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Chapter

Cardiorespiratory Fitness and Intellectual Disability

Vojtěch Grün, Marta Gimunová and Hana Válková

Abstract

This study discusses the heart rate (HR) in people with intellectual disability (ID) comparing the resting HR and HR after 2 minutes of exercise of athletes participating in Special Olympics (SO) in table tennis (TT) and cross-country (XC) skiing (XC skiing, 50 m, 1 km, and 3 km). The results showed a similar increase between the resting HR and HR after 2 minutes of exercise for TT players and XC skiers competing in 3 km race. Changes in HR in XC skiers competing in 50 m and 1 km races between the rest and exercise were noticeably higher indicating their lower fitness. Future studies focused on the relationship of HR variables, and training quality will provide a more detailed knowledge of the cardiorespiratory fitness and ID relationship.

Keywords: intellectual disability, cardiovascular fitness, cross-country skiing, table-tennis

1. Introduction

1.1 Intellectual disability

Approximately 200 million people, 1–3% of the global population, have an intellectual disability (ID) characterized by difficulties in learning and adapting to new environments. According to the American Association of Intellectual and Developmental Disabilities, ID is a condition characterized by IQ below 70–75 points, significant limitations in two or more adaptive areas such as communication or self-care, and manifests before the age of 18 [1].

Adults with ID are at increased risk of health decline associated with aging, low physical fitness, and related chronic diseases [2]. People with ID are not a homogeneous group as in many cases ID is not associated with a known biological etiology [3]. Some causes of ID happen before the delivery or soon after the birth due to genetic conditions, pregnancy complications, or toxic exposure, e.g., Down syndrome, fetal alcohol syndrome, fragile X syndrome, birth defects, and infections; other causes happen when the child is older, and these causes include severe head injuries, infections, or stroke [4].

In previous studies similar lifestyles were observed in persons with ID. Among the ID population, levels of smoking and regular alcohol intake are low compared to general population. Nevertheless, also the adherence to physical activity and healthy diet is poor [2, 5–8]. In sports, ID reduces the capacity to learn tactical concepts and to make correct decisions in constantly changing sport context. Besides, technical ability was found to be negatively

correlated with the level of ID as technical skills are dependent on cognitive processes such as information processing, visualization, and memory capacity [9]. Furthermore, the levels of physical activity among ID population are usually insufficient to achieve health benefits [3]. Previous studies on physical activity interventions show significant improvement in coronary heart disease risk factors after 12-week physical activity intervention [7], and the engagement in physical activity has been observed to improve also the social and general life competences needed for community inclusion [10, 11]. However, several barriers to engage physical activity such as lack of resources, limited options, or transportation constrain have been recognized [12].

2. Special Olympics

"Let me win. But if I cannot win, let me be brave in the attempt."
(Special Olympics Athletes Oath)

Special Olympics (SO), the world's largest sport organization for both children and adults with ID, included in word Olympic network, holds many sport events every year at both national and world levels and provides all year-round sport training for a continuous physical fitness development. SO offers more than 30 individual and team sports and gives people with ID a chance to discover new strength, abilities, skills, social inclusion, and success through sports [13].

The worldwide SO movement was started in the 1950s in the USA, when Eunice Kennedy Shriver held a summer day camp for young people with ID and recognized that through sports, people with ID can develop their mental and adaptive capacities. In 1968 the first SO competition was held, and the abilities of athletes with ID were highlighted instead of their disabilities to create the atmosphere for acceptance and inclusion for all people. Nowadays, SO includes 5 million athletes from more than 170 countries [14]. In the Czech Republic, approximately 3000 athletes participate in trainings and competitions within the Czech Special Olympics Movement. SO sport program includes athletes with ID below 75 IQ points, including athletes with Down syndrome, cerebral palsy, and perception impairment. Therefore, various sports or events with a differently demanding relation to sports are available, e.g., cross-country skiing 50 m or 3 km race, table tennis (TT), and bowling. Coaches or parents are responsible for appropriate choice of sport event according to the level of athlete executive functions, healthy status, athlete interest, and external environment. Coaches or parents are also responsible for regular training and motivation to compete with maximum effort and fair play behavior. The competitions are based on the principle of relativity, when athletes compete in groups depending on their actual abilities and limitations [15].

