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The Influence of Physical Activity Regime on Body Composition in Teenagers With and Without Intellectual Disabilities

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Abstract: This study aims to assess several morphofunctional parameters in female teenagers with and without intellectual disability to characterise normality and its disturbances. More precisely, the purpose was to examine the factors contributing to the differences in body composition elements between groups, such as the physical activity level. To evaluate these parameters, we used bioelectrical impedance analysis technology (BIA), most commonly used in studies concerning body composition because it is non-invasive, quick, with high data fidelity; it can be easily moved to various locations and applied straightforwardly among populations with diverse types of intellectual disability. Our research sample comprised 212 subjects (boys and girls) aged 17.1±0.6, divided into six groups by gender and type of intellectual disability. The study found influences of physical activity level on body composition components. In addition, we report a highly significant relationship for $p<0.05$, body mass index and the independent variable (No. of min./week) in some groups.

Keywords: body composition; physical activity; intellectual disability

1. Introduction

According to WHO, physical activity is "any bodily movement produced by skeletal muscles that requires energy expenditure. Physical activity refers to all movement, including during leisure time, for transport to and from places, or as part of a person's work"[1]. Physical activity can include various physical activities, such as planned physical effort (participation in Physical Education classes and sports practices), play, indoor/outdoor chores, leisure fitness, and walking [2].

Recent studies [3] have shown that exercising can improve general health, muscle development, cardiorespiratory health, and cognitive and mental performance. Numerous studies argue that physical activity brings benefits to persons with intellectual disability. A systematic review conducted in 2018 by Crespillo-Jurado examined the effects of physical exercises on health and quality of life in persons with intellectual disabilities. The study reports that physical exercises can improve these patients' general health, motor development, and quality of life [4]. Another research carried out in 2023 by Lancioni et al. analysed the effects of long-term physical exercise programs on health and motor skills in youths with an intellectual disability. They concluded that physical exercise programs significantly improved balance, muscle strength, and agility [5]. A different study focused on the effects of a workout routine on functional capacity and the quality of life in teenagers with an intellectual disability. Per the research, the workout routine improved physical effort resistance and quality of life [6]. An investigation conducted in 2020 examined the effects of a workout routine on motor skills and self-esteem in teenagers with an intellectual disability. According to the study, physical exercise programs significantly improved motor skills and self-esteem among the participants [7].

Physical activity correlates positively with cardiorespiratory and muscular fitness; both are essential components of general health, while physical idleness is the fourth most crucial risk factor of early death worldwide. Physical idleness is also a key risk factor for obesity and life-threatening disorders like cardiovascular disease, cancer, and diabetes [8]. Comprehensive research has been carried out on the health benefits of physical activity among adolescents with an intellectual disability. The research suggests that physical activity in and outside school positively impacts teenagers' physical, psychological, and social development. More precisely, physical activity has been proven to improve the quality of life [9], decrease the risk of disease, increase mental and emotional well-being [10–12], improve school performance and motor skills [13], increase the frequency of prosocial behaviours [14] and improve self-concept [15].

2. Materials and Methods

This investigation per se began a while ago, through conversations with Physical Education and Sports teachers within inclusive education centres that school children with an intellectual disability, discussions with specialists in the field, and the literature study. The activities took place in the gymnasiums of educational establishments and the physical therapy practices of the “Sf. Andrei” School Centre Gura Humorului (Suceava County), The “Constantin Păunescu” School Centre Iaşi, “Elisabeta Polihroniade” Inclusive Education School Centre Vaslui, “Emil Gârleanu” Special School No. 1 Galați. This study included 212 subjects from the aforementioned institutions, distributed in six groups by gender and type of disability, as illustrated in Table 1.

Table 1. Distribution of subjects by age, cases, and educational establishments.

Subjects	Gender	N	Age (mean±std.dev.)	Case Observation
Group 1(WID) Without intellectual disabilities	M	44	17.7±0.9	WID
Group 2 (WID) Without intellectual disabilities (WID)	F	55	17.2±0.7	WID
Group 3 (MID) Moderate intellectual disability	M	57	17.05±0.7	MID
Group 4 (MID) Moderate intellectual disability	F	22	16.6±0.8	MID
Group 5 (SID) Severe intellectual disability	M	23	17.4±0.8	SID
Group 6 (SID) Severe intellectual disability	F	11	17.1±0.8	SID

We used the TANITA MC 580 professional device to determine the body composition and a dedicated analysis software, i.e., TANITA PRO SOFTWARE – 3.4.5 version – the Tanita PRO software pack was developed in partnership with the most significant medical software developer (Medizin & Service GmbH). The software can store and analyse the data from the Tanita MC 580 monitor. According to EU Regulations, both the device for body composition and the software are medically approved, and they observe the Regulations in force (Council Directive 93/42/EEC of 14 June 1993 concerning medical devices). The use of TANITA MC580 and TANITA PRO SOFTWARE generates the following measurements: Body mass – Kg; BMI (kg/h2); Body fat %; Muscle mass %; BMR (kcal); Body fat – Kg; Muscle mass – Kg; SMM – skeletal muscle mass; Bone mineral mass; Segmental analysis on upper/lower limbs, left/right, which, besides height (determined using the telemeter) represent the dependent variables.

