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REVIEW PAPER

Effects of Physical Exercise on Motor Skills and Body Composition of Adults With Intellectual Disabilities: A Systematic Detailed Review

Milan Mitic[1], Marko Aleksandrovic[1]

[1]Faculty of Sport and Physical Education, University of Nis, Nis, Serbia

Abstract

People with intellectual disabilities (ID) make up about 2% of the total population, in addition to the cognitive and social problems which they face, physical abilities are at a very low level, during life. At the same time, people with ID show deficits in motor status which is associated with poor perception of information and inability to execute movements and with constant variation of body status indicators. The aim of this detailed review was to summarize previous works that examined the effects that regular physical activity has on motor and physical status in ID. The following index databases were used to collect adequate literature: GoogleScholar, PubMed, SciIndex, ResearchGate, MEDLINE. A systematic review of the available literature was performed in accordance with the guidelines of the Preferred Reports for Systematic Reviews and Meta-Analysis (PRISMA). The training processes of people with ID are adapted to the level of disability. Research that has studied the effects of adequate and regular physical activity highlights the importance of these programs in reducing the consequences and improving the quality of life of this population, improving motor skills and body composition, in the future this knowledge should be combined with the benefits of nutritional programs to see the overall effects on motor skills and body composition in people with ID, so future research examining long-term positive sides is necessary.

Keywords: *Disability, Training, Fitness, Abilities, Composition*

Introduction

Intellectual disability (ID) is an administrative name for various genetic, social and medical conditions whose common characteristic is significantly below average intellectual functioning (Schalock et al., 2010). People with ID make up about 2% of the total population (Lennox et al., 2007; Maulik, Mascarenhas, Mathers, Dua, & Saxena, 2011) and have problems with activities in everyday life.

In addition to the cognitive and social problems they face, physical abilities are at a very low level throughout life. At the same time, people with ID show deficits in motor status which is associated with poor perception of information and inability to execute movements. Earlier research (Graham & Reid, 2000; Van de Viet et al., 2006; Frey, Stanish, & Temple 2008) pointed to the problem of body composition, levels of physical fitness, especially cardiovascular endurance, muscle strength and endurance, coordination and balance in persons diagnosed with ID.

Namely, people with ID have problems with constant variation of body composition indicators (Elmahgoub et al., 2009), Obesity rate is about 50% (National Clinical Guideline Centre, 2014), and in combination with insufficient physical activity, the consequences are reduced strength, aerobic capacity and increased fat percentage and disturbed balance and postural stability at the same time pose a high risk for obesity, diabetes, cardiovascular disease, falls and injuries of the locomotor system (Dodd & Shields, 2005; Lotan, 2007; de Winter, Magilsen, van Alfen, Penning, & Evenhuia, 2009).

Regular physical activity and adequate training programs are the best prevention for high-risk profiles (Calders et al., 2011). Previous research (Bartlo & Klein, 2011; Heller, McCub-

Correspondence:

M. Aleksandrovic
University of Nis, Faculty of Sport and Physical Education, Carnojevića 10, 18000 Nis, Serbia
E-mail: marko.aleksandrovic@gmail.com

bin, Drum, & Peterson, 2011) has shown that there is a strong, positive effect of regular physical activity on improving balance, muscle strength and quality of life of people with ID. In addition, regular physical activity in people with ID improves aerobic capacity, flexibility and agility (Pestana, Barbieri, Vitorio, Figueiredo, & Mauerberg, 2018). However, in addition to all the benefits of regular exercise in people with ID, physical activity and exercise conditions are very limiting and deficient compared to the non-disabled population (Lotan, Isakov, Kessel, & Merick, 2004) and only about 16% of them (Hilgenkamp, Reis, van Wijck, & Evenhuis, 2012) complies with the guidelines of the World Health Organization (WHO), as well as research that dealt with the differences between people with ID and a healthy population (Graham & Reid, 2000) led to the conclusion that there are large qualitative differences in motor abilities, fitness components and body composition in favor of the population without disabilities in which a higher level of physical activity is noticeable, and thus the benefits it brings.

