Article

Differences in Special Olympics athletes and non-athletes with intellectual disability: Physical activity, strength and aerobic fitness

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Abstract: Adults with intellectual disability (ID) have higher degree of sedentary lifestyle and participate less in physical activity (PA) compared to the general population. The aim of this cross-sectional study was to analyse differences in the level of PA and the fitness level, i.e., body mass index (BMI), muscular strength and aerobic fitness, among people with ID based on participation in the Special Olympics. Data were analysed from the Special Olympics Sweden Invitational Games 2020, on athletes (n=38) and non-athletes with ID (n=20) on strength (partial sit-up, seated push-up, handgrip and timed sit to stand test), aerobic fitness (2 min step test), BMI, and a PA questionnaire. Athletes showed higher levels of moderate intensity PA, both groups had high BMI, low levels of aerobic fitness and strength. From this study, Special Olympics athletes and non-athletes with ID need to increase their PA consisting of both strength training and high intensity PA to improve physical health aspects.

Keywords: Disability sports; Healthy Athletes; health promotion; FUNfitness; physical health

Introduction

Approximately 2% of the world's population has an intellectual disability (ID) (Krahn et al., 2006). ID is defined as having an IQ below 70 and having problems with at least two adaptive abilities such as taking care of personal hygiene or finances (Holder, 2015). Adults with ID have a higher degree of sedentary lifestyle and participate in less physical activity (PA) compared to the general population (Rintala et al., 2016).

The World Health Organization (WHO) has updated their PA guidelines in 2020 and also provided guidelines for people with disabilities. The guidelines outline, adults with disabilities should do 150-300 minutes moderate intensity PA (e.g., a walk where heart rate increases) or 75-150 minutes high intensity PA (e.g., running where the heart rate increases markedly) throughout the week (Carty et al., 2021; World Health Organization, 2020). The WHO guidelines also recommend that all adults with a disability should perform strength training (ST) twice per week (World Health Organization, 2020). Earlier studies have shown that people with ID do not reach the recommended 150 minutes moderate PA per week (Hilgenkamp et al., 2012; Oviedo et al., 2017). A sedentary lifestyle leads to health problems such as overweight, obesity, high cholesterol, high blood pressure and cardiovascular diseases, and people with ID have these health problems to a greater extent than the general population (Bodde & Seo, 2009; Rintala et al., 2016).

Researchers have shown that people with ID have been excluded from participating in sports activities and do not have the same equal opportunities to participate in sports to people without ID (Hassan et al., 2012; Pack et al., 2017). People with ID who participate in sports have better physical health compared to people with ID who do not (Darcy & Dowse, 2013; Robertson & Emerson, 2010). The Special Olympics is one of the world's largest international sports organisations and offers year-round sports activities for children, youth and adults with ID (Lloyd et al., 2018). The Special Olympics' mission is for people with ID to be, and feel included within the society, and one way to achieve this is through sport participation. They want to develop and promote PA to show that it provides a better physical health and well-being (Special Olympics, 2020a). The World Games is organised by Special Olympics every two years, where it alternates between summer and winter games. Some examples of sports at the summer games are bowling, football, handball, horseback riding and swimming. The sports organised in the winter games are floorball, snowshoeing, cross-country skiing, figure skating, alpine skiing, short track speed skating and snowboarding. To be allowed to participate and to be selected to the Special Olympics World Games, it is required that the participant has an ID and is part of a sports association (Parasport, 2021).

In 1997, the Special Olympics introduced the Healthy Athletes program, which is a free health screening offered for all participants in Special Olympics. It covers eight different disciplines performed by trained health professionals (Lloyd et al., 2018). The eight different disciplines are Opening Eyes (vision), FUNfitness (physical therapy), Healthy Hearing (audiology), Health Promotion (healthy lifestyles), Strong Minds (psychology), Special Smiles (dentistry), Medfest (history and physical exam), and FitFeet (podiatry) (Lloyd et al., 2018; Special Olympics, 2020a). Healthy Athletes have arisen from observations that people with ID do not receive the health care they need because of their difficulties, e.g., communication, diagnostic overshadowing, discrimination, ignorance or indifference. One reason that people with ID suffer more from medical problems than people without ID is due to the lacking health care (Folch-Mas et al., 2017; Holder, 2015). This also leads to people with ID have significantly shorter life expectancy and a three times higher mortality rate compared to people without ID (Folch-Mas et al., 2017).

The Healthy Athletes disciplines of FUNfitness and Health Promotion are developed by Special Olympics to evaluate strength, mobility, balance, aerobic fitness, and to promote a healthy lifestyle. The purpose of Healthy Athletes program is also to help the participants to gain understanding of their own physical health and assist them in how to improve their well-being. Several studies have shown that there are social and mental benefits for people with ID when participating in sports (Harada et al., 2011; Svanelöv et al., 2020). To the authors' knowledge, there have been two studies exploring the association between participation in sports for people with ID (Rintala et al., 2016) and for people with Down syndrome (Guerra-Balic et al., 2000) with physical health aspects such as body mass index (BMI), muscular strength and aerobic fitness. However, these studies did not include detailed information of the participants level of PA or indicated how long-term exercise training may enhance the fitness-level. Therefore, the aim of this study was to analyse differences in levels of PA and fitness levels i.e., BMI, muscular strength and aerobic fitness among people with ID, based on participation in Special Olympics.

The specific research questions were as following:

1. Is the level of PA different for athletes who participate in Special Olympics Sweden Invitational Games than non-athletes?
2. Do athletes who participate in Special Olympics Sweden Invitational Games have different BMI, muscular strength and aerobic fitness than non-athletes with ID?
3. According to the testing guidelines, how many of the athletes compared to the non-athletes are given education after the tests (i.e. the percentage which are considered to be below the cuf-off limit and in risk for bad health)?

Materials and Methods

Study overview

This is a quantitative, comparative cross-sectional study design. The data used in this study were collected during the Healthy Athletes screening at the Special Olympics Sweden Invitational Games in February 2020. This study was approved by the Swedish Ethical Review Authority (Dnr 2020-02118). After a request, procedure data from the disciplines of Health Promotion and FUNfitness were provided to the authors by Special Olympics International (Special Olympics, 2020a).

