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Physical performance measures of young male football players with Down syndrome and mild intellectual disability versus untrained peers

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Abstract

Purpose: The present study aimed to assess physical performance and its relationship with age and BMI in young male football players with Down syndrome and mild intellectual disability compared to their untrained peers.

Methods: The study included 60 boys with Down syndrome and mild intellectual disability aged 11-13 years, assigned to the study group (trained football at the Futbol+ Sports Academy) and the control group (untrained peers). Research tools was the Eurofit Special test. The data were analyzed based on the using chi-square test, Student's t-test for independent variables, or Mann-Whitney U test, Pearson's linear correlation or Spearman's rank correlation.

Results: Young male football players with Down syndrome scored better for Standing Long Jump ($p<0.001$), Bent Knee Sit-ups in 30 seconds ($p<0.001$), 2 kg Medicine Ball Forward Push with one hand ($p<0.001$), and Walking on a Gymnastic Bench in the Upright Position ($p=0.001$), while for 25 m Run from a High Start, boys from the control group achieved better results ($p<0.001$). There were no statistically significant relationships of Eurofit Special test results with age and BMI.

Conclusions: Football training improves physical performance of boys with Down syndrome and mild intellectual disability, especially dynamic balance, muscle strength of the lower limbs, upper limbs and abdomen. It can therefore be assumed that these characteristics are the most important indicators of the effectiveness of football training in these individuals. Age and BMI should not be considered as determinants of motor fitness in children and adolescents with Down syndrome and associated mental retardation.

Key words: Down syndrome, disability, Eurofit Special test battery, somatic features.

1. Introduction

Down syndrome is a congenital disorder resulting from an extra chromosome (or part of it) in the 21st pair of the karyotype. It is characterised by the presence of specific features and symptoms that can be identified in an individual from birth [4], [5], [16], [21]. Developmental abnormalities, muscular hypotonia and excessive elasticity of the ligament-articular system are the cause of proprioception, kinesthesia, antigravity mechanism disorders and are the cause of postural defects and musculoskeletal dysfunction [8], [10], [17], [13]. As a result, the motor development of children with Down syndrome is not harmonious and its level is lower than what would be predicted by age-specific norms. People with Down syndrome also tend to be overweight, due to genetic, hormonal and metabolic disorders, lack of exercise and the inability to diagnose and articulate their own nutritional needs [1], [7], [14], [18]. A typical feature of Down syndrome is mental retardation. Intellectual deficits depend not only on genetic factors, but also on social and environmental factors. Therefore, the process of stimulation of the child from the first years of life is of great importance and the provision of varied stimuli with the right intensity is crucial for progress [6], [25]. There are studies in the literature that indicate that early and appropriate stimulation and behavioural intervention, a friendly environment, a positive and encouraging attitude of parents or caregivers are the basis for the management of children with Down syndrome. It is particularly important to develop appropriate skills in different areas of development, individualise training programmes and identify and manage specific behavioural deficits [11], [15], [22]. Nowadays, the opportunity for physical development, increased independence and integration is provided by sports clubs that aim to activate children and adolescents with Down syndrome by organising training and sports competitions. Despite the growing interest in sports adapted to the needs of people with various disabilities, especially in the context of social integration, physical and mental development, the topic of the effects of football on children with Down syndrome has been little studied. Similarly, the area of motor skills in people with Down syndrome is a topic that is rarely addressed in scientific work. Given the range of developmental disorders, data on the effect of participation in such initiatives on improving motor skills could provide valuable information. The analysis of the available literature and own reflections prompted the authors to take up the subject of the study. We envisage that obtained results will contribute evidence of key importance for understanding the impact of practicing football on physical fitness of children with Down syndrome, and may provide information which will help design activities matching the specific needs of each child. With the results obtained, coaches will be able to create personalized training methods that comprehensively support the motor development and thus improve the quality of life in children with Down syndrome. The present study aimed to assess physical performance and its relationship with age and BMI in young male football players with Down syndrome and mild intellectual disability compared to their untrained peers.