Additional programs of SO are oriented on families, independent behavior of the athletes, public awareness, education, research, and Healthy Athletes program including, e.g., FUNfitness, FitFeet, or Health Promotion screening [13, 16, 17]. Healthy Athletes program was started in 1997 and offers a free health screenings and healthy lifestyle education to SO athletes in a welcoming and fun environment including the area of podiatry, physical therapy, audiology, vision, dentistry, emotional well-being, sport physical exam, and better health and well-being. The aim of this program is to improve the access to health service for people with ID [18].

Benefits of physical activities for athletes with ID are similar to those for general population: (1) improved physical factors, e.g., aerobic capacity, gross motor function,

balance, and muscle strength; (2) improved psychological factors, e.g., self-concept, self-esteem, satisfaction, quality of life, and reduced aggression; and (3) improved social factors, e.g., social competence, popularity, and parent satisfaction [19].

3. Heart rate in people with ID

Heart rate (HR), expressed by a number of cardiac cycles per minute, is a commonly used indicator of intensity, cardiorespiratory fitness, and sympathetic activation in sports and exercise. The long-term endurance training should lead to a reduced resting HR [20]. Furthermore, individuals with Down syndrome exhibit reduced peak HR, and in severe and profound ID, HR can be used to assess the information about emotions as a lower HR in the first 6 seconds of stimulus presentation was observed when presenting a negative stimulus [21, 22].

3.1 Table tennis in SO

Table tennis is a complex and demanding game with many technical and tactical aspects. This game has specific requirements on attention, visual perception, executive functions, learning, and adaptation skills of the athlete [23, 24]. Eye-hand coordination and knowledge of tactics, e.g., appropriate stroke for the situation, are needed. Besides, top TT players study their opponents to attack their opponents' weakness to win [9, 24]. The aim in the TT in Special Olympics is to improve eye-hand coordination and quickness [13].

TT is characterized by short-term maximal efforts with passive resting intervals. The intensity during the game depends on the level and type of player (attacker-defender), gender, and age [25]. During the match in TT professional players, HR reaches the 90.3% of the players' maximal HR [26].

3.2 Cross-country skiing in SO

In SO cross-country skiing athletes with ID propel themselves across snow-covered terrain using skis and poles, and the distance differs from 50 m XC skiing race classical technique up to 10 km XC skiing race according to each athlete's skills [27]. Fifty and 100 m events are held on a flat terrain; 500 m to 10 km race respects the terrain plasticity (uphill, downhill, flat, and curves) [28].

During XC skiing HR values were described to depend on the terrain (uphill, downhill, flat section) [29], and during the race, the average HR of professional XC skiers is approximately 90% of the maximal HR [20].

4. Aim

The purpose of this study was to evaluate the difference between resting HR and HR after 2 minutes of exercise and to compare the cardiovascular fitness between table tennis players and in XC skiers with ID competing in 50 m, 1 km, and 3 km races.

5. Methods

Ten TT players (six males, 27 years of age; four females, 29.5 years of age; described in [30]) participated in the heart rate screening at the Czech National Table Tennis Tournament in 2015. Their pre-match HR was measured 1 minute before

		50 m XC skiing	1 km XC skiing	3 km XC skiing	TT
Male	n	11	20	8	6
	BMI	25.2	24.2	24.9	23.81
Female	n	5	8	2	4
	BMI	27.5	25.1	24.04	30.00

Table 1.
The number of female and male participants in each group and their BMI.

the match, and match HR was measured after 2 minutes of the play by sporttester Forerunner® 15, Garmin Ltd. Two matches of each participant were analyzed.

Fifty-four XC skiers (30.79 years of age; 15 females, 30.78 years of age; described in [15]) were measured during the Czech National Winter Games in 2015. Their resting HR was measured immediately before the exercise, and the exercise HR was measured after a 2-minute long step test by tonometer Omron M3.

