A study of Correlations between dominant handgrip strength with some selected anthropometric and physiological characteristics in inter-college male volleyball players of West Bengal, India

N. Mandal, S. Maity, D. Sahu

Abstract
The purpose of the present study was to estimate the dominant handgrip strength and its correlations with selected anthropometric and physiological characteristics in inter-college volleyball players. Three anthropometric characteristics, two body composition parameters, two physical and two physiological characteristics were measured on randomly selected 40 inter-college volleyball players (40 males) aged 18–25 years from inter college volleyball competition held in Vidyasagar Universities, Paschim Midnapore, West Bengal, India. An adequate number of control (40 males) subjects were also taken from the same place for comparisons. The results indicated statistically significant (p ≤ 0.05-0.01) differences between the male volleyball players and the controls in height, weight, BMI, right handgrip strength, left handgrip strength, %BF (Percent body fat), %LBM (Percent lean body mass), heart rate and VO2 max. It may be concluded that dominant handgrip strength had some strong positive correlations with all the variables studied in inter-college volleyball players.

Keywords: Anthropometric characteristics. Handgrip strength, VO2 max, Inter-college volleyball players.

Introduction
Volleyball is a traditional outdoor game played with minor variations in all regions of India - in fact, in most parts of Asia. Volleyball requires tremendous physical stamina, agility, individual proficiency, neuromuscular coordination, lung capacity, quick reflexes, intelligence and presence of mind on the part of both attackers and defenders.

Nutrition has a major influence on them magnitude of adaptation to training. Proper food intake and sound nutritional strategies will result in strength and muscular endurance improvements, and will facilitate athletic performance. Nutritional needs are influenced by the metabolism of energy providing nutrients (that is, mobilisation, utilisation, and storage of energy substrates) at rest and during exercise.

The power of handgrip is the forceful flexion of all finger joints with the maximum voluntary force that the subject is able to exert under normal biokinetic conditions (Richards et al. 1996, Bohannon 1997) [31, 4] uses several muscles in the hand and the forearm (Bassey and Harrie 1993) [1]. Grip strength is often used as an indicator of overall physical strength (Massey-Westrop et al. 2004, Foo 2007) [24, 13], hand and forearm muscles performances (Nwuga 1975) [26] and as a functional index of nutritional status (Chilima and Ismail 2001, Pieterse et al. 2002) [17, 20] and physical performance (Samson et al. 2000, Onder et al. 2002) [33, 27].

Handgrip strength is a physiological variable that is affected by a number of factors including age, body size and gender. Strong correlations between grip strength and various anthropometric parameters, (weight, height, BMI etc.) were reported earlier (Malina et al. 1987, Ross and Röswald 2002, Singh et al. 2009, Koley and Yadav 2009, Koley and Singh 2009, Koley et al. 2009, Jurimae et al. 2009, Kaur 2009) [23, 32, 18, 35, 19, 16, 17]. Several studies have examined the relationships between anthropometric and physiological characteristics of volleyball players (Fleck et al. 1985, Fry et al. 1991) [12, 14]. But information related to the correlations of handgrip strength and anthropometric characteristics in volleyball players are limited, especially in Indian context. So the present study was planned.
Materials and Methodology

Participants
The present cross-sectional study is based on randomly selected 40 inter-collage volleyball players (40 males) aged 18–25 years (mean 19.05 years, ± 1.40) from Vidyasagar University, Paschim Midnapora, West Bengal, India. An adequate number of controls (n = 40, males mean age 21.60 years, ± 2.13) with no particular athletic background were also collected from the same place for comparisons. The age of the subjects were recorded from the date of birth registered in their respective institutes. A written consent was obtained from the subjects. The data were collected under natural environmental conditions in morning (between 8 AM to 12 noon). The study was approved by the local ethics committee.

Measurements and calculations
Three anthropometric variables, viz. height (HT), weight (WT) and BMI, Two body composition parameters, viz. percent body fat (%BF), percent lean body mass (%LBM), two physical parameters, viz. right and left hand grip strength (RHGS and LHGS respectively) and two physiological variables, viz. heart rate (HR) and VO2 max (VO2M) were measured on each subject. Anthropometric variables of the subjects were measured using the techniques provided by Lohmann et al. (1988) [23] and were measured in triplicate with the median value used as the criterion. Dominant hand grip strength: Koley & Singh (2012) [20] pp 41-50 The height was recorded during inspiration using a stadiometer (Holtain Ltd., Crymych, Dyfed, UK) to the nearest 0.1 cm, and weight was measured by digital standing scales (Model DS-410; Seiko, Tokyo, Japan) to the nearest 0.1 kg. BMI was then calculated using the formula weight (kg)/height (m)². Percent body fat was assessed using skinfold measurements taken from four sites, viz. biceps, triceps, subcapular and suprailliac using Harpenden skinfold caliper (Holtain Ltd, Crosswell, Crymych, UK) to the nearest 0.2 mm, and using the Durnin and Womersley (1974) skinfold equation. Percent lean body mass was calculated subtracting percent body fat from 100. Heart rate was estimated manually immediately after step test. VO2 max was estimated by Queen’s College Step Test (McArdle et al. 1972) [23].