Material and methods

Participants

The study included 60 boys with Down syndrome and mild intellectual disability aged 11-13 years, assigned to the study and control group. The study group consisted of 30 schoolboys attending the Special Purpose School and Education Centers who, apart from their regular activities followed at school, trained football at the Futbol+ Sports Academy within the

„Efficient Dragons" association in Gorlice, Lesser Poland Voivodeship. A control group comprised 30 age- and gender-matched untrained peers, attending the Special Purpose School and Education Centers in the Podkarpackie and Lesser Poland Voivodeships, Poland.

The inclusion criteria were as follows: confirmed genetic diagnosis of Down syndrome by a pediatric neurologist, mild intellectual disability issued by the Psychological and Pedagogical Counselling Centre, where they had been assessed by a qualified psychologist experienced in working with individuals with intellectual disability, male gender, age between 11 and 13 years, attending the Special Purpose School and Education Center; parents' and/or legal guardians' written informed consent for their children's participation. In case of boys practicing football additional inclusion criterion was a health status allowing for participation in the football training and examinations; a 2-year training practice and attending training regularly, three times a week.

The exclusion criteria: neurological or mobility disorders, cognitive deficits impairing ability to understand and follow instructions which were necessary for the training and assessment procedures; coexisting conditions: autism, muscular dystrophy.

The data in Table 1 indicate no statistically significant intergroup differences in terms of age and body weight. The boys in the study group were characterized by greater body height values (p=0.033) and lower BMI (p=0.020). Intelligence quotient assessed using the Wechsler scale, as well as motor skills and independence according to the Barthel Index, did not differ among the boys assigned to the respective groups.

Table 1. Characteristics of study population

Variable	Study group	Control group	Statistics
Age [years], $\bar{x}$±SD (Me)	11.70±0.65 (12.00)	12.00±0.74 (12.00)	Z=-1.45 p=0.145
Age, n (%)			
11 years	12 (40.0)	8 (27.0)	$\chi^2(2)=3.11$ p=0.211
12 years	15 (50.0)	14 (46.0)	
13 years	3 (10.0)	8 (27.0)	
Body weight [kg], $\bar{x}$±SD (Me)	39.37±4.64 (40.20)	39.15±3.96 (39.35)	t=0.19 p=0.844
Body height [cm], $\bar{x}$±SD (Me)	141.90-7.72 (142.50)	138.07-5.78 (138.00)	t=2.17 p=0.033*
BMI, $\bar{x}$±SD (Me)	19.52±1.48 (19.62)	20.55±1.82 (20.67)	t=-2.39 p=0.020*
Body mass, n (%)			
Normal	22 (73.0)	16 (53.0)	$\chi^2(1)=2.58$

Overweight	8 (27.0)	14 (47.0)	p=0.108
Wechsler scale, $\bar{x}$±SD (Me)	59.20±5.03 (58.50)	58.60±5.31 (59.00)	t=0.32 p=0.782
Barthel Index [0-100 points], $\bar{x}$±SD (Me)	95.00±6.95 (97.50)	92.67±8.78 (95.00)	Z=0.76 p=0.444

n – number of subjects; % – percent of subjects; χ^2 – value of the chi-square test statistic; $\bar{x}$ – arithmetic mean value; SD – standard deviation; Z – value of the Mann Whitney U test statistic; t – value of the Student's t-test for independent variables statistics; p – probability value; *p<0.05

The duration of a single football training was 60 minutes, and the pace and difficulty of the exercises were adapted to the individual needs of the children, taking into account their level of physical capabilities, motor skills and social skills. The training consisted of a 10-minute warm-up (arm circles, bends, marching, stretching), 15-minute functional training (i.e. a series of complex, varied, proprioception-stimulating movement tasks designed to help the player function in space and improve motor parameters such as strength, speed, endurance and coordination), 15 minutes of work on football skills (learning and improving the technique and tactics of the game, including ball control, passing, shooting, putting the ball in play, agility, changes of direction), 10 minutes of play in the form of mini-games or team games (training the skills of team cooperation, communication, joining the team game). The final 10-minute session included stretching and relaxation exercises and a summary of the training by the coach (highlighting what had been achieved, praising the effort, reinforcing the sense of success).

