

Physical fitness levels of blind and visually impaired goalball team players

Tuncay Çolak^a, Belgin Bamaç^{a,*}, Mensure Aydın^b, Bergün Meriç^b and Aydın Özbek^a

^a*Kocaeli University, School of Medicine, Department of Anatomy, Kocaeli, Turkey*

^b*Kocaeli University, School of Physical Education and Sport, Kocaeli, Turkey*

Abstract. The purpose of this study to verify the effect of playing goalball on some measures of motor fitness. One hundred and three children (age 13–15 years) with varying degrees of blindness were assessed for motor fitness. All participants were male. The participants underwent motor fitness (balance, handgrip, flexibility, vertical jump, isokinetic concentric peak torque) assessments. There were significant differences between goalball players and non-goalball players regarding many motor fitness components. Non-goalball players were inferior in all motor fitness compared with goalball players. This study suggests that goalball may be considered effective option to improve motor skills in visually impaired children.

Keywords: Goalball, physical fitness

1. Introduction

Blindness can cause low physical work capacity, posture problems, orientation difficulties, depressions and problems with balance. Previous studies include information about these disturbances [1,14,18].

Participation in physical activity during childhood can aid the development of motor abilities and lay the foundation for good health [10]. Children who start sport participation soon in life gain additional bony mineral content and mineral density during growth. People with visual impairment need more support in their psychosocial and physical development. Sport gives the visually impaired child the chance to be part of the group. Craft suggested that physical education can promote the acquisition of daily living skills, orientation and mobility skills needed by students with visual impairments by helping to develop their physical fitness and psychomotor abilities [4].

Goalball was invented in 1946 by Hanz Lorenzen and Sepp Reindle, in an effort to help in the rehabilitation of

blinded war veterans. The game was introduced to the world in 1976 at the Paralympics in Toronto, and has been played at every Paralympic since. This game is now played in 112 countries in all IBSA (International Blind Sport Association) regions. Unlike other team ball events goalball is a unique ball game played only by the blind. Goalball is played by two teams of three players on a standard gymnasium volleyball court with tactile markings so that players can determine their location on the court and which direction that he/she is facing. The object is to throw a three-pound goalball, which is similar to a heavy basketball. The ball has embedded bells so that the sound projected from the moving ball allows the players to track and locate it audibly. Thus silence at events is vital. When the players hear the ball coming towards their end of the court they dive, usually head first, towards it hoping to block it with their body and stop it. If all three players miss the ball it goes past the back line and this is considered a goal. The team with the most goals wins the game. Each game consists of two ten-minute halves. In order to maintain an equal advantage, all team members must wear eye masks to block out light at all times, during the game [19–21].

Benefits of sports for blind and visually impaired people were investigated before [2,5,8,13,18]. How-

*Address for correspondence: Belgin Bamaç PhD, PT, Kocaeli University School of Medicine, Department of Anatomy, Derince, 41900 Kocaeli, Turkey. Tel.: +90 262 233 5980/1237; Fax: +90 262 322 21 40; E-mail: bbamac@hotmail.com.

ever the beneficial effect of goalball practice on motor skills is not well-documented. Therefore the aim of present study was to compare motor fitness levels between goalball players and non-goalball players with varying degrees of blindness.

2. Material and methods

2.1. Participants

A total of 103 visually impaired males volunteered. The goalball group consisted of 51 goalball players training for about 6 hours/week. The control group consisted of 52 nonactive subjects not participating in any kind of sport activity before. The participants had no other known disorder except being visually impaired. The participants were recruited from Türkan Sabancı School for Blind Children. All participants were informed of the study procedure, purposes and all gave their informed consent. The survey items were read aloud. The study was approved by the ethics committee of University of Kocaeli, Faculty of Medicine.

Participants were classified into three categories according to criteria adopted by USABA (The United States Association of Blind Athletes) in 1981 as follows: B1 – no functional vision, B2 – a visual acuity of less than 20/400 or a visual field of less than 5 degrees and B3 – visual acuity of 20/200–20/400 or a visual field of 5–20 degrees [18]. Demographic data are presented in Table 1, significant values (*p*) are included.

Standing height was recorded to the nearest half cm (Seca Stadiometer 208) with the subject barefoot and with the back against a vertical wall. Body weight was measured to the nearest 0.5 kg (Seca Beam Balance 710) with shoes, sweaters, coats and jackets removed.

The evaluator was blind to group membership.