The data collection was provided by the Healthy Athletes Clinical Directors and trained volunteers. All participants were in the spectrum of moderate levels of intellectual disability (below 70 points of IQ) and practiced the sports for at least 1 year as according to the Special Olympics rules participants of the national SO games have to pass minimum 1 year training before the competition. Their characteristics are shown in **Table 1**. The informed consent with Healthy Athletes noninvasive screenings is provided by athletes and their caregivers prior the sport events. The athletes with ID liked to participate in Healthy Athletes screening as the HR measurement was a new attraction for them.

6. Results

Resting HR, i.e., HR before the first and second match in TT (resting HR1 TT, resting HR2 TT) and before the step test in XC skiers, is shown in **Figure 1** and **Table 2**. As shown in **Figure 2**, the difference in resting HR between TT players and XC skiers competing at 1 km and 3 km race is slight. Only in the case of XC skiers competing in 50 m race, resting HR was noticeably lower than the other athletes. In

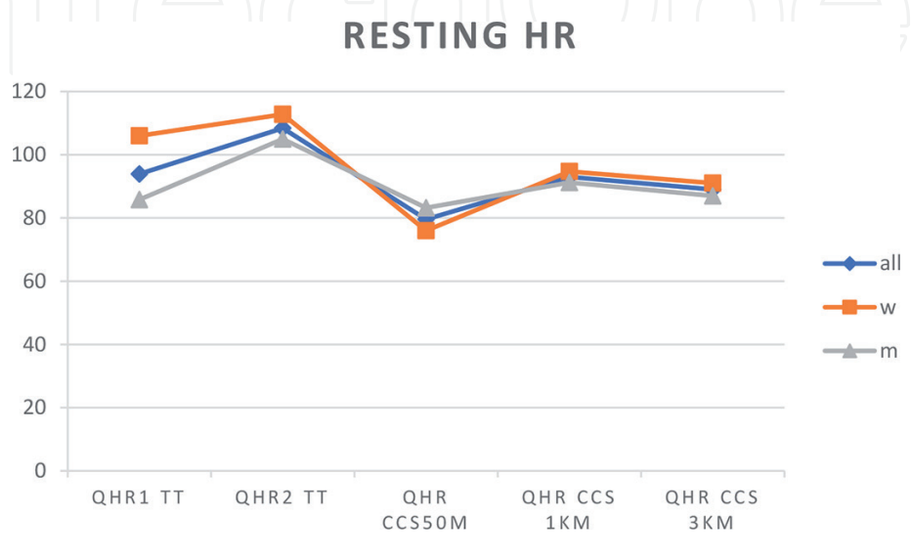

Figure 1.
The comparison of resting heart rate between XC skiers and the first and second match in TT players.

	Resting HR1 TT	Resting HR2 TT	Resting HR XC skiing (50 m)	Resting HR XC skiing (1 km)	Resting HR XC skiing (3 km)
Female + male	93.9	108.4	79.6	93.0	89.0
Female	106.0	112.8	76.0	94.7	91.0
Male	85.8	105.0	83.2	91.2	87.0

Table 2.
Resting HR in TT players and XC skiers.