The independent variables are gender, type of intellectual disability, and number of minutes of physical activity/week. We analysed the data collected using numerical syntheses in SPSS 20.0., thus removing some of the data to increase relevance.

Ethics: This study was conducted per the 1964 Declaration of Helsinki.

Hypothesis. Physical activity among teenagers with an intellectual disability can influence the body composition parameters.

3. Results

We used simple linear regression to assess the effect of physical activity (No. of min./week) on body composition parameters. Following this analysis, we identified just one interaction in the group of boys, between physical activity (No. of min./week) and skeletal muscle mass, for $p<0.05$ (Table 2); it can be considered that the independent variable (No. of min./week) influences skeletal muscle mass.

Table 2. Linear regression for SMM in the group of boys WID (ANOVA[a]).

Model		Sum of s#quares	df	Mean squ#ares	F	Sign. thresh.
1	Regression	156.055	1	156.055	4.817	.030[b]
	Residual value	3952.040	122	32.394		
	Total	4108.095	123			

a. Dependent variable: SMM; b. Prediction: (Constant), No. of min./week; F-approximation used to calculate significance; df-degree of freedom for Fisher distribution.

Thus, the value of (adjusted) regression coefficient $R^2 = 0.038$ (Table 3) represents the variation percentage, i.e., 3.8% in the dependent variable of skeletal muscle mass (SMM). This percentage can be explained by the independent variable (No. of min./week).

Table 3. The regression coefficient for the group of boys WID (Anova[b]).

Model	R	R^2	R^2 Adjusted	Estimated Standard Error
1	.195[a]	***.038***	.030	5.6916

a. Prediction: (Constant), No. of min./week; b-dependent variable; R- regression coefficient; R^2 – regression coefficient squared

We did not identify any statistically significant interactions for the two other groups of boys with MID and SID. However, we used a One-Way ANOVA test to determine the effect of physical activity on specific components of body composition. In this respect, to determine the relationship between the dependent variables and the independent variable (weekly physical activity), we identified four levels of physical activity/week in agreement with the activities conducted by the subjects during Physical Education classes, sports circle classes, or other extracurricular sports activities. Hence, we pointed out the following levels of physical activity:

NA 1 - Activity level 1 - physical activity < 90 min.

NA 2 - Activity level 2 - physical activity ranging between 90 – 135 min.

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NA 3 - Activity level 3 - physical activity ranging between 135 – 240 min.
NA 4 - Activity level 4 - physical activity >240 min.

As shown in Table 4, the weekly physical activity level generates significant differences for variables such as height, muscle mass (kg), and skeletal muscle mass. The multiple comparison (Bonferroni) between the activity levels highlights significant differences between NA 2 (AF - 90-135 min) and NA 4 (AF > 240 min) for skeletal muscle mass (Kg) p<0.05 (Table 5) with a difference between means of 6.08 kg skeletal muscle mass and between NA 1 (AF < 90 min.) and NA 4 (AF > 240 min), for the same dependent variable p<0.05 (Table 3), the difference between means with a value of 4.51 kg. Another significant difference was noted in muscle mass in kg for p<0.05 (Table 5) between NA 2 and NA 4 (the difference between means amounts to 9.00 kg).

Table 4. The ANOVA test for the dependent variables in the groups of boys.