2.2. Range of motion measurement

To obtain quantitative information about the mobility of the upper extremity, the range of motion was measured unilaterally, and assessed by standard goniometric measurement. All values are presented in degrees. In this study the same examiner who was experienced with these measurements, performed all range of motion evaluations. It can be questioned whether goniometric measurements represent real joint or bony motions. We evaluated flexion, extension, abduction, adduction, internal and external rotation degrees of the shoulder; flexion and extension degrees of the elbow and flexion, extension, radial deviation and ulnar deviation of the wrist.

2.3. Balance response

General balance response was tested using the Flamingo Balance Test (balancing on one leg as long as possible while standing on the preferred foot) with eyes opened [10].

2.4. Isokinetic concentric strength assessment

Unilateral isokinetic concentric peak torque strength (highest muscular force output any moment during a repetition) was measured by a Biodex System-3 Dynamometer. Concentric shoulder external/internal peak torque was measured at 60°/s and 180°/s. Participants were positioned and secured by Velcro strapping according to the Biodex testing manual.

2.5. Vertical jump

Athletic trainers and coaches use the vertical jump test to determine an athlete's physical ability. The vertical jump (counter movement jump with 90° knee flexion before the extension) as a test of lower body explosive power [3]. The jump was performed on a hard and flat surface using an ergojump (Jump-MD, Takei, Japan) adjusted to each participant's height. The participants were asked to perform a counter movement jump in which they began in a standing position, dropped in to the semi-squat position, and immediately jumped as high as possible. The jump height was given automatically by the ergojump. Three tests were performed with five minutes of rest between them. The best jump was used for analysis.

2.6. Handgrip strength

Grip strength is an important prerequisite for good performance of the upper limb. In this study, handgrip strength was measured using a standard adjustable handle Jamar Dynamometer (Irvington, NY, USA). Maximum handgrip forces for dominant hand were recorded in kilograms as the highest of two trials. Before testing the participants individually, the researcher gave a brief orientation to the entire group. The dynamometer was adjusted to the size of the hand of participant. The arm, the hand and the body position were standardized according to the suggestion of the American Society of Hand Therapists. Subjects were sitting, with shoulder adducted and neutrally rotated, elbow flexed at 90° resting on the table surface and the forearm in neutral and wrist in 0–30° extension. The test was performed by squeezing calibrated hand dynamometer as forcefully as possible with the dominant hand. Static strength was assessed.

Table 1
Group characteristics of goalball players and non-goalball players in class B1, B2 and B3

Measurement	B1			B2			B3		
	GP <i>n</i> = 17	NGA <i>n</i> = 15	P	GP <i>n</i> = 16	NGA <i>n</i> = 17	P	GP <i>n</i> = 18	NGA <i>n</i> = 20	P
Age (year)	14.3 ± 0.7	14.4 ± 0.5	0.757	15.6 ± 0.5	14.6 ± 0.9	0.133	15.8 ± 0.8	15.6 ± 1.1	0.943
Height (cm)	161.5 ± 8.1	162.5 ± 9.2	0.852	166.3 ± 5.6	157.3 ± 7.4	0.100	165 ± 10.1	164.3 ± 11.4	0.435
Weight (kg)	52.0 ± 8.5	56.8 ± 1.0	0.04	51.3 ± 2.31	61.1 ± 14.1	0.02	51.8 ± 8.6	54.5 ± 13.9	0.03

GP: Goalball Player, NGA: Non-Goalball Players. Values are given as mean ± SD.

2.7. Sit and reach test

This test measures the flexibility of the hamstrings, buttocks and lower back [10]. The participants were instructed to reach as far as possible from a sitting position.

2.8. Data processing

The results are presented as means ± SD. Differences between the groups were calculated using a nonparametric test for independent samples (Mann Whitney-U). The SPSS package for personal computer was used for the statistical analyses. A P-value less than 0.05 was considered significant.

3. Results

Group characteristics are shown in Table 1. In this study, there was significant difference in weight, but not in age and height between the groups. Non-goalball players were heavier than goalball players for all visual class.

Table 2 gives mean (SD) values for active range of motion for groups. The goalball players showed significantly greater range of motion for shoulder extension, abduction, adduction, internal rotation and wrist flexion, extension, ulnar and radial deviation than the non-goalball players in class B1 ($P < 0.05$). In class B2, the goalball players showed significantly greater range of motion for shoulder extension, abduction, adduction, internal rotation; elbow flexion and extension and wrist extension, ulnar and radial deviation degrees ($P < 0.05$). With regard to active range of motion measurements in class B3, goalball players showed significantly greater range of motion for shoulder extension, abduction and internal rotation; elbow flexion and extension and wrist flexion, extension, ulnar and radial deviation degrees ($P < 0.05$). No significant differences were found for the flexion and external rotation degrees of the shoulder between the two groups for all visual class ($P > 0.05$).

