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Original article

RELATIONSHIP BETWEEN BODY COMPOSITION AND MUSCLE STRENGTH IN EARLY ADOLESCENCE GOAL-BALL PLAYERSWITH VISUAL IMPAIRMENTS

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Abstract*

Aim. The aim of this study was to examine relationship between body composition and muscle strength in early adolescence goal-ball players with visual impairments.

Methods: Thirteen early adolescence goal-ball players with visual impairments that are goal-ball players participated (mean age 13.54±1.27 years, height 155.23±10.86 cm and, body weight 48.23±10.43 kg). Body composition measurements that were assessed included body mass index, body fat percentage and skinfold (abdominal, subscapular, triceps and suprailiac). Participants were also assessed on several strength measurements including standing long jump, the right hand grip, left hand grip, vertical jump, leg strength, sit-up and push up.

Results: Positive correlations between ages and height with the standing long jump, the right hand grip, the left hand grip, vertical jump were found in the early adolescence goal-ball players with visual impairments ($P<0.05$). Negative correlations were found between body mass index and body fat percentage with standing long jump, vertical jump, sit-up ($P<0.05$) and among skinfold (subscapular, triceps and suprailiac) with standing long jump, the right hand grip, left hand grip, vertical jump, push up ($P<0.05$) and between abdominal skinfold with standing long jump, the right hand grip, left hand grip, vertical jump, sit-up, push up ($P<0.05$). On the other hand, there was not a correlation between body weight with muscle strength and leg strength with body composition ($P>0.05$).

Conclusins: In an assessment of body composition and muscle strength, it was found that body weight did not significantly impact muscle strength in early adolescence goal-ball players with visual impairments. This finding could be of importance for understanding the role of muscle strength and body composition in routine training of goal-ball players.

Keywords: Body composition, children, goal-ball players, muscle, strength, visually impaired.

Introduction

Visual impairment technically encompasses all degrees of vision loss, including total blindness, that affect a person's ability to perform the usual tasks of daily life. Since the term "visual impairment" may not always connote total blindness to the general reader, the collective phrase "blindness and visual impairment" is often used to refer to the full range of vision loss (Bailey and Hall, 1990).The sports classifications were used as blind 1 (B1), blind 2 (B2), and blind 3 (B3) by the United State Association of Blind Athletes. (Stuart et al., 2006).Low physical activity may influence higher prevalence of overweight and obesity among children and young adults with vision loss (Augestad & Jiang, 2015). Children with visual impairments (both those who are blind and those with low vision) have consistently exhibited lower levels of fitness than have their sighted peers (Blessing, McCrimmon, Stovall, & Williford, 1993; Hopkins, Gaeta, Thomas, & Hill, 1987; Meekand Maguire, 1996; Lieberman & McHugh, 2001). Including children with visual impairments in physical activities contributes to a high quality of life by empowering them to achieve maximum independence in activities of daily living, including sports and recreational activities (Gleser, Margulies, Nyska, Porat, & Mendelberg, 1992; Marley & Beverly-Mullins, 1997). In general, the findings revealed lower levels of participation in physical activity, poorer physical fitness, and higher prevalence of overweight and obesity among children with visual impairments compared to children with no reported visual impairments (Augestad & Jiang, 2015).The loss of sight does not directly cause losses of motor and physical capability but likely the decreased participation in physical activities in children with visual impairments (Houwen, Visscher, Lemmink, & Hartman, 2008; Wagner, Haibach, & Lieberman, 2013; Lieberman, Houston-Wilson, & Kozub, 2002). By adapting the environment with modified