The data included in total 192 participants (127 athletes and 65 non-athletes) who had participated in the measurements of the FUNfitness and Health Promotion disciplines. All athletes who participated in the competitions had received information about the Healthy Athletes when entering the competitions. Also, the information about the measurements on Healthy Athletes was sent as a text document to people with ID living in communal group living settings (later called non-athletes) in two municipalities in the middle of Sweden. The staff at the communal group living setting informed the non-athletes verbally and by text about the Healthy Athletes program. Both athletes and non-athletes signed an informed consent form and agreed that the data would be allowed to be used in research. Furthermore, the participants were told they could withdraw their data at any time.

The datafile included the results of physical capacity from both athletes and non-athletes. Data from the Health Promotion discipline included height and weight and from the FUNfitness discipline, included one test of aerobic fitness, four tests of muscular strength and three questions of training levels of low PA (LPA), moderate PA (MPA) and muscular strength. Participants were assisted by staff, family, or coaches to interpret the questions if it was needed. All tests were considered as reliable and valid and have been used for about 20 years in Healthy Athletes (Burnstein et al., 2011; Van Biesen & Pineda, 2019).

Participants

Inclusion criteria

All athletes and non-athletes had ID, as defined as having an intelligence quotient (IQ) of less than 70. To compare groups (athletes vs non-athletes) with similar age and sex, these inclusion criteria were used, 1. Data from all four strength tests (described later) and the aerobic fitness test on FUNfitness were available, 2. Data of height and weight in Health Promotion were available, 3. Participant age between 20-50 years old, 4. Not using wheelchair.

Based on the above criteria, 38 athletes and 20 non-athletes were selected from the database for this study. The athletes represented Sweden (71%) and other countries. The non-athletes were from Sweden. Descriptive data are presented in Table 1.

Trained clinical professionals

The volunteering trained clinical professionals who performed the tests in the FUNfitness and Health Promotion disciplines were physiotherapists, sports scientists, assistant nurses, nurses, dietitians, or physiotherapists and sports science students. All trained clinical professionals had received information and videos about the tests one month before the screening and participated in a digital education about persons with ID and the Special Olympics. The day before the screening, all the trained clinical professionals received training on all the tests from the clinical directors (person who is responsible for ensuring that the measurements are correct and that they comply with the Special Olympics standard set) (Holder, 2015) for FUNfitness and Health Promotion.

Table 1. Descriptive data, age (years), height (m) and weight (kg) for the two groups (athletes vs non-athletes) and divided by sex in means and standard deviation (SD).

	Athletes (n = 38)		Non-athletes (n = 20)		p-value
All	Mean	SD	Mean	SD	
Age	30.8	8.6	31.7	6.5	.372
Height	1.73	0.11	1.69	0.12	.152
Weight	76.1	17.0	89.0	20.9	.014
Men	(n = 28)		(n = 9)		
Age	31.4	9.1	34.3	8.1	.329
Height	1.75	0.1	1.74	0.1	.789
Weight	77.6	14.8	96.2	16.6	.003
Women	(n = 10)		(n = 11)		
Age	29.3	7.0	29.5	4.1	.922
Height	1.67	0.7	1.64	0.9	.448
Weight	72.0	22.5	83.1	22.9	.205

The athletes did not perform any familiarization session prior to the tests. The trained clinical professionals demonstrated and explained the tests before the participants performed them.

BMI

Height and weight was measured of all participants and this was used to obtain their BMI. The formula for BMI is weight in kilograms divided by height in meters squared. Special Olympics uses the WHO BMI classification for adults where healthy weight is 18.5-24.9, overweight is ≥ 25 and obesity is ≥ 30 (Special Olympics, 2020b).

Muscular strength

Strength training levels

The FUNfitness muscular strength measurements included four tests: handgrip, timed sit to stand, partial sit-up and seated push-up. In connection with the strength tests, the participants also answered one question regarding their muscle strength, “On average, how many days a week do you do physical activities for muscle strength?”

Education

On each strength test there were guidelines for acceptable values (a cut-off value for achieving health benefits) and if a participant fell outside these guidelines, they were recommended education. This meant that they either received an exercise program with customized exercises, or that they were recommended to contact a health care specialist (for example a physiotherapist) to improve this area due to health aspects. For each strength test below, the limit for education (i.e., accepted values) was set according to the Healthy Athletes FUNfitness manual.

Handgrip test

This test is a method to evaluate the maximal strength of the forearm, the hand, and an overall marker for body strength (Bohannon et al., 2012). The test includes participants completing three maximal hand grip contractions with each hand (alternates between right and left hand) with a handgrip dynamometer and recording the highest value. The participants were instructed to sit up straight in a chair, keeping the arm and hand at the side of the trunk with the elbow bent to 90 degrees while squeezing the hand as hard as possible for six seconds (Elmahgoub et al., 2009; Graham & Reid, 2000; Kim et al., 2018). The highest value of the dominant hand was noted and compared with the standardized 10th percentile norm for age and sex (Special Olympics, 2020c). If the result was below the 10th percentile, education was recommended.

Partial sit-up test

The partial sit-up test is a method to evaluate abdominal muscle strength and endurance. The participant was lying in a supine position on a mat on the floor. The legs were flexed 90 degrees in hips and 90 degrees in knees and feet were placed on an adjustable chair. The arms were placed straight out from the chest with the elbows fully extended. The partial sit-up was defined as sitting up until the base of the scapula clears the floor and then go back to the starting laying position (Terblanche & Boer, 2013). Participants were asked to do as many sit-ups as they could within one minute. If the participants were unable to do 25 sit-ups within one minute, they were recommended education.

Seated push-up test

The seated push-up test is a method to evaluate upper body strength (triceps, shoulder and scapula). The participants were placed in a seated position on a mat on the floor with legs outstretched. With the help of holding on push-up blocks, the participants pushed their body up from the sitting position from the floor until the elbows are straight and hold statically (maximal 20 seconds), then slowly lower back into the floor (Van Biesen & Pineda, 2019). If participants were unable to hold at least 5 seconds twice, they were recommended education.

Timed sit to stand test

The timed sit to stand test is a method to measure functional lower extremity muscle strength. This test requires the participants to complete 10 full stands from a seated position as fast as possible without use of the arms. In the sitting position the participants have their hips and knees at 90 degrees flexion. The participants were instructed to have the arms by the side of the body with the elbows flexed 90 degrees the entire test (Boer, 2018; Terblanche & Boer, 2013). If participants were unable to do 10 stands or the time was greater than 20 seconds, they were recommended education.