Five motor fitness parameters were assessed in all participants: isokinetic concentric peak torque, flamingo balance, handgrip, vertical jump and sit and reach tests.

Table 3 shows the isokinetic concentric peak torque characteristics of the internal rotation motions of the dominant shoulder of groups. Significant differences were identified between the goalball players and non-goalball players for internal rotation isokinetic concentric peak torque strength ($P < 0.05$). For these measurements, significantly higher values were obtained for the goalball players on dominant sides for both velocities.

Significant differences were noted in favour of the goalball players when the balance assessment test was evaluated statistically ($P < 0.05$). The goalball groups had higher grip strength than control groups. Scores for vertical jump were significantly different between goalball players and non-goalball players. The goalball players attained better results in vertical jump ($P < 0.05$). Mean values were significantly higher for goalball players than non-goalball players at the sit and reach test ($P < 0.05$). All results are shown in Table 4.

4. Discussion

Many authors have described the benefits of sports in building fitness, teaching healthy fitness habits and healthy competition, developing self-confidence, building social skills and friendships and providing pleasure in the visually impaired. There have been increased opportunities and sports participation by athletes with disabilities during past decades [12,13].

Goalball was designed specifically for the blind and it can bring better physical conditions to visually impaired and blind people. The purpose of this study was to compare some motor fitness parameters between goalball team players and non-players with varying degrees of blindness.

Deficits in physical fitness may be a special problem for those with visual impairments who experience ex-

Table 2
Range of motion of upper extremity (dominant arm) of goalball players and non-goalball players in class B1, B2 and B3

Range of motion of upper extremity	B1			B2			B3		
	GP <i>n</i> = 17	NGP <i>n</i> = 15	P	GP <i>n</i> = 16	NGP <i>n</i> = 17	P	GP <i>n</i> = 18	NGP <i>n</i> = 20	P
Shoulder flexion degree	180.00 ± 0.00	180.00 ± 0.00	1.000	180.00 ± 0.00	178.75 ± 3.54	0.776	180.00 ± 0.00	180.00 ± 0.00	1.000
Shoulder extension degree	71.18 ± 14.31	55.71 ± 13.67	0.031	78.33 ± 7.64	56.88 ± 18.31	0.008	65.00 ± 15.81	60.00 ± 10.35	0.022
Shoulder abduction degree	185.29 ± 5.15	183.57 ± 4.76	0.004	183.33 ± 5.77	173.75 ± 4.43	0.0091	186.00 ± 4.18	181.88 ± 3.72	0.012
Shoulder adduction degree	54.41 ± 15.40	41.43 ± 6.90	0.046	52.50 ± 11.65	41.67 ± 10.41	0.0014	44.38 ± 10.50	42.00 ± 2.74	0.435
Shoulder internal rotation degree	98.82 ± 5.74	97.14 ± 9.06	0.005	98.33 ± 1.041	68.13 ± 7.53	0.001	96.25 ± 5.18	85.00 ± 5.00	0.011
Shoulder external rotation degree	100.00 ± 11.55	99.12 ± 10.79	0.901	96.34 ± 0.41	95.00 ± 10.69	0.630	98.75 ± 10.94	95.00 ± 8.66	0.524
Elbow flexion degree	141.43 ± 9.00	139.12 ± 11.35	0.757	145.00 ± 5.00	140.00 ± 7.07	0.03	145.00 ± 7.91	135.00 ± 7.07	0.022
Elbow extension degree	8.53 ± 3.43	8.57 ± 3.78	0.981	8.13 ± 5.00	5.00 ± 5.30	0.002	7.00 ± 2.74	5.88 ± 3.72	0.033
Wrist flexion degree	90.00 ± 0.00	88.57 ± 2.44	0.008	88.33 ± 2.89	85.00 ± 5.35	0.497	89.00 ± 2.24	85.63 ± 7.29	0.004
Wrist extension degree	78.24 ± 28.45	65.00 ± 10.80	0.03	75.00 ± 5.00	64.38 ± 19.54	0.007	71.88 ± 11.63	66.00 ± 5.48	0.004
Wrist ulnar deviation degree	37.94 ± 21.22	13.57 ± 3.78	0.001	23.33 ± 12.58	17.25 ± 12.77	0.002	25.63 ± 15.45	18.00 ± 11.40	0.00
Wrist radial deviation degree	55.71 ± 12.72	43.24 ± 14.57	0.001	58.33 ± 2.89	49.38 ± 20.95	0.004	54.50 ± 17.11	48.00 ± 7.42	0.008

GP: Goalball Player, NGP: Non-Goalball Player. Values are given as mean ± SD.