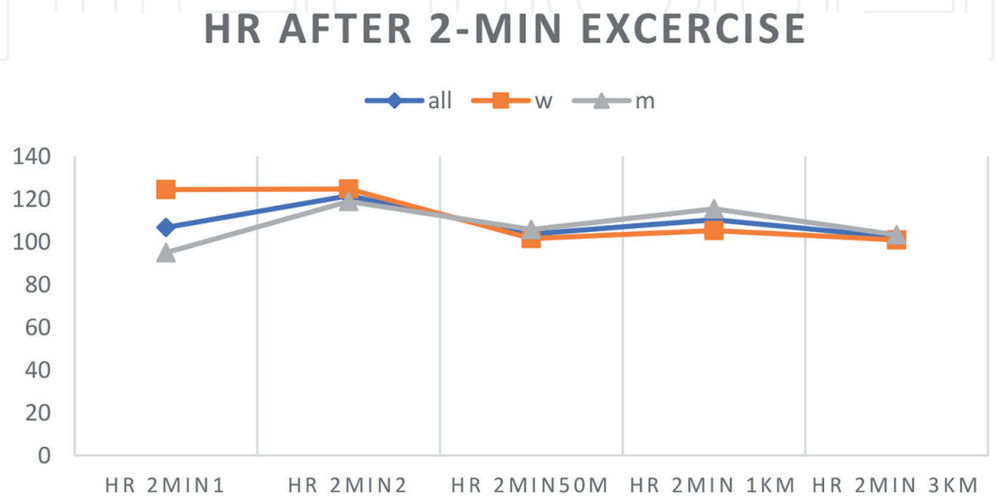

Figure 2.
The comparison of HR after 2 minutes of exercise between XC skiers and the first and second match in TT players.

	HR 2 min1	HR 2 min2	HR 2 min (50 m)	HR 2 min (1 km)	HR 2 min (3 km)
Female + male	106.8	121.6	103.7	110.4	102.2
Female	124.5	124.8	101.6	105.3	101.0
Male	95.0	119.0	105.8	115.5	103.3

Table 3.
HR after 2 minute of exercise in TT players and XC skiers.

the gender comparison, female participants had on average a higher HR than males, with the exception of XC skiers competing in 50 m race.

When comparing HR after 2 minutes of exercise, the values are similar for all sport groups. An interesting finding for HR after 2 minutes of exercise was observed in male TT players whose HR after 2 minutes of exercise differed noticeably between the first and second analyzed match, the difference consisted of 26 beats per minute. In female TT players, no difference in the HR after 2 minutes of exercise was observed between the matches. Additionally, in TT a significant difference between female and male players in HR after 2 minutes of exercise was observed, whereas XC skiers had HR very similar in both men and women depending on the distance they specialized. The values and differences are shown in **Table 3** and **Figure 2**.

The difference between the resting HR and HR after a 2-minute exercise was the most distinctive in XC skiers competing in 50 m race, for both men (23.6 beats per

	Dif TT1	Dif TT2	Dif Cross-country skiing (50 m)	Dif Cross-country skiing (1 km)	Dif Cross-country skiing (3 km)
Female + male	12.9	13.1	23.1	17.4	13.2
Female	18.5	12.0	25.6	10.6	10.0
Male	9.2	14.0	23.6	24.3	16.3

Table 4.
The average difference between the resting HR and HR after 2 minutes of exercise.

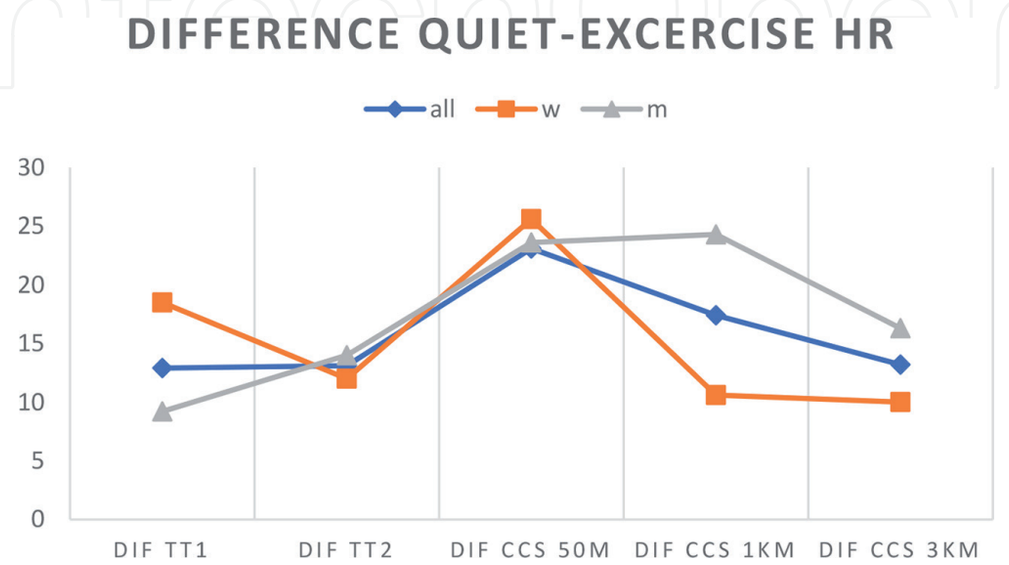

Figure 3.
The average difference between the resting HR and HR after 2 minutes of exercise in male and female TT players and XC skiers.