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equipment or rules, children with visual impairments can participate with their sighted peers in many activities. The impact of visual impairment is different for each phase of development: motor milestones are generally reached later and are sometimes even traversed in a different order. The functional development in terms of the action repertoire also shows impairment-specific trajectories in children with visual impairment (Reimer, Cox, Nijhuis-Van der Sanden, & Boonstra, 2011). Children with visual impairments develop the same motor skills as sighted children; however, the onset of many of their motor milestones is significantly delayed (Brambring, & Doreen 2010). Sighted children fulfill the requirements of physical activity by participating in daily play activities to maintain typical growth and development. However, children with visual impairments often are not active enough to develop their motor milestones at the same rate. This may be in large part due to the lack of incentive to move which often comes from visual stimuli (Hopkins, Gaeta, Thomas, Hill, 1987). They also may not receive visual models of the movement patterns to learn by watching their peers or older siblings performing the movement patterns. This reduced activity level often negatively affects their health and fitness levels (Hopkins, Gaeta, Thomas & Hill, 1987). However, their muscular strengths, hanging-arm flexibility and high-jump successes are at a comparable level with sighted persons (Hopkins, Gaeta, Thomas & Hill, 1987). Disabled individuals generally have slack muscle structures, their losses in motor development increase when they are older (Hendry & Kerr, 1983). It is considered that the motor developmental delays in children with visual impairments are mostly led by lack of experiences rather than loss of capabilities. Activities should be modified (Caps, Sigmen, Sena, Henker & Whalen, 1996), so that children with visual impairments can be included with their sighted peers or introduce sighted children to blind sports such as beep baseball, goal-ball, beep kickball, or showdown. The opportunity to be involved in developmental motor skills, fitness, aquatics, sports, and recreation is a fundamental right of all children, including those with sensory impairments, no matter how great the impairment (Lieberman & McHugh, 2001).

After researching data concerning the literature, we found one systematic review published regarding motor skill performance (Houwen, Visscher, Lemmink & Hartman, 2008; Houwen, Visscher, Lemmink & Hartman, 2009). However, we were not able to find a review regarding body composition and muscle strength among children and early adolescence goal-ball players with visual impairments.

Therefore, the aim of the study was to evaluate the relationship between body composition and muscle strength in the goal-ball players with visual impairments.

Methods

A total of 13 male early adolescence goal-ball players with visual impairments (mean ± SD; age: 13.54±1.27 years; weight: 48.23±10.43 kg; body height: 155.23±10.86 cm) volunteered to participate in this study after having all risks explained to them before the investigation. All of the goal-ball players had 2 years' sport experience. All goal-ball players had B3 of sport classifications. The B3 classification refers to those who have a visual acuity of 20/600 to 20/200 after best correction in the better eye or a visual field of less than 20 degrees and more than 5 degrees in the better eye, or both (that is, legal blindness) (Stuart, Lieberman & Hand, 2006). The body composition measurements assessed included body mass index, body fat percentage, skinfold (abdominal, subscapular, triceps and suprailiac). Functional and muscular strength assessments included the standing long jump, right hand grip, left hand grip, vertical jump, leg strength, sit-up and push up. The participants' height was measured with an instrument sensitive to 1 mm. Their body weight was measured with participants dressed in only shorts (and no shoes) with a weight-bridge sensitive up to 20 g. The study was approved by an ethics board and met the conditions of the Helsinki Declaration.

The major limitation to this study is the only participated of goal-ball players with visual impairments. A limitation to the study is that densitometry measurements were not obtained as part of the definition for body composition. A number of limitations should be kept in mind when interpreting the results of this study.

Body mass index (BMI): Body mass index was calculated as weight / [Height (m) ^{2}] (kg/m^2)

Percentage body fat: Percentage body fat was predicted from BMI, age and sex with a developed and validated formula (Johnson &Nelson, 1974).

Skinfold Measurement: During skinfold assessment, the participants stood in a relaxed posture. Measurements were taken on the right side of the body with a Holtain skinfold caliper and recorded to the nearest 0.1 mm. Skinfold thicknesses were measured at the following sites:

Triceps: Midway between the acromion and olecranon processes on the posterior aspect of the arm, with the fold running parallel to the long axis of the arm.

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Subscapular: Just beneath the inferior angle of the scapula with the fold sloping downward laterally at 45 degrees.

Subrailiac: Five to 7 cm above the anterior superior iliac spine on a line to tie anterior axilary border, with fold sloping downward, medially at 45 degrees.

Abdominal: Vertical fold 3 to 5 cm to the right of the umbilicus.

Hand grip strength: Hand grip strength was measured using a dynamometer (Takei Dynamometer) at trials 1 and 2 with midlife strength determined as the average of the best results in these 2 trials.

Leg strength: Leg strength was determined using an electronic dynamometer (Takei Scientific Instruments Co., Ltd, Niigata, Japan) with standardized protocols. The participants put their feet on the dynamometer with their knees bent 130–140°. They held the handle in a stretched position, and the chain was fixed to form the desired knee angle. The measurement was taken when the participant stretched the legs slowly but powerfully up without using the muscles on the back. The test was performed twice, interrupted with a 1-minute break; the best result achieved was recorded.

