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RESEARCH ARTICLE

Determining the Fitness Level of People with Down Syndrome Living in Kosovo Based on the ALPHA Protocol

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Abstract

Purpose: This study aimed to establish national norm values for body composition and fitness levels among individuals with Down syndrome. It also aimed to investigate gender differences in body composition features and fitness parameters, analyze the impact of the region where individuals with Down syndrome reside, and compare their fitness levels with international peers. **Methods:** The sample included 81 participants, 40 females (height: 146.6±4.88 cm, weight: 63.6±16.4 kg) and 41 males (height: 157.4±6.21 cm, weight: 66.8±14.8 kg). To assess the physical fitness levels of the participants with Down syndrome, a modified version of the ALPHA testing protocol was used. **Findings:** The results demonstrated significant gender differences ($p<0.05$) in body composition and fitness parameters, with males generally exhibiting better outcomes compared to females. Moreover, significant disparities ($p<0.05$) in body composition and fitness parameters were observed among individuals with Down syndrome residing in different regions of Kosovo. Noteworthy gender disparities exist in terms of body composition and physical fitness metrics, with male participants achieving superior results compared to their female counterparts. Furthermore, noticeable variations were observed among the regional Down syndrome centers, with participants from older centers displaying improved fitness metrics and body composition features compared to those from newly established facilities. **Conclusion:** Gender differences in body composition and fitness were evident, with males outperforming females, except in muscle mass. Future studies should explore fitness and health barriers in Kosovo's DS population, with a focus on improving physical activity through tailored strategies.

Keywords
Body Composition, Disabled People, Motoric Tests, Norm Values

INTRODUCTION

Down Syndrome (DS), is a genetic anomaly instigated by a trisomy of chromosome 21, emerging as the principal genetic determinant of intellectual disability (ID) (Franceschi et al., 2019). DS correlates with numerous health complications, including congenital heart disease, obstructive sleep apnea, celiac disease, and various endocrinopathies. These endocrine irregularities typically manifest as thyroid disorders, diminished bone density, diabetes, stature reduction, and a predisposition to overweight or obesity (Franceschi et al., 2019; Whooten et al., 2018). Indeed, prevalence of overweight and obesity among individuals with DS ranged from 23% to 70%, being significantly higher compared to their counterparts without DS (Brantmüller et al., 2015).

However, participating in regular physical activity (PA) is a cornerstone of a healthy lifestyle, applicable to people of all ages and backgrounds. The benefits of PA for children and adolescents with disabilities, including DS, are well-documented. These benefits encompass maintaining muscle strength, flexibility, and mental well-being (Martin Ginis et al., 2016; Toptaş Demirci & Dolaş, 2023); enhancing overall health and physical fitness (Collins and Staples, 2017);

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boosting self-confidence and self-efficacy (Shields et al., 2012; Must et al., 2015); and fostering social support from peers (Pan et al., 2015).

Yet, compared to their typically developing counterparts, children and adolescents with disabilities often face higher levels of physical inactivity, leading to an elevated risk of secondary or chronic conditions like obesity (Centers for Disease Control and Prevention, 2010). To counteract these health risks, it is recommended that all individuals aged 6-17, irrespective of disability, engage in at least 60 minutes of moderate to vigorous physical activity each day (WHO, 2010).

Given the increased susceptibility of children with intellectual and developmental disabilities to inactivity-related health issues, focusing on enhancing their physical capabilities for daily activities and overall well-being is imperative (Collins & Staples, 2017). In this regard, various international researchers have explored specific aspects of physical activity and fitness level among the individuals with Down Syndrome. More specifically, Tejero-Gonzalez et al., (2013) have tested the validity and the reliability of a protocol for evaluating physical fitness level of DS individuals. They have found the Assessing Levels of Physical Activity (ALPHA) battery of tests to be reliable and suitable for assessing health-related fitness in adolescents with Down Syndrome (Tejero-Gonzalez et al., 2013).

In the last decade, physical fitness level of children and adolescents in Kosovo has been investigated, based on which normative values were determined (Berisha & Çilli, 2018; Berisha & Çilli, 2020). In addition, Tishukaj and colleagues (2017) studied the impact of living environment on physical fitness and anthropometric characteristics of adolescents (Tishukaj et al., 2017). Despite this body of knowledge, regarding the fitness level of healthy population in Kosovo, there is a notable absence of information about the physical fitness, activity levels, and weight status among children and adolescents with Down syndrome in Kosovo. Furthermore, the lack of monitored fitness levels and tailored activities exacerbates the risk of poor physical and motor status. Addressing this gap requires answers to critical questions, which form the core of this study such as the determination of physical fitness level of individuals with DS, the establishment of standards for varying levels of physical fitness within this population, and the comparison of results with other developing and developed countries.

The study's objectives revolve around improving the fitness of individuals with Down syndrome in Kosovo, a cohort currently lacking tailored physical activity initiatives and systematic monitoring. Therefore, this study aimed to: a) create the national norm values of body composition and fitness level of individuals with down syndrome and b) investigate gender differences in body composition features and fitness parameters; c) analyze the effect of the region they DS individuals live in, on body composition characteristics and fitness parameters; d) compare their fitness level with international peers. Furthermore, it has been hypothesized that body composition features and physical fitness parameters are affected by gender and the geographic region.