Design

The Eurofit Special test (created by European Council's Committee for the Development of Sport) was used as the main research tool. This is a well-tested and reliable tool, designed to assess the overall physical performance of individuals with intellectual disability. Study participants performed the following tasks [23]:

1. Standing Long Jump [cm] – assessment of lower limb muscle strength – measurements were taken to the nearest 1 cm, with higher scores indicating greater lower limb muscle strength.
2. Bent Knee Sit-ups in 30 seconds [number of repetitions] – assessment of local muscular endurance – more repetitions reflected a better score.
3. Seated Forward Bend [points] – assessment of flexibility – measurements were taken to the nearest 1 cm, a higher score recorded from the '0' position reflected greater flexibility.

4. 25 m Run from a High Start [s] – assessment of speed – the time was measured in seconds to the nearest 0.1 s, a lower score meant that the designated distance was covered faster.
5. 2 kg Medicine Ball Forward Push with one hand [cm] – assessment of upper limb muscle strength – measurements were taken to the nearest 1 cm, a higher score reflected greater upper limb muscle strength.
6. Walking on a Gymnastic Bench in the Upright Position [points] – assessment of dynamic balance – boys could receive 1 to 6 points with a higher score reflecting a better result (1 point was awarded if the test attempt was not performed; 2 points were awarded for approaching the bench; 3 points for walking a 2-meter section on the bench or with support along the entire bench; 4 points for walking the entire bench without support; 5 points for walking a 2-meter section on the inverted bench with support along the entire bench; 6 points for walking the entire inverted bench without support).

A familiarization period was provided two weeks prior to data collection to ensure that all participants fully understood the physical fitness tasks and could perform them correctly. All measurements were conducted in the morning in a sports hall. Participants wore appropriate gym attire. Prior to performing the motor tasks, the boys completed a 10-minute general developmental warm-up.

Body measurements included body mass, assessed using an OMRON BF500635 medical scale (Omron Ltd., Japan), and body height, measured with a GPM anthropometer (Vitako Ltd., Switzerland). The obtained data were used to calculate Body Mass Index (BMI).

A research protocol was approved by the Bioethics Review Committee, University of Rzeszow (Approval Reference Number 3/04/2020). The examinations was fully anonymous, and was conducted in conformity to the guidelines of the Helsinki Declaration. Parents' and/or legal guardians' provided written informed consent for their children's participation, after obtaining detailed explanations about the research, including information about the study aim, data collection procedures, participants' right to withdraw at any point, ass well as anonymity and confidentiality of the data.

Statistical analysis

The normality of the variable distributions was assessed via the Shapiro-Wilk test. The collected data were analyzed using the chi-square test, Student's t-test for independent samples, or the Mann-Whitney U test, as well as Pearson's linear correlation or Spearman's rank correlation, depending on the type and distribution of the variables. The level of statistical significance was set at $p<0.05$. Statistical analyses were performed using Statistica 13.3 (StatSoft Inc., Tulsa, OK, USA; StatSoft PL, Krakow, Poland).

2. Results

Table 2 presents the comparison of all variables of the Eurofit Special test between trained football players and untrained subjects. Young male football players with Down syndrome scored better for Standing Long Jump ($p<0.001$), Bent Knee Sit-ups in 30 seconds ($p<0.001$), 2 kg Medicine Ball Forward Push with one hand ($p<0.001$), and Walking on a Gymnastic Bench in the Upright Position ($p=0.001$) while for 25 m Run from a High Start, boys from the control group achieved better results ($p<0.001$).

