

Aerobic capacity of handball players with hearing impairment

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Summary

Study aim: To determine the aerobic capacity of handball players with hearing impairment as compared with the healthy ones.

Material and methods: Two groups of subjects took part in this study: healthy national handball players (NHB; $n = 15$) aged 18 – 33 years and international handball players with hearing impairment (IHB; $n = 13$), winners of European Deaf-Mute Championships in 2008 (Belgrade, Serbia) and second place in Deaflympic games in 2009 (Taipei, Taiwan), aged 21 – 48 years. Cosmed T-170 treadmill (FSPE1 protocol) and a breath-by-breath gas analyser were used to determine the following indices of aerobic capacity: maximal heart rate (HRmax), $\dot{V}O_2\text{max}$, oxygen pulse, lung ventilation, tidal volume, maximum speed.

Results: Players from the IHB group attained significantly ($p < 0.05 - 0.01$) lower values of oxygen pulse and maximum speed (by 12%), heart rate 1 min post-exercise (by 6%), lung ventilation (by 11%) and tidal volume (by 14%) compared with NHB group. IHB players had also twice lower weekly training volume. On the other hand, no significant between-group difference was found for the relative $\dot{V}O_2\text{max}$.

Conclusion: The lower results attained by handball players with impaired hearing compared with the healthy ones could be attributed to lower training volume per week. Thus, an increase in the training volume for the disabled players would be recommendable.

Key words: Spiroergometry – Maximal oxygen consumption – Disabled athletes – Handball

Introduction

Hearing disability is best defined as a lack or reduction in the ability to hear clearly due to disorders in the hearing mechanism. That disorder limits the functioning of disabled individuals in the community and, in addition, affects their engagement in motor activities [1,9]. Some studies revealed that the level of physical activities of children with hearing loss was significantly lower compared with their healthy mates [21]. Impaired hearing affects the development of balance as a consequence of damages in the vestibular apparatus and its connections with higher nervous structures [1,8]. Nonetheless, subjects with hearing impairment are very often engaged in sport activities, and participate in competitions at all levels, from local to ParaOlympic Games.

Handball represents a complex, intermittent team game which requires that players have high aerobic and anaerobic capacities [10,11]. Aerobic capacity is a generalised feature of all metabolic processes contributing to the global work capacity of an athlete [12]. Maximal

oxygen consumption ($\dot{V}O_2\text{max}$) has been commonly used as a criterion of aerobic capacity and used in physiological monitoring of athletes [5,9] and is considered the best index of aerobic capacity [1,7,10]. The $\dot{V}O_2\text{max}$ is defined as the highest attainable oxygen uptake for given form of ergometry irrespectively of further increases in the work rate and effort [13]. The data on a laboratory assessment of aerobic capacity are not numerous [14,17] and no reports on that issue were found with respect to handball players with hearing impairment. Thus, the aim of this study was to determine the aerobic capacity of handball players with hearing impairment and to compare them with healthy handball players.

Material and Methods

Subjects: Two groups of subjects took part in this study: healthy national handball players (NHB; $n = 15$) aged 18 – 33 years and international handball players with hearing impairment (IHB; $n = 13$), winners of European Deaf-Mute Championships in 2008 (Belgrade, Serbia)

and second place in Deaflympic games in 2009 (Taipei, Taiwan), aged 21 – 48 years. The NHB players trained two times a day, 15 h (11 sessions) per week in the last 4 years. The IHB subjects trained 5 times a week (3 sport-specific and 2 fitness trainings) for the last 5 years. Basic data of players and their training experience are presented in Table 1.

Medical histories of the hearing status of subjects from the IHB group were assessed from questionnaire interviews. All those subjects were afflicted by hearing loss exceeding 80 dB (deep deafness) either inherited ($n = 7$) or congenital ($n = 6$). Apart from that, upon a detailed medical examination they were found to have excellent health without cardiovascular, respiratory or other disorders. All subjects gave their informed consents to participate after having been informed about the study protocol and details, and were familiarised with the procedures. The study was approved by the local Ethics Committee.

Methodology: The athletes were subjected to procedures included in the Faculty of Sport and Physical Education1 (FSPE1) protocol: first, ventilatory and metabolic indices were measured at rest for one minute, then for another minute on a treadmill at a speed of 3 km/h; then, starting at 7 km/h, the workloads incremented progressively at a rate of 0.5 km/h every 30 s until exhaustion. The inclination was equal to 2% throughout the test. The test was considered completed when the oxygen uptake reached plateau, and the respiratory and ventilatory quotients reached reference values, the perceived state of each participant being monitored throughout the test. That latter was attained using a modified Borg's Scale (rating perceived exertion; RPE), ranging from 0 (extremely easy) to 13 (extremely hard – impossible to continue).

The following variables were recorded: maximal heart rate (HR_{max}), oxygen pulse ($\dot{V}O_2/HR$), HR at 12 km/h, HR in the 1st minute of recovery, maximal oxygen uptake ($\dot{V}O_{2max}$; ml/min), relative $\dot{V}O_{2max}$ (ml/min/kg), maximal exercise ventilation (VE), tidal volume (VT), speed at $\dot{V}O_{2max}$ (km/h), maximal speed attained in the test (Speed_{max}, km/h). Treadmill T-170 (COSMED, Italy) and a breath-by-breath gas analyser (CPET, Italy). The expiratory airflow was measured by gas turbine with a mask; oxygen and CO₂ were determined in expired air, the latter by infrared gauge. Before each test, the volume was calibrated by 5 inspiratory and expiratory strokes at different flows with a 3-l pump; the gas analyser was calibrated with two gas mixtures of known oxygen and CO₂ concentrations (20.9% O₂, 0.03% CO₂ and 16.0% O₂, 5.0% CO₂, respectively).