In previous research, there is a doubt as to which is the most effective training program that will lead to improvements in motor abilities and body composition. In a meta - analysis (Bouzas, Martinez-Lemos, & Ayan, 2019) it was found that exercise training has the most benefits on physical abilities and psycho - social status, however, they did not establish what is the most adequate frequency of exercise, as well as the nutritional status of respondents. Also (Bouzas et al., 2019) found that physical exercise has the greatest impact on the moderate form of ID. Most studies have examined the effects of specially designed programs in children and the younger population (Golubović, Maksimović, Golubović, & Glumbić, 2012; Jankowicz-Szymanska, Mikolajczyk, & Wojitanowski, 2012; Ozer et al., 2012), while in the literature there is a lack of those based on the adult population, given that over time there is a decrease in physical activity in this population and impaired health status. The aim of this review was to summarize and analyze previous works that examined the effects that regular physical activity has on motor and physical status in ID.

Methods

Research selection strategy

To collect adequate literature the following index databases were used: GoogleScholar, PubMed, SciIndex, ResearchGate, MEDLINE. All works were collected by February 28, 2021. During the search, the terms and combinations of terms used were: "Intellectual disability", "Physical activity", "Training effects", "Fitness", "Strength", "Power", "Balance", "Benefits", "Body Composition", "Fat mass", Cognition", "Mental", "Retardation".

Including criteria

Research is included in the analysis if it is: 1) published in English; 2) respondents were adults diagnosed with ID; 3) existence of a control and experimental group; 4) existence of an experimental group; 5) longitudinal, experimental studies; 6) specific training program with clearly defined effects; 7) a clear explanation of the training process.

Excluding criteria

Research is excluded from the analysis if: 1) it is not published in English; 2) the respondents had some other form of disability; 3) transversal, retrospective studies, case studies; 4) with inadequately defined training process and effects; 5) studies that have an abstract only.

Data extraction and selection

A systematic review of the available literature was performed in accordance with the guidelines of Preferred Reports for Systematic Reviews and Meta-Analysis (PRISMA) (Mother, Liberati, Tetzlaff, & Altman, 2010) (Figure 1). The following information was extracted from each study: First author's name and year of publication, level of ID, sample characteristics (number of participants, gender, and age), the training program, specifies of training program and outcomes.

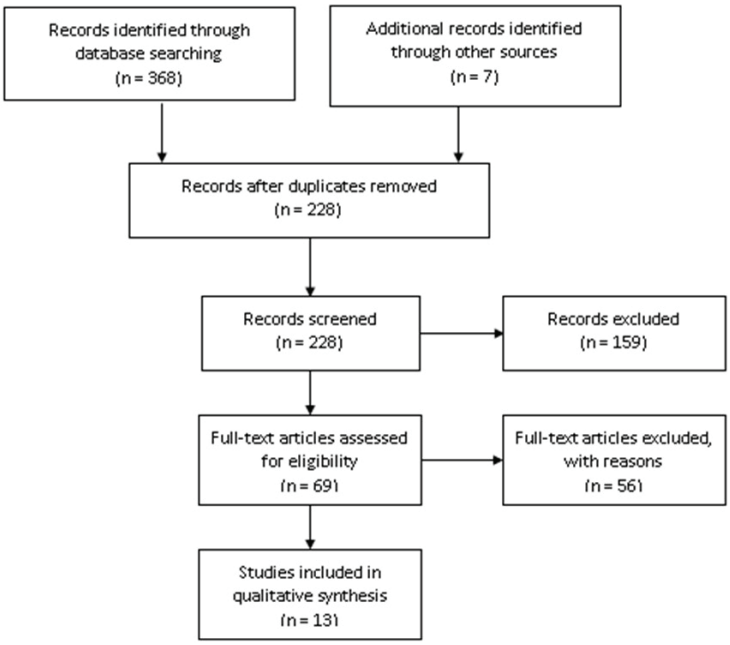

FIGURE 1. PRISMA, diagram of preferred reports for systematic reviews and meta-analysis