Aerobic fitness

Questionnaire PA levels

In addition to the aerobic tests, the participants also answered a questionnaire including two questions regarding their PA levels. Question 1 was, “On average, how many days each week do you do some physical activity (LPA; everyday exercise is an activity, such as walking where you do not get sweaty)?”. Question 2 was, “On average, how many days a week is your physical activity at a moderate level (MPA; working hard enough to make the heart-beat faster and possibly begin to sweat)?”

2-min step test

The 2-min step test is a submaximal test to assess aerobic fitness (Burnstein et al., 2011). Participants started by sitting on a chair and the pre-exercise heart rate and oxygen saturation was measured on the fingertip with a pulse oximeter. Before the test started, the participants were placed standing next to a wall, and a minimum stepping height was measured and marked on the wall with a tape. The minimum stepping height was the midway point between the iliac crest on the hip and mid-patella on the knee. Participants were instructed to lift each knee up to the tape marker and were encouraged to take as many steps as they could in two minutes. Participants were informed to always have one foot on the floor while marching on the spot and performing the test. Immediately after the test, the participants sat down on the chair and post-exercise HR was measured. Two minutes after the end of the test, the heart rate was measured again. Based on the volunteers’ professional knowledge, as well as criteria from the FUNfitness manual (Special Olympic, 2020b) and assessment of the participants' performance of the test, it was determined whether the participants were recommended education or not.

The criteria from the manual are illustrated in Figure 1. If the participants were recommended education, they were either given an exercise program on how to improve their aerobic fitness, or that they were recommended to contact a health care specialist (for example a physiotherapist) to improve this area due to health aspects.

If oxygen saturation was between 94-90% during the test or greater than 95 % before the test, and the participant showed signs or symptoms of respiratory distress or hypoxemia, the test would be discontinued.

Statistical analysis

All descriptive data are presented as means (standard deviation). Data were analysed using IBM SPSS Statistics, version 27.0 (IBM Corp., Armonk, N.Y., USA) and normal distribution was checked using the Shapiro–Wilk test. Timed sit to stand test, partial sit-up test, seated push-up test, LPA and MPA were analysed using a Mann-Whitney U test to investigate the differences between groups, and stratified by sex. BMI and strength tests were analysed using the Mann- Whitney U test to investigate any differences between groups and BMI on females and strength tests on males to investigate differences between groups divided by sex. Handgrip test was analysed using an independent student t-test to investigate any differences between groups and groups divided by sex. Strength tests on females and BMI on males were also analysed using an independent student t-test to investigate any differences between groups divided by sex. The effect size for the Mann-Whitney U-test was carried out by reporting the R effect size (R) (i.e., Tomczak & Tomczak, 2014) and for the student t-test the Hedges´g (*g*) was reported. The effect sizes were interpreted as small (0.2), medium (0.5) and large (0.8; Lakens, 2013). The statistical significance level was set at $p < .05$.

Results

The test performance of muscular strength, aerobic fitness and PA levels are presented in Table 2 divided into athletes, non-athletes, and by sex. The results also show the percentage of participants that were recommended education.

Levels of training PA and strength training

Athletes were significantly more physically active in MPA per week than non-athletes ($U = 98.5$, $p < .001$, $R = 0.37$) while there was no difference between the groups regarding strength training and LPA ($U = 372.5$, $U = 368$, $p = .899$, $p = .838$, $g < 0.001$). These results were the similar for males and females.

Body Mass Index

BMI for athletes was 25.3 (SD = 4.5) and for non-athletes 31.3 (SD = 6.6). The athletes had lower BMI than the non-athletes ($p < .001$, $g = 0.22$). The division of normal weight to overweight to obese (as indicated ratios, respectively) was that there were fewer people with obesity for the athletes 58%:31%:11% compared to non-athletes 15%:30%:55%. The male athletes had lower BMI than non-athletes ($p < .001$, $g = -1.72$), whereas there was no difference between the female athletes and non-athletes ($U = 30$, $p = .078$, $R = 0.15$).

