"IDO MOVEMENT FOR CULTURE. Journal of Martial Arts Anthropology",
Vol. 17, no. 4 (2017), pp. 32–36
DOI: 10.14589/ido.17.4.6

KINESIOLOGY

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Qualitative assessment of balance performance among judo players with visual impairment

Submission: 6.07.2017; acceptance: 12.09.2017

Key words: balance, judo, posture, visual impairment

Abstract

Background. Visual impairment is associated with decrements in the control of standing postural balance. At the same time, skill in many sports is associated with increased balance skills.

Aim. The study hypothesized that athletes with visual impairment would have better balance performance than non-athletes with visual impairment.

Methods. To evaluate this hypothesis the postural balance of highly experienced *judo* players were investigated. Standing postural balance was evaluated in three groups of male participants: judo players with visual impairment, non-athletes with visual impairment, and sighted non-athletes. Balance performance was measured by the Balance Error Scoring System during stance on a firm surface, and during stance on a foam surface.

Results. Balance errors were more common during stance on the foam surface, confirming previous findings. No significant difference was found in balance performance between the different participant groups ($p > 0.05$).

Conclusion. The study discusses the results in relation to the existing literature, and in terms of the sensitivity of different types of balance assessment. It will be important to include measures of the quantitative kinematics of body sway to better understand the effects of sports training and skill on the postural control of persons with visual impairment.

Introduction

Judo is a martial art that requires hand-to-hand fighting, and in which performance is strongly dependent upon precise control of balance and leverage. Benefiting from the opponent's mistakes, body weight and strength is used [Yerkov 1951]. Judo players are obliged to have an outstanding balance control. The techniques of this martial art require constantly changing movements aimed at unbalancing the opponent, so as to bring him/her down. So, the Judo player's ability to maintain body position in unstable dynamic conditions must be highly developed [Barrault *et al.* 1991].

Balance skills that are acquired in the context of sport expertise may also improve the efficiency of dynamic and static postural control in daily living activities. Empirical evidence exists to support this view [Perrin *et al.* 2002]. However, not all aspects of sports training emphasize balance skill, or even require it. For example, athletes may gain useful information through the viewing of videos of themselves or other athletes, but balance skills are not challenged during the viewing of video recordings. Therefore, it is not clear whether sports training that does not include balance exercises can have effects on balance skills [Hrysomallis 2008]. A related issue concerns athletes with sensory disabilities. Postural control can be influenced by information obtained from several perceptual systems (visual, vestibular, somatosensory, and auditory). The degradation or absence of any of these systems effects body sway, and is likely to influence athletic skills that depend upon balance [Giagazoglou *et al.* 2009; Stoffregen *et al.* 2010]. The present study addressed the control of balance in athletes with visual impairment.

As a general description the state of being impaired vision means the situation of having lower vision capa-

bility than normal vision capability [Ayça 2013]. Visual disability includes people both having partial sight and those with total blindness [Ozer 2013]. Individuals with visual impairment can be classified into three groups according to LogMAR: B1) less visual acuity than 2.60. B2) Visual acuity between 1.50 to 2.60 and / or visual angle less than 10 degrees. B3) Visual acuity between 1.40 to 1 and / or visual angle less than 40 degrees [IBSF 2017].

Typically, individuals with visual impairment have disorders of posture and gait.[5,10] However, the fact that the blind can stand and walk indicates that they can use non-visual information in the control of these functions. Controlled tests have confirmed this effect in terms of audition [Stoffregen *et al*. 2010; Easton *et al*. 1998; Demir, Şen 2009], and the somatosensory system [Perrin *et al*. 2002; Perrot *et al*. 2000].

The present study asked whether skill in judo is associated with improvements in balance control in athletes with visual impairment. In the study, balance performance was compared in three groups; judo players with visual impairment, non-athletes with visual impairment, and sighted non-athletes. Because sports skill is associated with improvements in the control of postural balance, it was predicted that balance performance in visually impaired judo players would be better than balance performance in visually impaired non-athletes.