Results

A total of 75 papers were found, after removal of duplicates, 228 papers were included in the further analysis process. After reading the abstract of the papers, it was rejected 159, while in the further process it was included 69, 56 papers did not meet the inclusive criteria so that after elimination, the remaining 13 papers that were included in the final analysis.All studies that met the inclusion criteria are shown in Table 1, ac-

cording to the following criteria: Reference; ID level; The goal; Sample of respondents; Training program; Program specifics; The results. A total of 13 studies were presented. The largest number of surveys is from 2009 (Elmahgoub et al., 2009; Fotiadou et al., 2009), 2017 (Hakim, Ross, Runco, & Kane, 2017; van Schijndel-Speet, Evenhuis, van Wijick, Van Montfort, & Echteld, 2017) and 2019 (Martinez-Aldao, Martinez-Lemos, Bouzas-Rico, & Ayan-Perez, 2019; Pejčić, Kocić, Berić, Kozomara, & Aleksandrović, 2019). The number of respondents varied. The largest number of respondents n = 146 (Wu et al., 2010), and the smallest (Fotiadou et al., 2009).Both sexes were included in all studies, and the number of men and women in each study group was relatively balanced. The oldest group of respondents was in the study (Wu et al., 2017), and the youngest (Elmahgoub et al., 2011). Motor abilities were included in 12 studies (Rimmer, Riley, Wang, Rauworth, & Jurkowski, 2004; Carmeli, Zinger-Vaknin, Morad, & Merrick, 2005; Shields, Taylor, & Dodd, 2008; Fotiadou et al., 2009; Wu & al., 2010 Elmahgoub et al., 2011; Oviedo, Guerra-Balic, Baynard, & Javierre, 2014; Hakim et al., 2017; Van Schjndel-Speet et al., 2017; Asonitou, Mpampoulis, Irakleous-Paleologou, & Koutsouki, 2018; Martinez-Aldao & al., 2019; Pejčić et al., 2019). Body composition has been the subject of seven studies (Elmahgoub et al., 2009; Wu et al., 2010; Elmahgoub et al., 2011; Oviedo & al., 2014; Van Schjndel-Speet et al., 2017; Asonitou & al., 2018; Martinez-Aldao et al., 2019).

Table 1. Training programs of persons with OI

Reference	ID	Aim	Sample / Age of respondents	Training program	Program specifics	Results
Rimmer, Riley, Wang, Rauworth, & Jurkowski (2004)	DS	Effects of a 12-week exercise program	n = 52 CG = 22 EG = 30 Age: 38.6 ± 6.2	12 weeks; 3 d / w 30 min cardio training 15 min strength and endurance training	Cardio training: 50-70 Vo2max Power: 1RMmax; 10-20h, with progressive load increase	↑ K - R endurance strength and endurance EG ↓ BW EG
Carmeli, Zinger-Vaknin, Morad, & Merrick (2005)	Middle ID	Effects of the program on balance, strength and general condition	n = 22 AG = 10 G: 60.9 ± 3.3 BG = 12 G: 61.5 ± 4.1	6 months 3 d / w A G– Balance + power; BG - General program General program - warm-up, walking, with minimal equipment	Power: 1-2 sets x 8 -10 reps, 70% 1RMmax, 10% ↑ load General program - according to the guidelines American College of Sport Medicine (ACSM)	↑ General condition of both groups, ↑ Balance AG ↑ Lower limb strength AG
Shields, Taylor, & Dodd (2008)	DS	Effects of progressive training with load on strength, endurance and functionality	n = 20 CG = 11 EG = 9 Age: 17.9 ± 2.6	EG: 10 weeks, 2 d / w,	2-3 sets x 10-12 reps GP; SGP; VUS; NP; NOT; PL	↑ Endurance of the upper extremities EG
Elmahgoubet et al. (2009)	ID; IQ = 40-75	Effects of training program on physical fitness, body composition and deprivation status	n = 30; CG = 15; EG = 15 Age: 14 - 22	10 weeks, 3 d / w; 50 min	heating, VSB - 10 min; F&REB - 10 min; Stepper - 10 min; F&RTB - 10 min; Aerobic training: 60 - 75% HRmax, Power: 60 - 80% 1RMmax	↓ BW, ITM ↓ Strip circumference, fat mass ↑ Relative BTM ↓ Triglycerides and cholesterol ↑ Muscle strength and fatigue resistance during exercise
Fotiadouet et al. (2009)	IQ 50-67	Effects of the training process on dynamic balance	n = 18 CG = 8 Age: 32 ± 2.3 EG = 10 Age: 28.2 ± 6.1	12 weeks, 3 d / n per week; 45 min	Elements of RG and rhythm with adaptations	↑ Dynamic equilibrium EG
Wu et al. (2010)	All levels of ID	Effects of healthy physical exercise programs in EBs stationed in the institution	n = 146; Age: 19 -67	7 d/w; 40 min, every day, 6 months	Acrobatics, Jogging Dance Climbing the stairs	↓ BW and BMI ↑ Flexibility ↑ No. of done abs for 30 and 60 s