Table 3
Mean peak torque values for the isokinetic concentric peak torque data of groups

Measurement	B1			B2			B3		
	GP <i>n</i> = 17	NGP <i>n</i> = 15	P	GP <i>n</i> = 16	NGP <i>n</i> = 17	P	GP <i>n</i> = 18	NGP <i>n</i> = 20	P
<i>Internal rotation</i>									
60°/s	77	43	0.01	78	48	0.01	78	43	0.03
180°/s	74	42	0.01	75	49	0.01	70	43	0.04
<i>External rotation</i>									
60°/s	56	42	0.22	55	40	0.15	54	45	0.30
180°/s	38	27	0.32	35	22	0.32	37	31	0.41

GP: Goalball Player, NGP: Non-Goalball Player. All data are expressed in N.m/kg.

tra demands in dealing with their environments [13]. Previous reports have shown that the aerobic work capacity of visually impaired people is lower than that of age-matched sighted counterparts [6,8,16,18]. In addition, it has been shown that visually impaired people are more obese than sighted people and the lower aerobic capacity and obesity may be partly attributable

to a lack of habitual physical activity [6,9]. Sedentary lifestyle predisposes to obesity and it has been found that childhood obesity predisposes to adult obesity and physical activity patterns in adulthood seem to be established during childhood and adolescence [10]. Singh and Singh showed that the visually handicapped who are active can have similar level of physical fitness,

Table 4
Motor fitness parameters of goalball players and non-goalball players in class B1, B2 and B3

Measurement	B1			B2			B3		
	GP <i>n</i> = 17	NGP <i>n</i> = 15	P	GP <i>n</i> = 16	NGP <i>n</i> = 17	P	GP <i>n</i> = 18	NGP <i>n</i> = 20	P
Sit and reach(cm)	18.7 ± 7.5	15.2 ± 0.0	0.02	17.9 ± 7.9	14.8 ± 5.4	0.04	19.8 ± 1.7	17.9 ± 3.7	0.06
Flamingo balance test (s)	10.5 ± 4.55	8.2 ± 4.98	0.000	11.00 ± 2.65	6.7 ± 4.44	0.012	12.7 ± 4.83	10.4 ± 2.94	0.002
Grip strength of dominant hand (kg)	27.3 ± 93.59	24.57 ± 91.18	0.087	30.00 ± 88.79	25.50 ± 119.2	0.025	31.00 ± 124.1	24.5 ± 142.93	0.033
Vertical jump (cm)	25.71 ± 7.24	17.43 ± 16.10	0.035	25.33 ± 7.23	19.50 ± 12.78	0.037	25.80 ± 13.29	18.75 ± 4.17	0.045

GP: Goalball Player, NGP: Non-Goalball Player. Values are given as mean ± SD.

lung function and explosive leg strength as those of their active sighted counterparts [17]. We investigated whether playing goalball has an effect on player's motor fitness. Our results indicated that playing goalball was effective in improving physical factors. As the result of range of motion measurements, there were significant differences between players and non-players. One possible explanation for these differences is that the athlete needs to create a movement pattern that increases range of motion. High number of actions which are characteristics of this sport are likely to increase flexibility of upper limb.

Balance is an indispensable factor for the blind and it helps to encourage the visually impaired person's integration in space. In this study goalball players showed a significant advantage over their respective control groups on the Flamingo balance test. The better result of goalball players on the balance test suggested, perhaps, that the training program may have effective on motor skills. The forces generated while rapidly changing direction, stopping, landing, as well as during jumping may confer excellent balancing properties. We considered that postural control capability better in the goalball players when we compared the non-players. It seems that goalball can help to control the visually impaired children his body better.

The handgrip strength in the goalball players was higher than the non-players for all visual class. Players try to score goals using the ball similar to basketball. This might be reason of the higher grip strength in the goalball players.

We observed significantly higher unilateral isokinetic concentric peak torque strength in the goalball players than in the non-goalball players for internal rotation strength. Shoulder internal rotation motions are highly involved in all strokes in goalball. Therefore, the playing goalball is associated with increased internal rotation strength. However, because of the lack of literature, we were unable to compare our results with another findings.

Vertical jump ability is a crucial skill in the performance of several sports. The execution of this motor task depends on the coordination of the segmental actions of the human body, which is determined by the interaction between the muscle forces and net moments that have to be generated around the joints to accomplish the mechanical demands of the task [15]. Goalball is a continuous game of power and agility. In view of the significant differences between players and non-players in vertical jump goalball seems to have an effect on this parameter as well.