minute) and women (25.6 beats per minute). Nevertheless, also in male 1 km XC skiers, HR increased by more than 20 beats per minute (24.3) on average. Greater increase in HR after exercise may indicate a lower aerobic fitness in aforementioned athletes. The difference between the resting HR and HR after 2 minutes of exercise is shown in **Table 4** and **Figure 3**.

7. Discussion

This study discusses the HR in people with ID comparing the resting HR and HR after 2 minutes of exercise of athletes participating in SO in two different sports. Table tennis and cross-country skiing at different distances (50 m, 1 km, and 3 km) were compared. Results of this study show increase in HR after 2 minutes of exercise in all compared groups. Furthermore, resting HR was increased before the second match in TT player compared to resting HR before the first match, probably associated with fatigue from the previous match or with the prestart condition and their prestart readiness during the tournament. However, future studies are needed to evaluate the prestart conditions in athletes with ID.

The heart rate changes with every heartbeat and its increase may be observed in a stressful situation. As a stressful situation, we can consider mental and physical strain or fatigue. In case of athletes, physical exercise is associated with psychological pressure, and HR therefore may vary considerably in each individual. This applies both to healthy people and to people with ID. Sperlich et al. focused

on monitoring metabolic and cardiorespiratory parameters during training and matches of adolescent elite table tennis players, and their results showed that the average HR during the match is approximately 126 beats per minute [31]. Compared with our measured results, elite adolescent TT players have an average HR higher than TT players competing in SO (107 beats per minute). In elite adult TT players during national and international tournaments, the HR reaches 164 beats per minute [32], differing greatly from values observed in our study in athletes with ID whose TT skills are limited.

If we compare the difference between the resting HR and HR after 2 minutes of exercise, the results show a similar increase for TT players and XC skiers competing in 3 km race. Changes in HR in XC skiers competing in 50 m and 1 km races between the rest and exercise were noticeably higher. This observation may be caused by the fact that athletes with a severe mental handicap compete in shorter distances, whereas both TT and 3 km race require advanced cognitive skills to manage the required technique (up and down terrain in XC skiing, eye-hand-ball coordination in TT) and maintain the intrinsic motivation for a longer time. Additional aspect may be the training—better trained individuals shows lower HR during the submaximal load; however the training of athletes with severe ID, who compete in shorter XC skiing distances, may not create a sufficient training load as the lower level of fitness performance was observed in athletes competing in short XC skiing distances in the previous study [15].

At the same time, people with mental disabilities are more likely to be overweight or obese compared to the general population [33, 34]. Also, in our participants, BMI of female skiers competing in 50 m and 1 km race indicates the overweight; in TT players the BMI shows class I obesity. In males, the overweight was observed in XC skiers competing in 50 m race. Female sex was observed to be a risk factor for obesity in both general population and in population with ID also in previous studies [5, 35–37].

8. Conclusion

This study discusses the HR in people with ID comparing the resting HR and HR after 2 minutes of exercise of athletes participating in SO in table tennis and cross-country skiing (50 m, 1 km, and 3 km). The results showed a similar increase between the resting HR and HR after 2 minutes of exercise for TT players and XC skiers competing in 3 km race. Changes in HR and in XC skiers competing in 50 m and 1 km races between the rest and exercise were noticeably higher indicating their lower fitness. Additionally, the high prevalence of overweight and obesity highlights the need for healthy lifestyle education in athletes with ID, especially in 50 m XC skiers. Despite the limitation of this study consisting of a small number of participants, the results highlight the coach's responsibility to select appropriate event according to the athlete's abilities and limits, but a more demanding training should be necessary. Future studies focused on the relationship of HR variables and training quality will provide a more detailed knowledge of the cardiorespiratory fitness and ID relationship.

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