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Reference	ID	Aim	Sample / Age of respondents	Training program	Program specifics	Results
Elmahgoub et al. (2011)	Different types of ID	Effects of aerobic and strength training on metabolic and physical fitness	n = 45 CG - n = 15 EGKT - n = 15 EGAT - n = 15 Age: 14 - 22	EGKT - 4 d / w, 20 weeks; 70min	EGKT - Sawdust - 5 min; VB - 10 min; F&REB - 10 min; stepper - 10 min; F&RTB - 10 min; Running - 10 min EGAT - cycling, stepper, walking or running	↓ Cholesterol level of both EG ↑ Aerobic capacity of both EG ↑ Increasing the power of both EG ↑ Systolic resting pressure of both EG ↓↓ ECGT Cholesterol Level ↑↑ 1RMmax of upper and lower extremities ECGT ↑↑ ECGT fatigue resistance ↑↑ VUSLP ECGT ↑↑ SP.EKGT
Oviedo, Guerra-Balic, Baynard, & Javierre (2014)	Mild and moderate ID	Influence of the combined program of aerobic training, strength and balance on cardiovascular condition, strength, balance and functional.	n = 72 CG - 29 EG - 37	14 weeks, 3d duration / n; 60 min. Aerobic tening Strength training Balance training	Aerobic training: 50 - 80% VO2max Power: is 2 series x 15; 2 series x 12 with constant load increase; 2 sets x 10 - 12 reps and 3 sets until canceled Balance - Progressive dynamic balance exercises	↑ K - R endurance ↑ Lower limb strength ↑ Fist grip strength, ↑ Balance ↓ BW IT .ITM
Hakim et al. (2017)	Middle and moderate ID	Determine the effects of duration training in water on physical performance	n = 22 37.14 ± 9.45	8 weeks, 2d / w; 45 - 60 min basic exercises in water with and without props. Each exercise was performed in 2 series, 10 repetitions	Basic exercises in water 2 sets of x 10 reps	↑ Endurance ↑ Balance ↑ Mobility
Van Schjndel-Speetet et al. (2017)	Moderate and middle ID	Determine the effects of the program on the level of physical activity and TS, metabolic factors and cognitive abilities	n = 81, Age:> 43	According to ACSM and AHS recommendations, the total was. 8 months, 3 d /w	Strength - 18 exercises Endurance - 14 exercises Balance - 17 6 flexibility exercises.	↑ Physical activity ↑ Muscle strength, ↑ SKP and DKP, ↑ HDL ↓ LDL ↑ Cognitive memory. ↕ Balance, ↕ Blood glucose, ↕ Walking speed, ↕ Depression ↕ Mobility