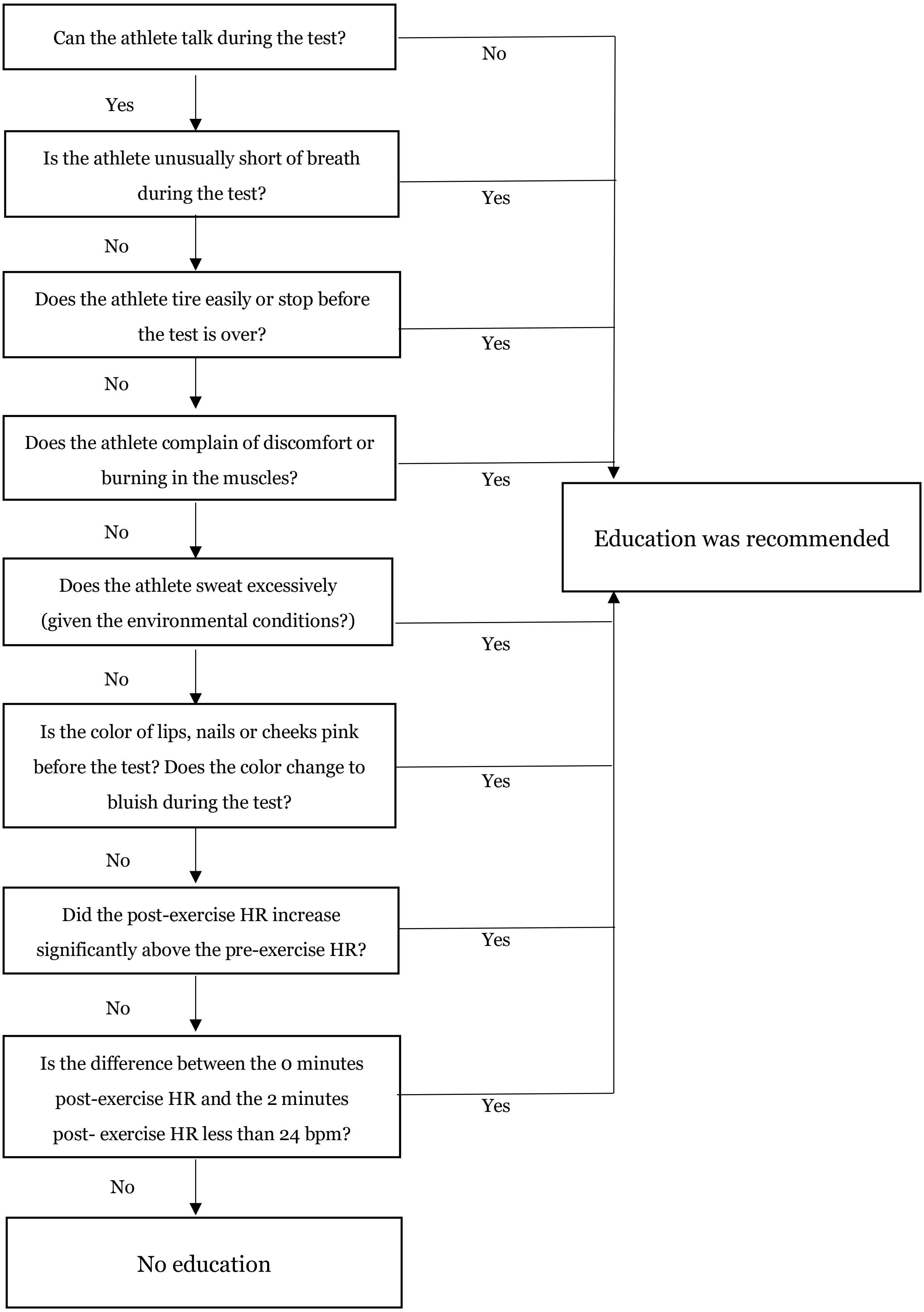

Figure 1. Education criteria for the 2-min step test.

Table 2. Mean and SD of the test performance of participants and stratified by sex.

	Athletes		Non-athletes				
All (n = 38 vs n = 20)	Mean	SD	Mean	SD	U –value	p-value	Effect size
Body mass (BMI)	25.3	4.5	31.3	6.6	164	< .001	0.22
Level of training							
ST	1.5	1.4	1.4	1.0	372.5	.899	< 0.001
PA low	5.1	2.0	4.9	2.4	368	.838	< 0.001
PA moderate	3.5	1.8	1.1	1.2	98.5	< .001	0.37
Strength tests							
Timed sit to stand test	18.6	3.0	25.0	7.6	162	< .001	0.22
Timed sit to stand test education	13	-	55	-	-	-	-
Partial sit-up test	23.2	4.1	21.3	4.1	296	.105	0.05
Partial sit-up test education	21	-	40	-	-	-	-
Seated push-up test	17.8	4.6	15.3	6.3	279	.051	0.07
Seated push-up test education	5	-	15	-	-	-	-
Handgrip	34.4	9.5	30.6	8.9	-	.144	0.40
Handgrip education	39	-	40	-	-	-	-
Aerobic fitness							
2 min step test education	39	-	55	-	-	-	-
Men	(n = 28)		(n = 9)				
Body mass (BMI)	25.2	3.6	31.8	4.3	-	< .001	1.72
Level of training							
ST	1.4	1.5	1.3	0.9	121	.854	< 0.001
PA low	5.1	2.3	5.2	2.8	121	.848	< 0.001
PA moderate	3.1	1.7	0.9	0.8	22	< .001	0.35
Strength tests							
Timed sit to stand test	19.4	2.9	24.3	5.1	47	.005	0.21
Timed sit to stand test education	18	-	56	-	-	-	-
Partial sit-up test	22.7	4.7	22.3	7.1	94.5	.191	0.05
Partial sit-up test education	25	-	33	-	-	-	-
Seated push-up test	18.0	4.6	17.6	5.8	120.5	.810	0.002
Seated push-up test education	7	-	0	-	-	-	-
Handgrip	36.6	9.9	35.7	9.6	-	.798	0.10
Handgrip education	54	-	56	-	-	-	-
Aerobic fitness							
2 min step test education	46	-	56	-	-	-	-
Women	(n = 10)		(n = 11)				
Body mass (BMI)	25.6	6.8	30.9	8.2	30	.078	0.15
Level of training							
ST	1.5	1.3	1.4	1.1	-	.796	0.11
PA low	4.8	1.6	4.6	2.3	53.5	.913	< 0.001
PA moderate	4.6	2.0	1.3	1.4	9	.001	0.52
Strength tests							
Timed sit to stand test	16.2	1.8	25.4	9.4	16	.006	0.36
Timed sit to stand test education	0	-	55	-	-	-	-
Partial sit-up test	24.5	1.6	22.0	6.3	39.5	.193	0.08
Partial sit-up test education	10	-	45	-	-	-	-
Seated push-up test	18.0	4.8	13.5	6.3	30	.050	0.18
Seated push-up test education	0	-	27	-	-	-	-
Handgrip	28.2	4.6	26.5	5.8	-	.458	0.32
Handgrip education	0	-	27	27	-	-	-
Aerobic fitness							
2 min step test education	20	-	55	55	-	-	-

Note: BMI = body mass index. ST = strength training days/week. PA low = Physical activity low intensity, days/week with exercise where you do not get sweaty e.g. walking. PA moderate = Physical activity moderate intensity, days/week with exercise which make the heart beat faster and possibly begin to sweat. Timed sit to stand test and seated push up test is presented in seconds, handgrip in kg and partial sit-up test in number of repetitions. Education on each test is presented in percentage.

Muscular strength tests

From the muscular strength tests, the athletes performed better in timed sit to stand test (U = 162, p <.001, R = 0.22), whereas there were no difference in handgrip, partial sit-up and seated push-up tests between athletes and non-athletes (U = 296, 279, p=.144, .105, .051, R < 0.05, 0.07 and *g* = 0.40, respectively). After stratifying by females and males, there was a difference in the timed sit to stand test, whereas athletes performed better for both females and males (U = 16, 47, p=.006, .005, R = 0.36 and 0.21, respectively). For the handgrip, partial sit-up and seated push-up tests there were no statistical difference between the athletes and non-athletes for neither females nor males.

The recommendation of education of strength tests was made more often for non-athletes than for athletes because of the results of the timed sit to stand test and the partial sit-up test. The test results of handgrip showed equally high levels of recommendation of education for athletes and non-athletes, 39% and 40% respectively. In three out of four strength tests (timed sit to stand test, handgrip, and seated push-up), no female athlete was recommended education (Table 2).

