Abnormal changes of workers heart rates may be can negative effects on the health of workers. Therefore, it should be provided that suitable work for worker's anthropometric and physiological properties. Rest periods and exposure time of forest workers should be regulated according to the theirs workload. Forestry workers should be subjected to health checks periodically. Workers should be fed as balanced and healthy diet taking into account the energy they spend daily.

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