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Reference	ID	Aim	Sample / Age of respondents	Training program	Program specifics	Results
Asonitou, Mpampoulis, Irakleous-Paleologou, & Koutsouki (2018)	IQ 55 – 70	Effects of training programs on improving muscle strength, speed, balance and flexibility.	n = 38 CG - 19 EG - 19 Age: 28 - 45	16 weeks, 2 d / w; 60 min in three parts and 12 sections	Warm upFlexibility, Power, Stability Cardio training, Stretching 3 parts / 12 sections	↓ BW ↓ BMI ↓ Fat deposits ↑ Power ↑ Durability in strength ↑Speed ↑ Flexibility ↑ K - R endurance
Martinez-Aldao et al. (2019)	Light form, Moderate form ID Severe form of ID	Effects of exercise programs with music on TS, cardiorepiratory and muscular endurance	n = 30 Age: 36.37 ± 11.24	10 weeks, 2 d / w; 60 min	Baćata and Latin pop dances + Aerobic exercises + Agility Choreography + Aerobics	↓ BW ↓ BMI ↑ K - R endurance ↑ Muscular endurance
Pejčićet et al. (2019)	IQ50 – 70	Effects of a special program of sports games on the improvement of physical abilities	n = 60 EG - n = 30 CG - n = 30 Age: 13 - 17	12 weeks, 4 d / w; 30 min CG - Regular physical activity prescribed by MENiT	EG - Football - OE Basketball - OE CG - Strength, stretching and running with tasks OE sports games Muscle relaxation	↑ Explosive power of the upper extremities EG ↑ Local endurance EG ↑ EG speed ↑ Flexibility of the hip joint EG

Note: ↑ - Improvement; ↑↑ - Improvement between groups; ↓ - Deterioration; ↕ - No change; ± - Standard deviation; II - Intellectual impairment; CG - Control group; EG - Experimental group; DS - Down syndrome; BW - Body weight; BMI - Body Mass Index; ST - Shoulder thrust; SCP - Sitting Chest Pressure; RIS-Rowing in the sed; LT - Leg Thrust; FE - Foot extension; LC - Lifting calves; FFBW - Fat-free body weight; RG - Rhythmic gymnastics; K-R - Cardiorespiratory; SBP - Systolic blood pressure; DBP - Diastolic blood pressure; HDL / LDL - Healthy / Unhealthy Cholesterol; F&REB - Front and rear elbow box F&RTB - Front and rear thigh box BE - Basic elements; MENiT - Ministry of Education, Science and Technology; ACSM - American College of Sport Medicine