Aerobic fitness test

From the results of the aerobic fitness test, 39% of the athletes and 55% of the non-athletes were recommended education. Among females, 20% of the athletes and 55% of the non-athletes were recommenced education, whereas for males 46% and 56% were given education, athletes and non-athletes respectively.

The aim of this study was to investigate differences in levels of PA and fitness levels i.e., BMI and muscular strength among people with ID based on participation in Special Olympics. The main findings are that athletes, compared to non-athletes, reported higher levels of MPA but similar levels of LPA and strength training. The athletes had lower BMI, slightly better aerobic fitness (i.e., fewer athletes were recommended education) and slightly better strength (better results in sit-to-stand test and similar results in partial sit up test, seated push up test and handgrip test, and less percentage were recommended education). There was also no sex difference in both athletes and non-athletes of PA and timed sit to stand test, whereas, for BMI there was a larger part of the males compared to the females that were recommended education.

The athletes stated in the questionnaire that they trained more days with MPA than the non-athletes did, whereas both groups stated equivalent training levels on LPA. The major health benefits with training more high-intensity training are improved aerobic fitness, increased metabolism, and better muscular strength (Elmahgoub et al., 2011). It is hard to compare the results of the questionnaire with the WHO recommendations for levels of PA, due to the lack of information about the duration of training per day. However, 39% of the athletes and 55% of the non-athletes were recommended education in aerobic fitness, which indicates that the PA level of aerobic exercise needs to be enhanced for both groups in order to achieve health benefits. Regarding the strength training, the reported amount of training was similar for athletes and non-athletes respectively. This is just slightly below the recommendation from WHO of 2 days/week, the strength tests, the only significant difference was observed in the timed sit to stand test, with better results for athletes. This strength test was the only one in this test battery that included a lift of the own-body weight, and because the BMI of the athletes were lower the strength capacity might therefore be similar between the groups. However, still many athletes and non-athletes were recommended education of strength activities and this indicated a need of more PA including strength components. Of course, the reliability of the PA questionnaire can also be questioned due to the participants' impairment of cognition and the self-report nature of the questionnaire and that it has not been validated. With that in mind, the results of this questionnaire indicated that participation in sports as Special Olympics activity may increase PA levels of moderate intensity but do not change ST and PA low levels in general.

Considering BMI, the athletes were on average, considered overweight, and the non-athletes had an average that is considered obese (Special Olympics, 2020b). Obesity is a chronic disease that means that the risk of developing diseases such as high blood pressure or type 2 diabetes is increased. Overweight is not a disease but means that the weight is unhealthily high and can develop into obesity (Must et al., 1999). This is in line with results of previous studies that both Special Olympics athletes and non-athletes suffer from a high degree of overweight and obesity (Foley et al., 2013; Rintala et al., 2016; Walsh et al., 2018). BMI has been proven to be a key indicator of health for people with ID because BMI is a significant predictor of cardiovascular diseases and type 2 diabetes (Foley et al., 2013). It is positive that the athletes had lower BMI than the non-athletes, which could indicate that their MPA training have given results. However, the problem of overweight and obesity for people with ID is a complex matter including social and psychological determinants to promote PA and a healthy diet (Doherty et al., 2018). Nevertheless, the current study indicates that the weight would need to decrease further for both athletes and non-athletes to be defined as a healthy weight according to definitions of WHO. However, BMI as a method has limitations because it does not distinguish if the high body mass is due to large muscle mass or fat mass (Gómez-Ambrosi et al., 2012). Therefore, the higher BMI for the athletes could indicate larger muscle mass than non-athletes. However, the strength test did not differ between the athletes and non-athletes, which thereby indicates a similar amount of muscle mass and hence the higher BMI for non-athletes are probably due to a larger fat mass.

From the results of the aerobic fitness test, the 2-min step test, many of the participants, both athletes and non-athletes. There was a common occurrence of need for education, particularly among non-athletes. After disaggregating by sex, fewer female athletes were recommended need for education. There is no information about the history of training in the current study, some athletes might recently have started to participate in organised sports and therefore the aerobic fitness might be generally higher than others. In the study of Guerra-Balic et al. (2000), the training history was documented for over a year among participants with Down syndrome and that study also showed higher level of aerobic fitness for the athletes compared to non-athletes. Therefore, the intensity, duration per week and duration over longer period of time should be considered to improve aerobic fitness.

The 2-min step test as the aerobic test has good reliability for people without disability (Bennett et al., 2016). However, people with ID have difficulties to pace themselves (Van Biesen et al., 2017) and the 2-min step test requires the participant is able to adopt a self-paced submaximal frequency of the knee raising, and therefore the reliability of the test might be lower. Special Olympics has ongoing work to evaluate and develop the tests of aerobic fitness and the criteria for education. Anyhow, the result of the current study gives an alert that both Special Olympics athletes and non-athletes have low aerobic fitness which means that they are at higher risk of developing cardiovascular disease, obesity, high blood pressure, the inability to manage one's daily life, and in worst case premature death (Graham & Reid, 2000).

The timed sit to stand test have shown a high validity and reliability to measure leg strength (Newcomer et al., 1993). It has also been reported that the performance of this test is affected by the balance capacity (Lord et al., 2002). Poor balance capacity among people with ID is a well-known problem and about 50% of all medical injuries have been reported to consist of fall accidents for people with ID (Hsieh et al., 2001). From our study, athletes performed better than non-athletes, and most non-athletes were recommended education.

Because these non-athletes are showed a combination of poor leg strength and balance, they are in risk for fall injuries, lower quality of life and premature death (Chiba et al., 2009).