Methods

Participants

The participants comprised 43 male volunteers. There were 10 Judo players from the Turkish Visually Impaired Judo National Team, 15 visually impaired non-athletes, and 18 sighted non-athletes. The mean age of the participants 28.67± 5.83 year, mean height 173.14 ± 5.64 cm and mean weight 76.84 ± 13.11 kg. The Judo players reported an average of 8.2 years (± 3.1 years) sports experience. The degree of visual impairment is reported in Table 1. Prior to the research participants gave informed consent. The study protocol was approved in advance by the Institutional Review Board at Selçuk University.

Procedure

The Balance Error Scoring System (BESS) was used to evaluate balance performance [Riemann, Guskiewicz 2000]. In the BESS test, participants adopted three test stances (double leg, single leg and tandem stance) while standing on a firm surface, and while standing on a foam surface, for a total of 6 trials. On each trial, participants were asked to stand with their eyes closed for 20 seconds. During each trial, participants were monitored for one or more of several different types of errors: (1) Raising hands from the top of the iliac, (2) opening eyes, (3) taking a step, stumbling or to come down (4) doing flexion or abduction of the hip joint for more than 30° angle, (5) raising the forefoot and the heel from the ground, (6) staying out of the test position for more than five seconds [Erkmen *et al*. 2009; Valovich *et al*. 2003]. The maximum error score for each test position is 10. The foam surface comprised medium density foam blocks (Airex Balance Pad, Alcan Airex AG, CH-5643 Sins/ Switzerland), 6 cm in height, arranged to form a surface 50 × 41 cm. During testing, participants were barefoot.

Error scores calculated separately for each condition and the total BESS scores for firm and foam surfaces were obtained by summing the scores according to the test stances (3 conditions for firm surface and 3 conditions for foam surface). Scores were computed using the method of Riemann and Guskiewicz [2000]. To ensure familiarity with the different conditions, participants were allowed to practice briefly before testing.

Data analysis

The data obtained in the study were presented as mean and standard deviation. For comparison of the groups One-Way ANOVA and a 2-way ANOVA were conducted according to the results of normality tests. Statistical significance level was taken as 0.05. SPSS 20.0 software package was used for statistical analysis.

Results

Participants' mean age, height, and weight are shown in Table 2. One-way analysis of variance (ANOVA) revealed no significant differences between groups for age ($F_{[2-40]} = 2.649$; $p > 0.05$), height ($F_{[2-40]} = 2.969$; $p > 0.05$) or weight ($F_{[2-40]} = 0.611$; $p > 0.05$).

Table 3 shows mean scores for each of the groups during stance on the firm surface and the foam surface. A 2-way ANOVA on mean BESS scores (across participants) was conducted, with factors Groups (JpVI, NaVI, SnA) and surfaces (firm, foam). The main effect of surfaces was significant, $F(1,85) = 380.39$, $p < 0.001$, partial $\chi^2 = 0.83$. The main effect of groups, and the surfaces × groups interaction were not significant.

Table 1. Degree of impairment for each participant with visual impairment, using the LogMAR classification

	B1	B2	B3
Judo players with visual impairment	3	3	4
Non-athletes with visual impairment	4	5	6

Discussion

Balance performance was evaluated in three groups; judo players with visual impairment, non-athletes with visual impairment, and sighted non-athletes. Across groups, balance performance during stance on a foam surface was reduced, relative to performance during stance on a firm surface. Contrary to our prediction, no evidence was found for differences in balance performance between groups. These results are discussed in turn.

Effects of support surface

Common findings was replicated that standing balance is powerfully affected by variations in the rigidity of the support surface [Stoffregen *et al.* 2009]. This replication confirms the sensitivity of the BESS instrument for both sighted and visually impaired individuals.

Differences between groups

The prediction in the study that judo skill would be associated with improved balance performance in individuals with visual impairment was not confirmed. No evidence was found between groups in BESS scores, either on the firm surface or on the foam surface. The absence of group differences is at variance with previous studies that have reported decrements in balance among populations with visual impairment [Aydog *et al.* 2006; Anand *et al.* 2003; Sforza *et al.* 2000]. By contrast, the absence of group differences is compatible with the hypothesis that persons with visual impairment learn to use non-visual information to achieve robust control of standing balance.