Handgrip strength measurement
The grip strength of both right and left hands was measured using a standard adjustable digital handgrip dynamometer (Takei Scientific Instruments Co., LTD, Japan) at standing position with shoulder adducted and neutrally rotated and elbow in full extension. The dynamometer was held freely without support, not touching the subject’s trunk. The position of the hand remained constant without the downward direction. The subjects were asked to put maximum force on the dynamometer thrice from both sides of the hands. The maximum value was recorded in kilograms. Anthropometric equipment and handgrip dynamometer were calibrated before each assessment. All subjects were tested after 3 minutes of independent warm-up. Thirty seconds time interval was maintained between each handgrip strength testing.

Statistical analysis
Standard descriptive statistics (mean ± standard deviation) were determined for directly measured and derived variables. One way analysis of variance was tested for the comparisons of data among inter-university volleyball players and controls, followed by post hoc Bonferroni test. Pearson’s correlation coefficients were applied to establish the relationships among the variables measured. Data were analyzed using SPSS (Statistical Package for Social Science) version 17.0. A 5% level of probability was used to indicate statistical significance.

Results
Descriptive statistics of selected anthropometric, body compositional, physical and physiological characteristics in inter-college volleyball players and controls were shown in following Table. Volleyball players were compared with their control groups, statistically significant differences (p≤0.05 - 0.01) were found in all the variables studied. Right handgrip strength of volley ball player and control group is (41.55 ± 6.21 and 35.34±4.35)Kg also left handgrip strength of volley ball player and control group is (40.26 ± 2.65 and 33.56±3.48)Kg had significantly increased ( P<0.05 and p≤0.01 respectively) in volleyball players in compared with their control group. Among the other variables, height (176.34 ± 3.54 and 164.64±6.54) cm, weight(65.07 ± 9.82 and 56.63±5.23)Kg and BMI(36.09 ± 3.54 and 34.39±1.04) Kg/m² in volleyball player and control group respectively had significantly increased (p≤0.05) in volleyball players compared with their control group. Percent body fat (12.45 ± 2.38 and 21.52±3.28)% and percent Lean body mass(87.55 ± 2.38 and 78.48±5.28)% in volleyball player and control group respectively had significantly decreased and Increased respectively (p≤0.01) in volleyball players compared with their control group. On the other hand, VO2 max(70.28± 4.27 and 61.85±6.46) ml/kg/min in volleyball player and control group respectively had significantly increased (p≤0.01) and heart rate(86.06± 2.68 and 116.28 ±12.38 ) beats/min in volleyball player and control group respectively had significantly decreased (p<0.05) in volleyball players compared with their control group.

Table 1: Height (cm) of inter-college volleyball player and with Control group.

<table>
<thead>
<tr>
<th>Group</th>
<th>Height(cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volleyball players(n=40)</td>
<td>176.34 ± 3.54*</td>
</tr>
<tr>
<td>Controls(n=40)</td>
<td>164.64±6.54</td>
</tr>
</tbody>
</table>

Value shows: Mean ± S.E

![Fig 1: Height (cm) of inter-college volleyball player and with Control group.](Image 307x196 to 560x328)

Table 2: Weight (Kg) of inter-college volleyball player and with Control group.

<table>
<thead>
<tr>
<th>Group</th>
<th>Weight(Kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volleyball players(n=40)</td>
<td>65.07 ± 9.82*</td>
</tr>
<tr>
<td>Controls(n=40)</td>
<td>56.63±5.23</td>
</tr>
</tbody>
</table>

Value shows: Mean ± S.E
Table 3: BMI (Kg/m²) of inter-college volleyball player and with Control group.

<table>
<thead>
<tr>
<th>Group</th>
<th>BMI (Kg/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volleyball players (n=40)</td>
<td>36.09 ± 3.54*</td>
</tr>
<tr>
<td>Controls (n=40)</td>
<td>34.39±1.04</td>
</tr>
</tbody>
</table>

Value shows: Mean ± S.E

**P<0.05

Fig 2: Weight (Kg) of inter-college volleyball player and with Control group.