Handgrip tests have high reliability and validity in various populations (Cuesta-Vargas & Hilgenkamp, 2015). Grip strength is a good method for evaluating physical health, predicting individuals with sarcopenia and a predictor of premature mortality (Cuesta-Vargas & Hilgenkamp, 2015). Low handgrip strength among people with ID has been observed in previous studies, with reports of participants as early as 20-30 years old. If individuals do not build up their muscle mass during early age, it might be a risk when aging (Cuesta-Vargas & Hilgenkamp, 2015). In our study, there was no difference between athletes and non-athletes in the results of the handgrip, partial sit-up, and seated push-up strength tests. A reason for the difference might be that the strength training levels actually do not differ between the groups as reported in the questionnaire. Looking more closely, more than half of the participants, both male athletes and non-athletes, were recommended education from the handgrip test. None of the female athletes were recommended education i.e., below the cut-off for achieving physical health benefits. The results of the current study are not completely consistent with the Finnish study of athletes and non-athletes (Rintala et al., 2016). Both in our study and the Rintala and colleagues study (2016) reported low values of grip strength for Special Olympics athletes and non-athletes. This could be context dependent due to differences in sports participation between countries as the current study mainly included Swedish participants.

From the results of the partial sit-up there were no statistically significant differences between the athletes and the non-athletes although a fifth of the athletes and two-fifths of the non-athletes were recommended education (less than 25 sit-ups in one minute). For females, fewer athletes were recommended education than non-athletes. Core strength is important for a strong and good posture, it optimises performance and reduces the risk of low back pain (Diener et al., 1995). Therefore, many participants in our study have increased risk of poor posture and low back pain. Summing up, our study raises an urgent need of increased strength training for both Special Olympics athletes and non-athletes and this is in line with the study by Rintala and colleagues (2016).

From the overall results for both athletes and non-athletes of BMI, muscular strength and aerobic fitness, many participants were below the cut-off in several tests and thereby recommended a training program or to visit a health care specialist. We expected that, because athletes have higher levels of training, they would have lower BMI and higher levels of aerobic fitness and strength. From our study, even though the Special Olympics athletes reported higher levels of MPA, their physical fitness was not especially different compared to the non-athletes. These results are similar to the study of Rintala and colleagues (2016) which also indicates that both groups, Special Olympics athletes and non-athletes, need to increase their PA (both strength training and MPA) to improve their physical health. The current study is also in line with the large-scale study by Temple and colleagues (2022) with over 30 000 Special Olympics athletes, whereby it was noted that the athletes could benefit from additional strength and conditioning training.

Although, this research shows that the physical fitness levels of Special Olympics athletes are not remarkably high, it is important to remember that one step towards an active lifestyle is better than no step. Motivation is an important key for success also for people with ID (Temple & Walkley, 2007). The organisation Special Olympics is working globally to increase participation and inclusion in sports and society as whole through spreading joy of movement and promoting sports. To reach further with promotion of PA for people with ID it is important to combine the effort from different stakeholders such as public authorities, health care sector, school and sports associations to encourage autonomy and the joy of movement (Howie et al., 2012).

The WHO recently created and specified PA recommendations for people with disabilities is an important step in highlighting this target group and promoting the importance of PA (World Health Organization, 2020). Hopefully, this will lead to a guide for public stakeholders, staff, sports associations and clubs, family, and friends to people with ID regarding how to implement PA in order to maintain and increase the physical health. People with ID both need and are dependent on the support of staff, family and friends to perform PA. Researchers have reported that there also seems to be an acceptance in society (e.g., families and staff at communal living arrangements) whereby people with ID are sufficient with PA at low intensity and sedentary activities (Cartwright et al., 2016) and also the current study indicates a need of more PA for people with ID. This is a message to society in general and public stakeholders about their responsibility and willingness to change this attitude around PA.

Limitations

There was no information on what type of disability or the exact level of ID of the participants. For example, people with Down syndrome are associated with a low cardiovascular fitness and decreased muscle strength (González-Agüero et al., 2010). Due to the random selection of both athletes and non-athletes the distribution is assumed to be similar. In general, the test conditions during a Healthy Athletes event are difficult to standardise, no familiarisation is applied, and the event often leads to distractions for the participants (Van Biesen & Pineda, 2019). However, test conditions were equal for all participants in the current study, both athletes and non-athletes. Using questionnaires is a general problem with people with ID concerning the understanding of the questions and how they are assisted. The questionnaire used in the current study has not been validated for people with ID. However, the physical tests in the study and the questionnaire indicated both a need of increased PA.

Conclusions

This study showed that both Special Olympics athletes and non-athletes had high BMI, low levels of aerobic fitness, low levels of strength and the athletes only had slightly better results compared to non-athletes. To improve physical health aspects this study indicates that both Special Olympics athletes and non-athletes with ID can increase the amount of PA and include both more ST and PA at higher intensities. This study wants to encourage public stakeholders, society and sports movement to support people with ID to improve their physical health by increasing the amount and intensity of training and PA.

Perspectives

People with intellectual disability have less good health and physical capacity than people in general. This study showed the low levels of PA, strength capacity and aerobic fitness both for people with ID who participate in sports and those who do not participate in sports. Both groups are suggested to increase the amount of PA, including both strength and aerobic training, in order to improve their physical health.

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References

Bennett, H., Parfitt, G., Davison, K., & Eston, R. (2016). Validity of submaximal step tests to estimate maximal oxygen uptake in healthy adults. *Sports Medicine, 46*(5), 737-750. https://doi.org/10.1007/s40279-015-0445-1

Boer, P. H. (2018). Effects of detraining on anthropometry, aerobic capacity and functional ability in adults with Down syndrome. *Journal of Applied Research in Intellectual Disabilities, 31*, 144-150. https://doi.org/10.1111/jar.12327

Bohannon, R. W., Magasi, S. R., Bubela D. J., Wang, Y.C, & Gershon, R.C. (2012). Grip and knee extension muscle strength reflect a common construct among adults. *Muscle & Nerve*, *46*(4), 555-558. https://doi.org/10.1002/mus.23350

Burnstein, B. D., Steele R. J., & Shrier. I. (2011). Reliability of fitness tests using methods and time periods common in sport and occupational management. *Journal of Athletic Training, 46*(5), 505-513. https://doi.org/10.4085/1062-6050-46.5.505

Carty, C., van der Ploeg, H. P., Biddle, S. J., Bull, F., Willumsen, J., Lee, L., & Milton, K. (2021). The first global physical activity and sedentary behaviour guidelines for people living with disability. *Journal of Physical Activity and Health, 18*(1), 86-93. https://doi.org/10.1123/jpah.2020-0629

Cartwright, L., Reid, M., Hammersley, R., & Valley R. M. (2016). Barriers to increasing the physical activity of people with intellectual disabilities. *British Journal of Learning Disabilities, 45*(1), 47-55. https://doi.org/10.1111/bld.12175