One possible explanation of the null result for groups relates to the nature of this assessment. The BESS provides a qualitative assessment of balance performance. That is, the BESS is sensitive only to variations in balance that are visible to the naked eye. A related example is the Romberg test [Munafo *et al.* 2015]. Testing procedures that rely on the quantitative kinematics of body sway, as measured using force- or motion-tracking technologies, commonly reveal subtle characteristics of postural control that cannot be detected or quantified using naked-eye coding. Accordingly, it might be expected to find group differences if the present study were repeated with the addition of quantitative data on the kinematics of postural sway. This is a testable hypothesis.

Another possible explanation for the null result for groups is the fact that data were collected only when

Table 2. Demographic data for the three groups

Variables	Groups	Mean	Std. Deviation
Age (Year)	JpVI	25.10	3.98
	NaVI	29.60	7.17
	SnA	29.89	4.85
Height (cm)	JpVI	171.5	6.47
	NaVI	171.4	4.32
	SnA	175.5	5.55
Weight (kg)	JpVI	77.60	12.56
	NaVI	73.87	13.42
	SnA	78.89	13.42

JpVI: Judo players with visual impairment; NaVI: Non-athletes with visual impairment; SnA: Sighted non-athletes.

Table 3. Descriptive statistics (mean BESS scores) for each group on each surface

Variables	Groups	Mean	Std. Deviation
Firm Surface	JpVI	3.70	3.95
	NaVI	3.33	2.41
	SnA	3.83	2.55
Foam Surface	JpVI	16.50	3.54
	NaVI	16.00	3.66
	SnA	18.06	2.58

JpVI: Judo players with visual impairment; NaVI: Non-athletes with visual impairment; SnA: Sighted non-athletes

the eyes were closed, and only during bipedal stance. Few athletic skills are routinely performed with the eyes closed, and it might be the case that balance skills acquired through Judo might not generalize to eye closure. While this argument may have intuitive appeal, it is not compatible with data reported by Almansba *et al*. [2012].

Conclusion

BESS was used to conduct a qualitative assessment of balance skills in judo players with visual impairment, in non-athletes with visual impairment, and in sighted non-athletes. Consistent with previous research, balance performance was better during stance on a firm surface than during stance on a foam surface, for all groups. Despite the significant effect of support surfaces, no evidence was found that balance performance differed among the three groups. The results of this study suggest that qualitative assessments, such as the BESS, may not be sensitive to group-related differences in the quantitative kinematics of postural control. In future research, it will be important to include measures of the quantitative kinematics of body sway to better understand the effects of sports training and skill on the postural control of persons with visual impairment.

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Jakościowa ocena równowagi wśród zawodników *judo* z upośledzeniem wzroku

Słowa kluczowe: równowaga, judo, postawa, upośledzenie wzroku

Abstrakt

Tło. Upośledzenie wzroku wiąże się ze zmniejszeniem kontroli nad stanem równowagi postawy stojącej. Jednocześnie zręczność w wielu dyscyplinach sportowych łączy się ze zwiększoną zdolnością równowagi.

Cel. W badaniu postawiono hipotezę, że sportowcy z upośledzeniem wzroku powinni mieć lepszą równowagę niż nie-sportowcy z upośledzeniem wzroku.

Metody. W celu analizy tej hipotezy zbadano równowagę postawy stojącej wysoce doświadczonych zawodników *judo*. Postawa ta została oceniona w trzech grupach uczestników: zawodników *judo* z upośledzeniem wzroku, nie-sportowców z upośledzeniem wzroku oraz nie-sportowców widzących. Wydajność równowagi mierzono za pomocą systemu *Balance Error Scoring System* podczas utrzymywania postawy stojącej na twardej powierzchni i na powierzchni z pianki.

Wyniki. Błędy w równowadze były bardziej powszechne wówczas, gdy zawodnicy stali na powierzchni z pianki, potwierdzając tym samym wcześniejsze ustalenia. Nie stwierdzono istotnych różnic w wynikach zachowania równowagi pomiędzy różnymi grupami uczestników badań ($p > 0,05$).

Wnioski. W niniejszej pracy omówiono wyniki w odniesieniu do istniejącej literatury oraz pod względem wrażliwości na różne typy oceny równowagi. Uwzględnienie pomiarów ilorazowej kinematyki ciała jest ważne w celu lepszego zrozumienia efektów treningu sportowego i umiejętności w zakresie kontroli postawy osób z upośledzeniem wzroku.