		Sum of Squares	**df**	**Mean Squares**	**F**	**Sign. Thresh. (p)**
Height - cm	Between groups	830.194	3	276.731	3.524	*** .017***
	Within the groups	9424.041	120	78.534		
	Total	10254.234	123			
Body mass-Kg	Between groups	1403.089	3	467.696	2.172	.095
	Within the groups	25839.632	120	215.330		
	Total	27242.721	123			
BMI (kg/m2)	Between groups	33.594	3	11.198	.561	.642
	Within the groups	2396.306	120	19.969		
	Total	2429.900	123			
Body fat %	Between groups	60.423	3	20.141	.306	.821
	Within the groups	7904.260	120	65.869		
	Total	7964.683	123			
Muscle mass %	Between groups	17.109	3	5.703	.178	.911
	Within the groups	3834.498	120	31.954		
	Total	3851.607	123			
BMR (kcal)	Between groups	438542.076	3	146180.692	2.307	.080
	Within the groups	7603922.916	120	63366.024		
	Total	8042464.992	123			
Body fat-Kg	Between groups	40.084	3	13.361	.203	.894
	Within the groups	7885.495	120	65.712		
	Total	7925.580	123			
Muscle mass-kg	Between groups	964.858	3	321.619	4.175	*** .008***
	Within the groups	9244.679	120	77.039		
	Total	10209.538	123			
SMM	Between groups	503.634	3	167.878	5.589	*** .001***
	Within the groups	3604.461	120	30.037		
	Total	4108.095	123			

df-degree of freedom for Fisher distribution; F-approximation used to calculate significance; *Significance threshold for p<0.05.

Table 5. Significance threshold and the difference between means for the group of boys WID.

Dependent Variable	**(I) Phys. act. lev.**	**(J) Phys. act. lev.**	**The Difference Between Means(I-J)**	**Er. Std.**	**Sig.**	**95% Confidence Interval**	
						Lower Limit	**Upper Limit**
Muscle mass-Kg	1.00	2.00	3.0655	1.9699	.734	-2.219	8.350
		3.00	-4.7827	4.5041	1.000	-16.866	7.300

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		4.00	-5.9382	2.3037	.067	-12.118	.242
	2.00	1.00	-3.0655	1.9699	.734	-8.350	2.219
		3.00	-7.8481	4.7025	.586	-20.463	4.767
		4.00	***-9.0037****	2.6708	***.006***	-16.169	-1.839
	3.00	1.00	4.7827	4.5041	1.000	-7.300	16.866
		2.00	7.8481	4.7025	.586	-4.767	20.463
		4.00	-1.1556	4.8518	1.000	-14.171	11.860
	4.00	1.00	5.9382	2.3037	.067	-.242	12.118
		2.00	***9.0037****	2.6708	***.006***	1.839	16.169
		3.00	1.1556	4.8518	1.000	-11.860	14.171
SMM	1.00	2.00	1.5690	1.2300	1.000	-1.731	4.869
		3.00	-4.9532	2.8124	.485	-12.498	2.592
		4.00	***-4.5143****	1.4385	***.013***	-8.373	-.655
	2.00	1.00	-1.5690	1.2300	1.000	-4.869	1.731
		3.00	-6.5222	2.9363	.169	-14.399	1.355
		4.00	***-6.0833****	1.6677	***.002***	-10.557	-1.609
	3.00	1.00	4.9532	2.8124	.485	-2.592	12.498
		2.00	6.5222	2.9363	.169	-1.355	14.399
		4.00	.4389	3.0295	1.000	-7.688	8.566
	4.00	1.00	***4.5143****	1.4385	***.013***	.655	8.373
		2.00	***6.0833****	1.6677	***.002***	1.609	10.557
		3.00	-.4389	3.0295	1.000	-8.566	7.688

The difference between means is significant for the threshold $\alpha < 0.05$.

In the female groups, the most relevant effects of the independent variable No. of min./week on the dependent variables were identified in the group with moderate intellectual disability, as follows:

Skeletal muscle mass (SMM) can be influenced by up to 18.5% by the number of minutes of physical activity (Table 6), for p<0.05 (Table 7)

Table 6. The regression coefficient (SMM) for the group of girls with MID.

Model	R	R^2	R^2 Adjusted	Estimated Standard Error
1	.431a	.185	.145	2.9579

a. Prediction: (Constant), No. of min./week; b-dependent variable; R-the regression coefficient; R^2 – regression coefficient squared.

Table 7. Linear regression for SMM in the group of girls MID (ANOVA[a]).

Model		Sum of Squares	df	Mean Squares	F	Sign. thresh.
1	Regression	39.825	1	39.825	4.552	.045[b]
	Residual value	174.978	20	8.749		
	Total	214.804	21			

a. Dependent variable: SMM; b. Prediction: (Constant), No. of min./week; F-approximation used to calculate significance; df-degree of freedom for Fisher distribution.

Concerning body mass index, we note a highly significant relationship for p<0.05 between it and the independent variable (No. of min./week) (Table 8).

Table 8. Linear regression for BMI in the group of girls MID (ANOVA[a]).

Model		Sum of Squares	df	Mean Squares	F	Sign. thresh.
1	Regression	150.807	1	150.807	8.709	.008[b]
	Residual value	346.324	20	17.316		

Total	497.131	21

a. Dependent variable: BMI; b. Prediction: (Constant), No. of min./week; F-approximation used to calculate significance; df-degree of freedom for Fisher distribution.