Standing Long Jump: The participant stood behind the starting line, with feet together, and pushed off vigorously and jumped forward as far as possible. The distance was measured from the take-off line to the point where the back of the heel nearest to the take-off line landed on the mat or no slippery floor. The test was repeated twice, and the best score was retained (in cm).

Vertical Jump: Countermovement vertical jump height (cm) was measured using a vertical jump mat and belt (Takei Jump Meter, Japan). Participants were instructed to keep their hands on their hips at all times and were permitted up to two trials (>15 seconds of recovery) to practice jumping technique followed by two recorded jumps.

Sit up: Participants lay on their backs with knees flexed at a right angle and with hands on the back of the neck. A tester kept the participants' heels in contact with the floor. For 30 seconds participants continually sat up to touch their knees with their elbows.

Push-up: Participants supported themselves on the palm of his left or right hand with placed on flat the floor. Their hands were placed approximately 2 shoulder widths apart. Their back and legs were held straight, and their body was supported on the toes. On the command ‘‘go,’’ the participant lowered himself toward the ground until his elbows were bent at 90°. The participant then forcefully pushed himself back up with complete extension of the arms, while shifting the hand on the ground across to the new position on flat the floor. The participant moved across and back for a period of 30 seconds. The researcher recorded the maximum number of repetitions completed in the designated time period. A hand stopwatch was used for to record the duration of each trial.

Statistical Analysis

Dependent variables for raw data were calculated as means and SD. Data were checked for normal distribution using scatter plot, histogram and QQ-plots. A Pearson's correlation analysis was performed to evaluate possible linear relationships between body composition measures and muscle strength measurements in goal-ball players. An alpha level of 0.05 was used for all analyses. Statistical analyses were conducted in SPSS (15.0; SPSS, Inc., Chicago, IL).

Results

Table 1. Means and Standard Deviation (SD) for Body Composition and Muscle Strength in Boys with Visual Impairments

Variables		Mean	S.D
Body Composition (N=13)	Age (years)	13,54	1,27
	Height (cm)	155,23	10,43
	Weight (kg)	48,23	8,91
	Body mass index (kg/m^2)	20,27	4,73
	Percentage fat (%)	32,65	6,66
	Supscapulaskinfold (mm)	11,97	5,48
	Triceps skinfold (mm)	11,52	6,80
	Abdominal skinfold (mm)	13,62	8,33
	Suprailiacskinfold (mm)	11,92	8,02
Muscle Strength (N=13)	Standing long jump (cm)	164	62,52
	Right hand grip strength	22,38	6,61
	Left hand grip strength	22,65	7,44
	Vertical jump (cm)	22,62	9,13
	Leg strength	79,81	26,94
	Push up (number)	22,54	10,97
	Sit-up (number)	17,85	6,53

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Table 2. Relationship Between Body Composition and Muscle Strength in Boys with Visual Impairments

Variables			Muscle Strength						
			Standing long jump	Right hand grip strength	Left hand grip strength	Vertical jump	Leg strength	Push up	Sit-up
Body Composition	Age	R	0,608*	0,686*	0,769*	0,675*	0,227	0,151	0,394
		P	0,027	0,010	0,002	0,011	0,456	0,622	0,183
	Height	R	0,633*	0,554*	0,669*	0,675*	0,508	0,176	0,455
		P	0,020	0,049	0,012	0,011	0,076	0,566	0,119
	Weight	R	-0,291	-0,102	-0,143	-0,225	-0,039	-0,246	-0,447
		P	0,334	0,741	0,640	0,461	0,899	0,419	0,126
	Body mass index	R	-0,631*	-0,436	-0,533	-0,593*	-0,343	-0,341	-0,665*
		P	0,021	0,137	0,061	0,033	0,251	0,254	0,013
	Percentage fat	R	-0,610*	-0,401	-0,496	-0,565*	-0,339	-0,343	-0,661*
		P	0,027	0,174	0,085	0,044	0,257	0,251	0,014
	Supscapula	R	-0,772*	-0,585*	-0,625*	-0,649*	-0,416	-0,433	-0,836*
		P	0,002	0,036	0,023	0,016	0,157	0,140	0,000
	Triceps	R	-0,811*	-0,702*	-0,751*	-0,737*	-0,467	-0,519	-0,793*
		P	0,001	0,007	0,003	0,004	0,107	0,069	0,001
	Abdominal	R	-0,773*	-0,762*	-0,694*	-0,733*	-0,167	-0,626*	-0,806*
		P	0,002	0,002	0,008	0,004	0,586	0,022	0,001
	Suprailiac	R	-0,726*	-0,661*	-0,694*	-0,662*	-0,384	-0,523	-0,746*
		P	0,005	0,014	0,008	0,014	0,195	0,067	0,003