It is important to find new ways to encourage social relations between visually impaired persons and their peers as well as other people outside their homes [7]. Sport is an integration factor of the physically handicapped as it enables a disabled person to participate with peers. Furthermore, a blind child must learn to develop his or her physical capacities. He/she will then have a better control of the body. Therefore sports may be used as a rehabilitation method. Labronici et al. evaluated thirty handicapped people. After two years, basketball and swimming groups presented with high vigor and low depression levels. Considering the social aspects, both groups presented substantial improvement, especially regarding their relationship to one person or more people and also in the everyday activities, thus leading them to better social integration [11].

Competitive sports such as wrestling and judo become increasingly available for visually impaired athletes. However goalball is designed specifically for the blind and the results of this study are strongly indicative of its tangible potential in enhancing a number of motor skills in this special need group.

References

- [1] M.A. Abolfotouh and A. Telmesani, A study of some psychosocial characteristics of blind and deaf male students in Abha City, Asir Region, Saudi Arabia, *Public Health* **107** (1993), 261–269.

- [2] B.E. Barnett and W.J. Merriman, Personal values in sport of visually impaired and sighted wrestlers, *Percept. Mot. Skills*. **77** (1993), 816–818.
- [3] C. Bosco, La valoración de la fuerza con el et est de Bosco, in: *collection Deporte e Entrenamiento*, J. Riu, ed., Paidotribo, Barcelona, 1994.
- [4] D. Craft, Curriculum adaptations, in: *Foundations of education for the blind and visually handicapped children and youth*, G.T. School, ed., New York: American Foundation for the Blind, 1986, pp. 396–397.
- [5] J.M. Gleser, J.Y. Marguiles, M. Nyska, S. Porat, H. Mendelberg and E. Wertman, Physical and psycosocial benefits of modified judo practice for blind, mentally retarded children: a pilot study, *Percept. Mot. Skills*. **74** (1992), 915–925.
- [6] W.G. Hopkins, H. Gaeta, A.C. Thomas and P.M. Hill, Physical fitness of blind and sighted children, *Eur. J. Appl. Physiol. Occup. Physiol.* **56** (1987), 69–73.
- [7] T.M. Huurre and H.M. Aro, Psychosocial development among adolescents with visual impairment, *European Child and Adolescent Psychiatry* (1998), 73–78.
- [8] L.W. Jankowsky and J.K. Evans, The exercise capacity of blind children, *Journal of Visual Impairment and Blindness* **75** (1981), 248–251.
- [9] T. Kakiyama, Y. Koda and M. Matsuda, Effects of physical inactivity on aortic distensibility in visually impaired young men, *Eur. J. Appl. Physiol.* **79** (1999), 205–211.
- [10] Y. Koutedakis and C. Bouziotas, National physical education curriculum: motor and cardiovascular health related fitness in Greek adolescents, *Br. J. Sports Med.* **37** (2003), 311–314.
- [11] R.H. Labronici, M.C. Cunha, A.D. Oliveira and A.A. Gabbai, Sport as integration factor of the physically handicapped in our society, *Arq. Neuropsiquiatr.* **58** (2000), 1092–1099.
- [12] D.R. Patel and D.E. Greydanus, The pediatric athletes with disabilities, *Pediatr. Clin. North Am.* **49** (2002), 803–827.
- [13] P.E. Ponchillia, B. Strause and S.V. Ponchillia, Athletes with Visual Impairment: Attributes and Sports Participation, *Journal of Visual Impairment and Blindness* **96** (2002), 267–276.
- [14] C.V. Portfors-Yeomans and C.L. Riach, Frequency characteristics of postural control of children with and without visual impairment, *Dev. Med. Child. Neurol.* **37** (1995), 456–463.
- [15] A.L.F. Rodacki, N.E. Fowler and S.J. Bennett, Vertical jump coordination: fatigue effects, *Med. Sci. Sports Exerc.* **34** (2002), 105–116.
- [16] W. Seelye, Physical fitness of blind and visually impaired Detroit public school children, *J. Visual Impairment Blind* **77** (1983), 117–118.
- [17] R. Singh and H.J. Singh, Anthropometric and physiological profiles of active blind Malaysian males, *J. Sports Med. Phys. Fitness.* **33** (1993), 378–382.
- [18] S. Sundberg, Maximal oxygene uptake in relation to age in blind and normal boys and girls, *Acta Paediatr. Scand.* **71** (1982), 603–608.
- [19] www.dhamilton.net.
- [20] www.usparalympics.org.
- [21] www.angelfire.com.

Copyright of Isokinetics & Exercise Science is the property of IOS Press and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.