Table 4: Body Fat Percentage (%BF) of inter-college volleyball player and with Control group.

<table>
<thead>
<tr>
<th>Group</th>
<th>% BF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volleyball players (n=40)</td>
<td>12.45 ± 2.38*</td>
</tr>
<tr>
<td>Controls (n=40)</td>
<td>21.52±3.28</td>
</tr>
</tbody>
</table>

Value shows: Mean ± S.E

**P<0.01

Fig 3: BMI (Kg/m²) of inter-college volleyball player and with Control group.

Table 5: Lean Body Mass Percentage (%LBM) of inter-college volleyball player and with Control group.

<table>
<thead>
<tr>
<th>Group</th>
<th>% LBM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volleyball players (n=40)</td>
<td>87.55 ± 2.38**</td>
</tr>
<tr>
<td>Controls (n=40)</td>
<td>78.48±5.28</td>
</tr>
</tbody>
</table>

Value shows: Mean ± S.E

**P<0.01

Fig 5: Lean Body Mass Percentage (%LBM) of inter-college volleyball player and with Control group.

Table 6: Right Handgrip Strength (Kg) of inter-college volleyball player and with Control group.

<table>
<thead>
<tr>
<th>Group</th>
<th>RHGS(Kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volleyball players (n=40)</td>
<td>41.55 ± 6.21*</td>
</tr>
<tr>
<td>Controls (n=40)</td>
<td>35.34±4.35</td>
</tr>
</tbody>
</table>

Value shows: Mean ± S.E

*p<0.05

Fig 4: Body Fat Percentage (%BF) of inter-college volleyball player and with Control group.

Table 7: Left Handgrip Strength (Kg) of inter-college volleyball player and Control group.

<table>
<thead>
<tr>
<th>Group</th>
<th>LHGS(Kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volleyball players (n=40)</td>
<td>40.26 ± 2.65**</td>
</tr>
<tr>
<td>Controls (n=40)</td>
<td>33.56±3.48</td>
</tr>
</tbody>
</table>

Value shows: Mean ± S.E

**P<0.01

Fig 6: Right Handgrip Strength (Kg) of inter-college volleyball player and with Control group.
Discussion

Volleyball is an intermittent sport. It requires players to participate in frequent short bouts of high-intensity exercise, followed by periods of low-intensity activity (Kunstlinger et al. 1987, Viitasalo et al. 1987) [21, 38]. The high intensity bouts of exercise, coupled with the total duration of the match requires players to have well-developed aerobic and anaerobic systems (Polglaze and Dawson 1992, Viitasalo et al. 1987) [29, 38]. As a result, volleyball players require well-developed speed, agility, upper-body and lower body muscular power, and maximal aerobic power (VO2 max).

In volleyball, teams compete by maneuvers handling the ball above the head, height is considered to be the most important physical attribute. In the present study, the mean height of the male players (176.34 cm, ± 3.54) was significantly greater than the control group. It is previously reported by Bandopadhyay that the height of the West Bengal volleyball players (173.10 cm ± 4.19) in (2007). In the study, significantly greater body weight among volleyball players might be disadvantageous for them in attaining a good jumping height as they have to lift a greater weight.

In case of relationships of handgrip strength, a physical performance indicator, with stature, weight, BMI, it was found that volleyball players attained greater values for those anthropometric variables and also had greater handgrip strength values their control counterparts also reported by the different study (Benefice and Malina 1996, Koley et al. 2009, 2010) [2, 18, 19, 35]. The findings of the present study followed the same line showing strong positive correlations with dominant right handgrip strength and all the variables studied.

Body composition greatly affects the energy-related physical strength and skill in various sports (Kitagawa et al. 1974). In volleyball players, the estimated % body fat was lower and %LBM was reported to be higher than controls, and followed the findings of Tsunawake et al. (1995) [36] and Filaire et al. (1998) [11]. These differences between players and controls in the variables studied might be due to regular physical exercise and prolonged training effect. Handgrip strength is found to be a significant determinant of bone mineral content and bone area at the forearm sites and has a positive relation with lean body mass and physical activity. The findings of the present study also showed very strong positive relations between dominant handgrip strength and VO2 max, establishing close association between physical and physiological characteristics in volleyball players. The results followed the findings of Beunen et al. (1992) [3].

The limitations of the study were the less sample size and consideration of players only from inter-college level competitions. In future studies, all these limitations would be taken care.

Conclusions

The data presented in the present study carry immense practical application and should be useful in future investigation on player selection, talent identification in volleyball and training program development.

References

2. Benefice E, Malina R. Body size, body composition and motor performances of mild-to-moderately