Chiba, Y., Shimada, A., Yoshida, F., Keino, H., Hasegawa, M., Ikari, H., Miyake, S., & Hosokawa, M. (2009). Risk of fall for individuals with intellectual disability. *American Journal on Intellectual and Developmental Disabilities, 114*(4), 225-236. https://doi.org/10.1352/1944-7558-114.4:225-236

Cuesta-Vargas, A., & Hilgenkamp, T. (2015). Reference values of grip strength measured with a Jamar dynamometer in 1526 adults with intellectual disabilities and compared to adults without intellectual disability. *PloS One*, *10*(6), e0129585. https://doi.org/10.1371/journal.pone.0129585

Darcy, S., & Dowse, L. (2013). In search of a level playing field–the constraints and benefits of sport participation for people with intellectual disability. *Disability & Society*, *28*(3), 393-407. https://doi.org/10.1080/09687599.2012.714258

Diener, M. H., Golding, L. A., & Diener, D. (1995). Validity and reliability of a one-minute half sit-up test of abdominal strength and endurance. *Research in Sports Medicine: An International Journal, 6*(2), 105-119. https://doi.org/10.1080/15438629509512042

Doherty, A. J., Jones, S. P., Chauhan, U., & Gibson, J. M. (2018). An integrative review of multicomponent weight management interventions for adults with intellectual disabilities. *Journal of Applied Research in Intellectual Disabilities*, *31*, 39-51. https://doi.org/10.1111/jar.12367

Elmahgoub, S. S., Calders, P., Lambers, S., Stegen, S. M., Van Laethem, C., & Cambier, D. C. (2011). The effect of combined exercise training in adolescents who are overweight or obese with intellectual disability: the role of training frequency. *The Journal of Strength & Conditioning Research*, *25*(8), 2274-2282. https://doi.org/10.1519/JSC.0b013e3181f11c41

Elmahgoub, S. M., Lambers, S., Stegen, S., Van Laethem, C., Cambier, D., & Calders, P. (2009). The influence of combined exercise training on indices of obesity, physical fitness and lipid profile in overweight and obese adolescents with mental retardation. *European Journal of Pediatrics*, *168*(11), 1327-1333. https://doi.org/10.1007/s00431-009-0930-3

Folch-Mas, A., Cortés-Ruiz, M. J., Vicens Calderón, P., & Martínez-Leal, R. (2017). Health profiles in people with intellectual developmental disorders. *Salud Pública de México*, *59*, 400-407. https://doi.org/10.21149/8199

Foley, J. T., Lloyd, M., & Temple, V. A. (2013). Body mass index trends among adult US Special Olympians, 2005–2010. *Adapted Physical Activity Quarterly*, *30*(4), 373-386. https://doi.org/10.1123/apaq.30.4.373

Gómez-Ambrosi, J., Silva, C., Galofré, J. C., Escalada, J., Santos, S., Millán, D., Vila, N., Ibañez, P., Gil, M. J., Valenti, V., Rotellar, F., Ramírez, B., Salvador, J., & Frühbeck, G. (2012). Body mass index classification misses subjects with increased cardiometabolic risk factors related to elevated adiposity. *International Journal of Obesity*, *36,* 286-294. https://doi.org/10.1038/ijo.2011.100

González-Agüero, A., Vicente-Rodríguez, G., Moreno, L. A., Guerra-Balic, M., Ara, I., & Casajus, J. A. (2010). Health-related physical fitness in children and adolescents with Down syndrome and response to training. *Scandinavian Journal of Medicine & Science in Sports*, *20*(5), 716-724. https://doi.org/10.1111/j.1600-0838.2010.1111

Graham, A., & Reid, G. (2000). Physical fitness of adults with an intellectual disability: A 13-year follow-up study. *Research Quarterly for Exercise and Sport*, *71*(2), 152-161. https://doi.org/10.1080/0271367.2000.10608893

Guerra-Balic, M., Cuadrado-Mateos, E., Geronimo-Blasco, C., & Fernhall, B. O. (2000). Physical fitness levels of physically active and sedentary adults with Down syndrome. *Adapted Physical Activity Quarterly, 17*(3), 310-321. https://doi.org/10.1123/apaq.17.3.310

Harada, C. M., Siperstein, G. N., Parker, R. C., & Lenox, D. (2011). Promoting social inclusion for people with intellectual disabilities through sport: Special Olympics International, global sport initiatives and strategies. *Sport in Society*, *14*(9), 1131-1148. https://doi.org/10.1080/17430437.2011.614770

Hassan, D., Dowling, S., McConkey, R., & Menke, S. (2012). The inclusion of people with intellectual disabilities in team sports: Lessons from the Youth Unified Sports programme of Special Olympics. *Sport in Society*, *15*(9), 1275-1290. https://doi.org/10.1080/17430437.2012.695348

Hilgenkamp, T. I., Reis, D., van Wijck, R., & Evenhuis, H. M. (2012). Physical activity levels in older adults with intellectual disabilities are extremely low. *Research in Developmental Disabilities*, *33*(2), 477-483. https://doi.org/10.1016/j.ridd.2011.10.011

Holder, M. (2015). The Special Olympics healthy athletes experience. *Current Sports Medicine Reports*, *14*(3), 165-170. http://doi.org/10.1249/JSR.0000000000000158

Howie, E. K., Barnes, T. L., McDermott, S., Mann, J. R., Clarkson, J., & Meriwether, R. A. (2012). Availability of physical activity resources in the environment for adults with intellectual disabilities. *Disability and Health Journal*, *5*(1), 41-48. https://doi.org/10.1016/j.dhjo.2011.09.004

Hsieh, K., Heller, T., & Miller, A. B. (2001). Risk factors for injuries and falls among adults with developmental disabilities. *Journal of Intellectual Disability Research*, *45*(1), 76-82. https://doi.org/10.1111/j.1365-2788.2001.00277.x

Kim, K. H., Lee, B. A., & Oh, D. J. (2018). Effects of aquatic exercise on health-related physical fitness, blood fat, and immune functions of children with disabilities. *Journal of Exercise Rehabilitation*, *14*(2), 289. https://doi.org/10.12965/jer.1836068.034