Table 2. Intergroup comparison of Eurofit Special test results

Group	$\bar{x}$ ±SD	Max-Min	Q_{25}	Me	Q_{75}	Student's t-test for independent variables	
Standing Long Jump [cm]							
Study	130.73±15.77	159.00-103.00	119.00	131.00	140.00	t=3.80	p<0.001*
Control	113.90±18.45	142.00-71.00	103.00	115.50	129.00		
Bent Knee Sit-ups in 30 seconds [number of repetitions]							
Study	16.90±5.24	27.00-8.00	13.00	17.00	20.00	t=4.22	p<0.001*
Control	12.03±3.53	20.00-6.00	9.00	12.00	14.00		
Seated Forward Bend [points]							
Study	26.87±9.00	40.00-15.00	21.00	28.50	34.00	t=0.00	p=1.000
Control	26.87±7.99	41.00-15.00	20.00	25.50	34.00		
25 m Run from a High Start [s]							
Study	5.97±1.10	8.84-4.28	5.09	5.69	6.71	t=5.30	p<0.001*
Control	4.57±0.94	6.79-3.18	3.88	4.19	5.17		
2 kg Medicine Ball Forward Push with one hand [cm]							
Study	203.57±32.86	260.00-143.00	182.00	202.50	233.00	t=3.98	p<0.001*
Control	174.20±23.51	210.00-138.00	155.00	171.00	201.00		
Walking on a Gymnastic Bench in the Upright Position [points]							
Study	4.60±0.81	5.00-2.00	5.00	5.00	5.00	t=3.35	p=0.001*
Control	3.90±0.80	5.00-2.00	3.00	4.00	4.00		

$\bar{x}$ – arithmetic mean value; SD – standard deviation; Q_{25} – lower quartile; Me – median; Q_{75} – upper quartile; t – value of the Student's t-test for independent variables statistics; p – probability value
*p<0.05

The data in Table 3 indicate no statistically significant relationships of Eurofit Special test results with age and BMI.

Table 3. Relationships between Eurofit Special test results with age and BMI of study participants

Variables	Study group	Control group

Age [years]	Standing Long Jump [cm]	R=-0.02; p=0.926	R=-0.25; p=0.182
	Bent Knee Sit-ups in 30 seconds [number of repetitions]	R=-0.17; p=0.356	R=-0.23; p=0.231
	Seated Forward Bend [points]	R=-0.04; p=0.820	R=-0.10; p=0.588
	25 m Run from a High Start [s]	R=0.02; p=0.935	R=0.15; p=0.420
	2 kg Medicine Ball Forward Push with one hand [cm]	R=0.24; p=0.199	R=-0.38; p=0.057
	Walking on a Gymnastic Bench in the Up-right Position [points]	R=0.06; p=0.741	R=-0.09; p=0.645
BMI	Standing Long Jump [cm]	r=-0.18; p=0.354	r=-0.02; p=0.910
	Bent Knee Sit-ups in 30 seconds [number of repetitions]	r=-0.07; p=0.703	r=-0.24; p=0.194
	Seated Forward Bend [points]	r=0.15; p=0.443	r=0.21; p=0.252
	25 m Run from a High Start [s]	r=0.04; p=0.852	r=0.00; p=0.985
	2 kg Medicine Ball Forward Push with one hand [cm]	r=0.01; p=0.937	r=0.04; p=0.823
	Walking on a Gymnastic Bench in the Up-right Position [points]	r=0.12; p=0.542	r=0.19; p=0.313

R – Spearman's rank correlation coefficient; r – Pearson's linear correlation coefficient; p – probability value

3. Discussion

Our study showed that boys who practiced football regularly performed better on the tasks: Standing Long Jump, Bent Knee Sit-ups in 30 seconds, 2 kg Medicine Ball Forward Push with one hand, and Walking on a Gymnastic Bench in the Upright Position, than their non-practicing peers. This suggests that playing football has an effect on improving lower limb, upper limb and abdominal muscle strength and dynamic balance in boys with Down syndrome. Moreover, it indicate that functional training, which offers the possibility of using varied combinations of exercises and training loads, should be used not only in amateur and competitive sport for people with Down syndrome, but also in shaping skills used in everyday life and in rehabilitation to improve muscle strength and restore control and function of the neuromuscular system. There is a lack of studies in the literature on the effects of exercise training on functional fitness in people with Down syndrome. The few studies include those by Gupta et al. [9], which have shown a positive impact of a 6-week training program containing progressive resistive exercises on lower limb muscle strength and balance in children with Down syndrome. Aly and Abonour [2] found that eight weeks of core stability exercises are effective in improving postural stability and balance of children with Down syndrome.