Data analysis: Student's *t*-test for independent data was used to assess the between-group differences. The level of $p \leq 0.05$ was considered significant.

Results

Mean values ($\pm$ SD) of basic somatic data and training experience of handball players are presented in Table 1 and the recorded functional variables in Table 2.

Table 1. Mean values ($\pm$ SD) of basic somatic variables determined in handball players with hearing impairment (IHB) and in healthy ones (NHB)

Variable	IHB ($n = 13$)	NHB ($n = 15$)
Age (years)	30.4 $\pm$ 9.1	26.2 $\pm$ 3.6
Body height (cm)	187.6 $\pm$ 7.5	188.8 $\pm$ 7.6
Body mass (kg)	87.1 $\pm$ 10.4	94.5 $\pm$ 10.7
Training experience (years)	13.1 $\pm$ 2.6*	10.3 $\pm$ 4.1

* Significantly ($p < 0.05$) different from the NHB group

Table 2. Mean values ($\pm$ SD) of functional variables determined in handball players with hearing impairment (IHB) and in healthy ones (NHB)

Variable	IHB ($n = 13$)	NHB ($n = 15$)
HR _{max} (bpm)	185.2 $\pm$ 12.6	189.7 $\pm$ 7.7
$\dot{V}O_2/HR$ (l/bpm)	22.1 $\pm$ 3.5*	25.0 $\pm$ 3.8
HR _{12 km/h} (bpm)	173.1 $\pm$ 12.3	167.5 $\pm$ 9.3
HR _{1st min recovery} (bpm)	166.1 $\pm$ 15.7*	177.3 $\pm$ 6.9
$\dot{V}O_{2max}$ (l/min)	4.03 $\pm$ 0.53*	4.55 $\pm$ 0.61
$\dot{V}O_{2max}$ (ml/min/kg)	46.8 $\pm$ 6.1	48.4 $\pm$ 3.2
$\dot{V}E$ (l/min)	150.3 $\pm$ 19.4*	168.3 $\pm$ 25.5
$\dot{V}T$ (l)	2.87 $\pm$ 0.57*	3.33 $\pm$ 0.61
Speed at $\dot{V}O_{2max}$ (km/h)	14.1 $\pm$ 0.9**	16.1 $\pm$ 0.9
Speed _{max} (km/h)	14.4 $\pm$ 1.1**	16.4 $\pm$ 0.9

Significantly different from the NHB group: * $p < 0.05$; ** $p < 0.01$

Handball players with impaired hearing did not differ significantly from the healthy ones in heart rate either maximal or at the speed of 12 km/h and in the relative $\dot{V}O_{2max}$. However, their heart rate at the 1st minute of recovery was significantly ($p < 0.05$) lower by about 6% than in their healthy mates. They attained also significantly lower values of oxygen pulse (by 12%), absolute $\dot{V}O_{2max}$, pulmonary ventilation (by 11%), tidal volume (by 14%; all $p < 0.05$), maximal speed and speed at $\dot{V}O_{2max}$ (by 12%; $p < 0.01$). It should be noted that the training volume of IHB subjects was much lower than that of their NHB mates (7.5 and 15 h per week, respectively).

Discussion

Handball represents a strenuous contact sport that requires both anaerobic and aerobic capacities. Although

anaerobic capacity is essential in handball, a high aerobic capacity can improve the rate of recovery during a game and to endure its intensity and duration [11,18]. In a competitive handball match, the heart rate usually ranges from 168 to 198 bpm [6] and may average 85% of peak HR throughout one-hour play and exceeds 80% of peak HR in about 70% of match time [15]. Both groups of subjects in this research had relatively high HRmax values recorded in the treadmill test until exhaustion. This suggests that handball activity appears to be appropriate for shaping and maintaining cardio-respiratory fitness. That latter was higher in the NHB players as reflected by their high oxygen pulse which is indicative of a high cardiac output and, thus, high oxygen supply to working muscles [19]. Lower values of aerobic capacity indices noted in players with impaired hearing, compared with their healthy mates, could be attributed to lower training loads (mainly training volume) of the former, despite their higher sport level (international vs. national leagues). On the other hand, IHB players seemed to have a more efficient adaptability to workloads as reflected by their faster decrease in HR one minute post-exercise compared with the NHB group.

The aerobic system contributes to the players ability to sustain maximal effort throughout the match and to recover faster during the short periods of lower intensity or rest [18]. The presented results suggest that NHB players had a higher aerobic potential compared to the IHB group, as reflected by pulmonary ventilation and tidal volume values, the key indices of the overall aerobic capacity. They also attained higher ($p < 0.01$) speed, either maximum or at $\dot{V}O_{2\max}$ which was most likely due to the running technique., represents Running economy is one of the important factors of success in handball, an intermittent activity sport [4,5], which requires from the athletes to execute short bursts of effort and then to be able to recover by getting oxygen back into the system.

Summing up, shaping aerobic, as well as anaerobic mechanisms is indispensable for a high performance in handball. The presented results for handball players with hearing impairment were, generally, lower than in the healthy ones which could be attributed to a lower training volume of the former. Yet, the impaired players showed a faster recovery of heart rate following maximal tests. Further research should be conducted to compare the hearing-impaired handball players with their mates practicing other sports or with the untrained ones. In addition, due to lower running economy of IHB subjects and considering its improvement it is necessary to modify the training protocol by adding it is necessary to improve basic technique by adding more technical sessions per week.

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Received 26.06.2010

Accepted 6.07.2010

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