Discussion

The aim of the review was to present research that investigated the training effects on motor skills and body composition in people with ID. A review of previous work has shown that the effects of specific training show qualitative changes in various components of physical fitness, which was confirmed by previous review studies with meta-analysis (Shin & Park, 2012; Jeng, Chang, Liu, Hou, & Lin, 2017) where was noticed a large improvement in muscle and cardiovascular endurance, a moderate improvement in muscle strength, and a small improvement in flexibility. Analysis of the papers confirms that balance, postural stability, and dynamic balance are improved (Carmeli et al., 2005; Oviedo et al., 2014; Fotiadou et al., 2009; Hakim et al., 2017; van Schjndel-Speet et al., 2017) which is crucial for people with ID, because they have an increased risk of loss of balance and falls (Enkelaar, Smulders, van Schrojenstein-Lantman de Valks, Geurts, & Weerdesteyn, 2012). Also, there has been an increase in flexibility (Wu et al., 2010; Hakim et al., 2017; Van Schjndel-Speet et al., 2017; Pejčić et al., 2019), an ability that in combination with balance has a positive effect on the prevention of falls and injuries of the locomotor system in adults with ID, but also allows daily activities. Positive changes have also been observed in cardiorespiratory endurance (Rimmer et al., 2004; Oviedo et al., 2014; Hakim et al., 2017; Asonitou et al., 2018; Martinez-Aldao et al., 2019; Pejčić et al., 2019) and strength and its components (Rimmer et al., 2004; Carmeli et al., 2005; Elmahgoub et al., 2009; van Schjindel-Speet et al., 2017; Asonitou et al., 2018; Pejčić et al., 2019). In his review research Bartlo & Klein (2011) points out that strength is not an important ability whose development should be done primarily, because it has no impact on daily activities. Our opinion is that strength training, especially training aimed at the development of explosive power is necessary, given the aging process in people with ID can be accelerated which results in loss of muscle mass and the appearance of sarcopenia (Carmeli et al., 2012; De Winter, Bastiaanse, Hilgenkamp, Evenhuis, & Echteld, 2012), and thus the risk of falls increases, so injuries to the locomotor system can occur (Benichou & Lord, 2016). According to (Caserotti, 2010), explosive power has a much greater impact on fall prevention than other aspects of strength, because it improves voluntary muscle contraction (Hvid et al., 2016). Differences in effects exist in relation to the type of training, where combined strength and endurance training had more impact than stand-alone on endurance training. For comparison, Calders et al. (2011) concluded that combined load training causes an improvement in strength in the upper and lower extremities, due to the use of fast walking, running and pedaling on a hand ergometer and a stationary bicycle, on the other hand Shields et al. (2008) did not observe an improvement in the components of muscle performance in the lower extremities. The explanation lies in the length, frequency of training and degree of disability. Namely, people who have a moderate form of ID need a certain period of time to learn the correct form of exercise movement (Shields et al., 2008). However, the analysis of the works confirms that the positive effects

occurred regardless of the duration of the program. Interestingly, in the study (Hakim et al., 2017), the training program lasted only eight weeks, however, it was performed in water that has numerous benefits and reliefs, while acting on the body and physical fitness as well as exercise on dry land (Girold, Maurin, Dugue, Chatard, & Mille, 2007).

Training programs also show progress in body composition indicators (Rimmer et al., 2004; Elmahgoub et al., 2009; Wu et al., 2010; Elmahgoub et al., 2011; van Schjindel-Speet et al., 2017; Asonitou et al., 2018; Martinez-Aldao et al., 2019; Pejčić et al., 2019). There was a reduction in body weight, fat deposits, lipid status, body mass index, as well as in the circumference of the extremities, despite uncontrolled diet, as well as activity and a sedentary lifestyle on days when there was no training. However, although our work highlights the existence of changes in body composition, the results are contradictory in relation to research and meta-analysis (Harris, Hankey, Murray, & Melville, 2015) in which there were no statistically significant changes in body composition. It should be noted that a large number of different types of intellectual disabilities were included in this review paper, in the previous meta - analysis, the respondents were mostly people diagnosed with Down syndrome. This group of respondents has a low level of physical fitness (Temple, Frey, & Stanish, 2006), reduced muscle mass and a high percentage of fat deposits (González-Agüero, Moreno, Vicente-Rodríguez, & Casajús, 2011), which significantly negatively affects their performance in training programs (Rimmer et al., 2004). In addition, ID represents a wide range of diseases, with a milder or more severe clinical picture (Harris et al., 2015). These are the expected results, but very important, given that most people with ID are inactive, so any increase in the intensity of activity leads to an improvement in the mentioned parameters, which can have a negative impact on health status. Also, an important factor in changing the body composition is the duration of the program. It is interesting that in the works taken in the analysis there was a reduction in body weight for 10 weeks with a tendency to progress as the number of weeks of a specific training program increased, although it was proven that the minimum period of metabolic adaptation to load is 12 weeks (Pollock et al., 1998), and that the most authoritative indicator of a change in body composition is a training program lasting at least one year according to the National Institute of Health and Care (Centre for Public Health Excellence at NICE, 2006). It should be noted that the improvement in body composition occurred regardless of the fact that nutritional intake was not controlled, which would probably have even greater effects on the reduction of body fat, body volume and muscle mass. Also, the fact that people with IO use drug therapy (Doan, Lennox, Taylor-Gomez, & Ware, 2013) which has an additional negative impact on metabolism and overweight problems (Wharton, Raiber, Serodio, Lee, & Christensen, 2018) was not taken into account.