*P<0,05

As shown in table 2, A positive correlation was found between ages and height with the standing long jump, right hand grip, left hand grip, and vertical jump in the early adolescence goal-ball players with visual impairments (P<0.05). A negative correlation was found between body mass index and body fat percentage with standing long jump, vertical jump, sit-up (P<0.05). Also, there was a negative correlation among skinfold (subscapular, triceps and suprailiac) with standing long jump, the right hand grip, left hand grip, vertical jump, and push up (P<0.05). However, a negative correlation was found between abdominal skinfold with standing long jump, the right hand grip, left hand grip, vertical jump, sit-up, push up (P<0.05). On the other hand, there were no significant correlations between body weight with muscle strength or between leg strength with body composition (P>0.05).

Discussion

In this study has shown that goal-ball players with visual impairments have significant relationship between ages and height with the standing long jump, right hand grip, left hand grip, and vertical jump. It was found significant relationship between body mass index and body fat percentage with standing long jump, vertical jump, and sit-up. Also, there was a negative correlation among subscapular, triceps and suprailiac and abdominal (as measured by skinfolds) with standing long jump, the right hand grip, left hand grip, vertical jump, and push up. Also, a negative correlation was found between abdominal skinfold and sit-up. On the other hand, there were no significant correlations between both weight with muscle strength measurements and leg strength with body composition measurements (Table 2).In previous a study tested 46 children with visual impairments (26 girls and 20 boys) aged 9-19performed items from the fitness gram health-related fitness test**.** It found that fewer than 20% of the children with visual impairments passed at least four items on the fitness gram, compared to 48%-70% of the sighted children. In comparison of passing rates of girls and boys with visual impairments, the passing rate for the boys exceeded that for girls by 17% in the one-mile walk/run, and the passing rates for the girls exceeded those for the boys in push-ups (15%), curl-ups (14%), the BMI (27%), and shoulder stretch (right, 35%, and left, 16%) (Lieberman & McHugh, 2001).The results of several studies have shown that children with visual impairments have a higher percentage of body fat (as measured by skinfolds) that does sighted children (Blessing, McCrimmon, Stovall, & Williford, 1993; Hopkins, Gaeta, Thomas, &Hill, 1987; Jankowski &Evans, 1981). Children blind had higher skinfold measure than children with low vision and sighted children (Hopkins, Gaeta, Thomas & Hill, 1987). In a study, shown no significant differences between the skinfold measure of children who were blind and those who were sighted, but significantly higher skinfold measure among children with low vision (Short & Winnick, 1986). A previous study, Show that both body size and countermovement depth confound the relationship between the muscle power output with the performance of maximum vertical jumps. Regarding routine assessments of muscle power from jumping performance and viceversa, the use of countermovement jump is recommended, while peak power, rather than peak average, should be the variable of choice (Markovic, Mirkov, Nedeljkovic, & Jaric, 2014).

Children who are blind have been found to perform significantly worse in locomotor and object control skills, whereby running, leaping, kicking and catching are the most affected skills, and corresponding differences are related to most running, leaping, kicking and catching component (Wagner, Haibach, & Lieberman, 2013). Variables such as age, gender and level of visual impairment have been assessed in regard to motor skill performance (Haibach, Wagner, &Lieberman, 2014), however, the influence of body composition upon performance has not been assessed in this group. Physical fitness of visually impaired goal-ball players was higher than that of the more sedentary group ($p<0.05$), except shoulder-stretch test values ($p>0.05$) (Karakaya, Aki, & Ergun, 2009).

Conclusions

In conclusion, in an assessment of body composition and muscle strength, it was found that body weight did not impact muscle strength in goal-ball players with visual impairments, however, body fat composition and BMI was a determinant for some strength measures, restricting movement against gravity when skinfold and body mass index values increased. Considering the results of previous research indicating that children with visual impairments are behind their sighted peers, the present research indicates that the body composition levels are another important factors these children. This finding could be of importance for understanding the role of muscle strength and body composition in routine training of goal-ball players.

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