As illustrated in Table 9, the value of the regression coefficient squared is 0.303, i.e., the body mass index value can be influenced by up to 30.3% by the No. of min./week. of physical activity.

Table 9. The regression coefficient (BMI) for the group of girls with MID.

Model	R	R^2	R^2 Adjusted	Estimated Standard Error
1	.551[a]	.303	.269	4.1613

a. Prediction: (Constant), No. of min./week; b-dependent variable; R-the regression coefficient; R^2 – regression coefficient squared.

To determine the effect of the independent variable (physical activity - No. of min./week) on several components of body composition (dependent variables), like in the groups of boys, we used a One-Way ANOVA test for the entire group of girls concerning the four levels of physical activity, but no statistically significant differences were identified.

4. Discussion

Various research [16,17] reports that the physical activity level influences muscle mass in boys. It is due to vigorous physical exercises increasing the synthesis of muscle proteins, which can increase muscle mass. Generally, these studies demonstrate that the physical activity level and the type of physical exercises performed by boys significantly impact muscle mass. Besides these studies, other research indicated that the physical activity level can have a crucial impact on muscle mass in boys. For instance, another investigation conducted by [18] shows that strength training in combination with a protein-rich diet can significantly increase the muscle mass of teenage boys [19].

Studies show that around 47% of disabled adolescents are obese, i.e., 10% higher than typical teenagers [20–22]. Generally, the activity level of disabled persons is insufficient to prevent disease and other chronic diseases driven by idleness. Physical activity usually decreases as young people reach adulthood. However, studies have shown that specific physical exercise programs can reverse this trend and create favourable premises for physical activity to remain present in the life of this population [23].

The current methods of adapted sports fail to approach the complexity of life among teenagers with an intellectual disability. Little attention has been given to the motivation necessary to be physically active in a population at risk that requires increased physical activity [24]. However, disabled people usually cannot experience it due to personal and significant environmental barriers or the few opportunities to participate in sports or other physical activities from a young age [25]. Furthermore, as young people become adults, their physical activity level decreases [26,27].

Consequently, disabled people do not carry out enough physical activity to prevent illnesses related to idleness and other chronic diseases driven by inactivity [20,28]. However, youths with intellectual disabilities do not entirely benefit from it because they tend to be less physically fit and overweight than developing youths without intellectual disabilities. Fortunately, previous research [29] has proven that individuals with disabilities can improve their body composition indicators by exercising [30].

Disabled people are significantly less physically active than their typical peers, which can lead to a variety of adverse health consequences [13,31]. The outcomes of this idleness manifest in several secondary diseases, among which cardiovascular disease, i.e., the first cause of death among these persons [20]. Persons without disabilities usually learn valuable motor skills and appreciate sporting activities and other leisure programs from a young age [32,33]. However, disabled people face many barriers to becoming more physically active, primarily due to the lack of proper recreation and adapted sports programs.

Youth programs positively influence physical activity levels until adulthood [26,34]. In contrast, inefficiently designed and unfolded youth programs negatively impact the future physical activity level due to low effort or lack of motivation, which play a significant role in forming a positive attitude for a disabled child. Hence, during training, the recommendation is to insist on the repeated execution of successful actions, on the permanent use of reinforcements and encouragements, and on repeating appreciation regarding the positive aspects of subjects [35].

Disabled youths are disproportionately underserved by the recreation and adapted sports programs compared to typical youths. This lack of programs contributes to higher idleness among youths with disabilities, persisting to adulthood [36]. Providing adapted sports programs is a crucial characteristic of a society promoting equal opportunities [37,38].

In addition, it is relevant to mention that the physical activity level is not the only factor influencing muscle mass in boys. Other significant factors include proper nutrition, hormone level, and the quantity and quality of sleep [39].

5. Conclusions

Generally, adolescents with severe intellectual disabilities tend to have a different body composition than persons without intellectual disabilities. More precisely, individuals with severe intellectual disability tend to have a lower or higher weight than the population's average value.

Concerning physical activity in persons with an intellectual disability, there is mounting evidence in favour of structured physical exercise programs for these populations, demonstrating body composition alterations. Furthermore, combined exercise programs have positively affected aerobic capacity and muscle power. However, practical and methodological guidelines are not clear concerning the organisation of components suggested for the structure of training sessions and the programs to improve the physical shape and health of persons with intellectual disabilities.

Finally, it is worth noting that the physical activity level is essential in increasing muscle mass in boys. However, it is crucial to consider other factors that can influence this process.

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