When it comes to the content of the training program, most researchers used a combination of strength and endurance training (Martinez-Aldao et al., 2019). However,the effects of dance step combinations on motor skills and body composition were also investigated and it was concluded that zumba dance steps have positive effects on people with ID (Martinez-Aldao et al., 2019). Previously, zumba showed positive effects in obese women without disabilities (Cugusi et al., 2015), but not in the population without physical problems (Barene, Holtermann, Oseland, Brekke, & Krustup, 2016), also Pejčić et al. (2019) in their research used elements of basic techniques from team sports, where the group that practiced this type of training had better results in explosive strength, local endurance, speed and flexibility compared to the group that was subjected to conventional training. After eight weeks of training in water, subjects showed improvement in endurance, balance, and mobility (Hakim et al., 2017). Also, Shields et al. (2008) pointed out that specific programs lead to greater and more effective impacts compared to programs prescribed by institutions and which involve a regular exercise procedure, because they often do not cause the desired adaptive responses of the organism to was also pointed out by Carmeli et al. (2005). Training processes are adapted to the level of disability, on the other hand, through variations in training and setting tasks such as basket shots and goal shots - through sports (Pejčić et al., 2019) and dance games and tasks (Martinez-Aldao et al., 2019), people with EB encourage unconscious learning, improve the level of cognitive abilities that they can practically apply for better functionality in the daily life of the population (Keeley & Fox, 2009). However, such programs are often unfeasible in everyday life, for most people with ID, given the barriers that exist for their smooth exercise (Temple, 2007). It should be noted that barriers do not only mean material means and problems with transport, but also insufficient knowledge about the importance of regular physical activity (Hawkins & Look, 2006). Asonitou et al. (2018) emphasize the influence of the duration of the training process as an important mediator of improvement in motor skills and body composition. In most studies, training programs last 8 to 12 weeks (Rimmer et al., 2004; Shields et al., 2008; Elmahgoub et al., 2009; Fotiadou et al., 2009; Martinez-Aldao et al., 2019; Hakim et al., 2017; Pejčić et al., 2019) which is not a good indicator of the true condition, given that this period is sufficient to initiate adaptation processes in the body and short-term effects but not long enough to show long-term and stable effects of exercise.

The limitation of our detailed review is certainly the number of papers found, however the number of studies examining the effects of training on the adult population with ID is quite in deficit, so future research on the impacts of specially designed training programs for adults is necessary. Also, when it comes to body composition, it is necessary that future experimental studies try to control the intake of nutrients and thus indicate completely the importance of the combination of training and nutrition on the physical status of people with ID.

Conclusion

People with ID lead a sedentary lifestyle, which is reflected in the anthropological dimensions of the personality. People with ID have problems with body composition, low levels of physical activity and all this affects the appearance of problems in health status. Research that has studied the effects of adequate and regular physical activity highlights the importance of these programs in reducing consequences, improving motor skills and body composition, and improving the quality of life of this population. Quality of life implies the fact that people with ID can function independently and perform daily activities without the risk of injury, but also improve in the psychological, social and emotional field. However, it remains unclear which training program provides the most complete and best benefits in terms of motor skills and body composition in relation to the type and level of ID. It is necessary to emphasize the importance of regular exercise through education and to cover the ID with adequate training programs, taking into account the type and degree of disability. This problem is multidisciplinary in nature, so it is necessary to include the medical side, as well as experts in the field of intellectual disability. Also, in the future, this knowledge should be combined with the benefits of nutritional programs in order to see the overall effects on motor skills and body composition in people with ID, so future research examining long-term benefits is necessary.

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Conflict of Interest
The authors declare that there is no conflicts of interest.

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