Similarly, Alsakhawi and Elshafey [3] showed that core stability exercises and treadmill training improved balance, while Querido et al. [19] observed that swimmers with Down syndrome performed better than untrained individuals with Down syndrome in tests assessing dynamic balance, muscle strength and speed.

Our research has shown that non-exercising boys performed better on a 25-meter running test than those who had been trained in soccer. This may be due to a number of factors, including the specific nature of football training, which focuses on improving technique, coordination and endurance as well as speed. In addition, although footballers are fast on the pitch, they do not necessarily perform best in standardised tests that measure only speed over a short distance. This suggests that coaches should introduce more speed-enhancing exercises into football training. This will certainly lead to improvements in players' dribbling, change of direction speed and running speed over a distance other than 25 meters.

An interesting issue is the problem of flexibility in people with Down syndrome. We did not find any intergroup differences in the results of the forward bending test in a straight sitting position. This is puzzling as the genetically determined muscle hypotonia and joint hypermobility characteristic of Down's syndrome should translate into improved results in the limberness test. However, studies by other authors do not support this assumption, and in fact show the opposite. In fact, Wieczorek et al. [24] found low, below normal, levels of flexibility in 13-year-old boys with Down syndrome. Sadziak and Wieczorek [20] came to similar conclusions in their study of people with Down syndrome and moderate mental retardation aged 12 to 20. Querido et al. [19] also observed a moderate Cohen's effect size in adult swimmers with Down syndrome in relation to improvement in flexibility under the influence of swimming training. Therefore, taking into account the results of our study and the reports of other authors, it can be concluded that flexibility is a characteristic that cannot be modified by sports training. The lack of a clear picture of the development of flexibility in people with mental retardation was pointed out by Skowronski et al. [23], who pointed out that this characteristic of the body should be treated individually, taking into account conditions that increase flexibility (flaccidity), so that it is the genes that determine a person's potential abilities.

Our research did not show any relationships between the results of individual motor performance tests with age and BMI. The difficulty in establishing these relationships may be due to the influence of other developmental factors specific to Down syndrome on motor skills. In particular, BMI should not be used as a determinant of motor performance in children and young people with Down syndrome and intellectual disability. Due to the lack of scientific reports addressing a similar issue, it is difficult to compare our findings with those of other authors.

In conclusion, our research provides new information on aspects of physical performance that distinguish young male footballers with Down syndrome from their untrained peers. The study showed that a football training can improve physical fitness of boys with Down syndrome and mild intellectual disability, especially dynamic balance, muscle strength of the lower limbs, upper limbs and abdomen. Accordingly, it can be concluded that the listed characteristics are the most important indicators of the effectiveness of football training in these individuals. The ability to maintain balance, as well as muscle strength, translates into the ability to perform activities of daily living. According to Gupta et al. [9], Santoro et al. [21], Lagan et al. [12], Zulqar et al. [26], children's performance is a set of individual characteristics, the expression of which is the functional capacity of the body. It is considered a measure of overall resourcefulness, i.e. the ability to perform activities of daily living independently and safely in order to meet basic life needs. Therefore, regular participation in football training can make a difference in terms of improving physical function to enable active participation in life.

The way the subjects were admitted into the study pursued in line with the adopted inclusion criteria, on the one hand, allowed to ensure homogeneity within a group fully corresponding to pertinent characteristics of the 11-13 years old population of boys with Down syndrome, and mild intellectual disability, residing in the Podkarpackie and Lesser Poland Voivodeships, Poland, while on the other affected the restriction of the study range to one area and age group which might well be regarded as a study limitation. Therefore, future research should focus on the assessment of other age groups and on comparative analysis of different populations from various regions of Europe and other continents.

4. Conclusions

1. Football training improves physical performance of boys with Down syndrome and mild intellectual disability, especially dynamic balance, muscle strength of the lower limbs, upper limbs and abdomen. It can therefore be assumed that these characteristics are the most important indicators of the effectiveness of football training in these individuals.
2. The results of the individual motor performance tests were not related to age and BMI, so these variables should not be considered as determinants of motor performance in children and adolescents with Down syndrome and associated mental retardation.

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