Krahn, G. L., Hammond, L., & Turner, A. (2006). A cascade of disparities: health and health care access for people with intellectual disabilities. *Mental Retardation and Developmental Disabilities Research Reviews*, *12*(1), 70-82. https://doi.org/10.1002/mrdd.20098

Lakens, D. (2013). Calculating and reporting effect sizes to facilitate cumulative science: a practical primer for t-tests and ANOVAs. *Frontiers in Psychology*, *4*, 863. https://doi.org/10.3389/fpsyg.2013.00863

Lloyd, M., Foley, J. T., & Temple, V. A. (2018). Maximizing the use of Special Olympics International's Healthy Athletes database: A call to action. *Research in Developmental Disabilities*, *73*, 58-66. https://doi.org/10.1016/j.ridd.2017.12.009

Lord, S. R., Murray, S. M., Chapman, K., Munro, B., & Tiedemann, A. (2002). Sit-to-stand performance depends on sensation, speed, balance, and psychological status in addition to strength in older people. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences*, *57*(8), M539-M543. https://doi.org/10.1093/gerona/57.8.M539

Must, A., Spadano, J., Coakley, E. H., Field, A. E., Colditz, G., & Dietz, W. H. (1999). The disease burden associated with overweight and obesity. *JAMA*, *282*(16), 1523-1529. https://doi.org/10.1001/jama.282.16.1523

Newcomer, K. L., Krug, H. E., & Mahowald, M. L. (1993). Validity and reliability of the timed-stands test for patients with rheumatoid arthritis and other chronic diseases. *The Journal of Rheumatology*, *20*(1), 21-27. https://doi.org/10.1016/j.toxicon.2009.03.028

Oviedo, G. R., Travier, N., & Guerra-Balic, M. (2017). Sedentary and physical activity patterns in adults with intellectual disability. *International Journal of Environmental Research and Public Health*, *14*(9), 1027. https://doi.org/10.3390/ijerph14091027

Pack, S., Kelly, S., & Arvinen-Barrow, M. (2017). "I think I became a swimmer rather than just someone with a disability swimming up and down:" paralympic athletes perceptions of self and identity development. *Disability and Rehabilitation*, *39*(20), 2063-2070. https://doi.org/10.1080/09638288.2016.1217074

Parasport (2021. January 10). Intellektuell funktionsnedsättning. https://www.parasport.se/tranaochtavla/safunkarparasport/intellektuellfunktionsnedsattning/

Rintala, P., Asunta, P., Lahti, J., & Loovis, E. M. (2016). Physical fitness of individuals with intellectual disability who have Special Olympics experience. *European Journal of Adapted Physical Activity*, *9*. https://doi.org/10.5507/euj.2016.006

Robertson, J., & Emerson, E. (2010). Participation in sports by people with intellectual disabilities in England: A brief report. *Journal of Applied Research in Intellectual Disabilities*, *23*(6), 616-622. https://doi.org/10.1111/j.1468-3148.2009.00540.x

Special Olympics. 2020a. "Inclusive Health, Healthy Athletes". Accessed 20 September. https://www.specialolympics.org/our-work/inclusive-health/healthy-athletes?locale=en

Special Olympics. 2020b. "Special Olympics Health Promotion. Clinical Director Manual. September 2020." Accessed 30 May. https://media.specialolympics.org/resources/health/disciplines/health-promotion/manual/Health-Promotion-Clinical-Director-Manual-Sept-2020-2.pdf?_ga=2.67450386.227045215.1622298331-1291524852.1615292683

Special Olympics. 2020c. Special Olympics FUNfitness: Learn how to organize, promote and present. Accessed 10 August. https://media.specialolympics.org/resources/health/disciplines/funfitness/FUNfitness-Training-Manual-September-2020.pdf?_ga=2.228501854.2140653826.1605464307-1715434474.1586332510

Svanelöv, E., Wallén, E. F., Enarsson, P., & Stier, J. (2020). 'Everybody with disability should be included': A qualitative interview study of athletes' experiences of disability sports participation analysed with ideas of able-mindedness. *Scandinavian Journal of Disability Research*, *22*(1). http://doi.org/10.16993/sjdr.676

Temple, V. A., Rintala, P., Zeitz, S., Lloyd, M., & Foley, J. T. (2022). Age and sex-based differences in functional strength of adults participating in Special Olympics. *European Journal of Adapted Physical Activity, 15*(1), 1-1. https://doi.org/10.5507/euj.2021.009

Temple, V. A., & Walkley, J. W. (2007). Perspectives of constraining and enabling factors for health-promoting physical activity by adults with intellectual disability. *Journal of Intellectual and Developmental Disability*, *32*(1), 28-38. http://doi.org/10.1080/13668250701194034

Terblanche, E., & Boer, P. H. (2013). The functional fitness capacity of adults with Down syndrome in South Africa. *Journal of Intellectual Disability Research*, *57*(9), 826-836. http://doi.org/10.1111/j.1365-2788.2012.01594.x

Tomczak, M., & Tomczak, E. (2014). The need to report effect size estimates revisited. An overview of some recommended measures of effect size. *Trends in Sport Sciences*, *1*(21), 19-25.

Van Biesen, D., Hettinga, F. J., McCulloch, K., & Vanlandewijck, Y. C. (2017). Pacing ability in elite runners with intellectual impairment. *Medicine and Science in Sports and Exercise*, *49*(3), 588-594. https://doi.org/10.1249/mss.0000000000001115

Van Biesen, D., & Pineda, R. C. (2019). Balance and strength assessment of Special Olympics athletes: how feasible and reliable is the Fun Fitness test battery? *European Journal of Adapted Physical Activity*, *12*(1)1-12. http://doi.org/10.5507/euj.2019.004

Walsh, D., Belton, S., Meegan, S., Bowers, K., Corby, D., Staines, A., McVeigh, T., McKeon, M., Hoey, E., Trépel, D., Griffin, P., & Sweeney, M. R. (2018). A comparison of physical activity, physical fitness levels, BMI and blood pressure of adults with intellectual disability, who do and do not take part in Special Olympics Ireland programmes: Results from the SOPHIE study. *Journal of Intellectual Disabilities*, *22*(2), 154-170. https://doi.org/10.1177/1744629516688773

World Health Organization. (2020). “Physical Activity”. Accessed 18 January. https://www.who.int/news-room/fact-sheets/detail/physical-activity