MATERIALS AND METHODS

Participants

The study sample consisted of 81 volunteers aged 15 and above randomly selected out of the population that is approximately 160 children and adolescents with Down Syndrome in the Republic of Kosovo. The sample group consisted of 40 females (H: 146.6±4.88, W: 63.6±16.4), and 41 males (H: 157.4±6.21, W: 66.8±14.8). While the 34 participants were between 15-18 years (16.3±1.41), old 47 of them were above 18 years old (25.4±6.4). All participants were registered in one of the DS centers in the Republic of Kosovo, located in five biggest regions of the country e.g. Pristine (01), Prizren (04), Mitrovica (02), Ferizaj (05), and Gjilan (06). Whereas there is not DS centers located in Peja (03), and Gjakova (07) regions.

This research has met ethical rules. Research ethical approval was obtained from the Research Ethics Committee of the Institutional Review Board at the University for Business and Technology (UBT) with approval letter code 12334/45. Participants provided informed consent, with the volunteer form covering research details, risks, benefits, confidentiality, and participant rights. The research strictly adhered to the ethical principles of the Declaration of Helsinki, prioritizing participant's rights and well-being in design, procedures, and confidentiality measures.

All study procedures were realized in close collaboration with "Down Syndrome Kosova (DSK)", which organized the participants and

ensured a sustainable environment for testing team to administer fitness tests according to the ALPHA protocol. Prior to the participation in the study, after received detailed information regarding the study procedures, all children and adolescents, and their parents/guardians provided written informed consent.

Figure 1. Locations of DSK centers in kosovo

The following criteria were used as inclusion criteria: to be diagnosed with Down syndrome, to be registered in the Down Syndrome Kosova organization, absence of any acute or chronic illness that may worsen as a result of participating in the activities foreseen in the research, participants in the research must have a doctor's approval. The following exclusion criteria were considered: individuals with severe to profound intellectual disability, individuals with difficulties in gripping objects, individuals who use crutches, individuals dependent on others to perform motor tasks, individuals with amputations and physical disabilities and individuals dependent on wheelchairs.

Procedures

The data were collected between the months of September and November. Initially, all participants completed the anthropometric and body composition assessments. The physical fitness tests were conducted in the same day and consisted of four tests selected to assess the same health-related fitness components assessed by ALPHA fitness testing protocol for people with Down Syndrome Tejero-Gonzalez et al., (2013) evaluating body composition, upper-body strength and cardiorespiratory endurance (Tejero-Gonzalez et al., 2013). The ALPHA protocol includes also the 20-meter shuttle run test (Level) and 4x10 meters shuttle run test (sec). However, the data collected with our sample for these two tests were not valid and reliable due to the fact that more than 50% of participants could not perform properly these tests, and those who performed the tests could not follow the test protocol. Therefore, in order to have more accurate results these tests were excluded. As a result, a modified version of the burpees test, explained below, was used to test the cardiorespiratory capacity and local endurance and force. Before conducting the physical fitness tests, every participant underwent a standardized dynamic warm-up led by the fitness test coordinator.

Physical Fitness Tests

The tests used in order to determine the fitness level of people with "Down Syndrome", assess the same fitness components as the ALPHA protocol developed and used by (Tejero-Gonzalez et al., 2013; Jonatan R Ruiz et al. 2011). The ALPHA test protocol is a reliable and valid tool to assess health-related physical fitness components in children and adolescents with DS.

Anthropometrics

The height of participants was measured employing a portable stadiometer (Seca, Hamburg, Germany) to the nearest 0.5 cm. Body mass was measured to the nearest 0.1 kg using a digital scale (Seca, Hamburg, Germany), with participants wearing light sports clothing and no shoes. In addition, Waist circumference, taken at the narrowest point at umbilicus level, was measured to the nearest 0.1 cm using an elastic circumference tape (Seca 201, Hamburg, Germany). All anthropometric measures were taken in the morning.

Body Composition

The Tanita (BC454) body composition analyzer was utilized to assess body composition features. An experienced professional conducted all measurements. Participants received instructions to abstain from alcohol and caffeine for 24 hours prior to the test, and to refrain from consuming food and fluids for at least four to five hours beforehand. Additionally, they were advised to avoid engaging in physical activity for 12 hours preceding the test. All measurements were taken in the morning. The parameters assessed were the following: body fat

percentage, fat mass, muscle mass, total body water, Body Mass Index (BMI), and basal metabolic rate (kilocalories).

Upper body strength

Dynamometric measurement of handgrip strength serves as a reliable and valid testing procedure for upper body strength (Nhantumbo et al., 2012; Oppewal, & Hilgenkamp, 2020), and the procedures recommended in the Brockport Fitness Test Manual (Winnick, & Short. 2001) were used. Following a brief demonstration and adjustment for hand size, isometric handgrip strength was assessed in both the dominant and non-dominant hands using a portable hydraulic dynamometer (Jamar, Warrenville, IL, USA). Participants were instructed to sit with their shoulders adducted and neutrally rotated, elbows flexed at 90 degrees, and to exert maximal force while squeezing the handle for at least two seconds. Each hand underwent two trials, with a 10-second resting period between attempts, alternating testing sides. The highest scores attained from the two trials were selected for further analysis, presenting absolute values.

Cardiorespiratory fitness

Burpee is a multi-joint exercise that is executed by activating the major muscle groups of the whole body. Recently, Yamashita (2023) conducted a study demonstrating a positive relationship between the 3 Minutes Burpees Test (3MBT) and maximal oxygen uptake estimated using the Yo-Yo IRT (Yamashita, 2023). To assess the cardiorespiratory fitness level of participants, a Modified Burpees Test (MBT) was utilized. Given the specific nature of the sample, the test was modified to enhance its validity and reliability. This was achieved by implementing a 5-second rule, which required participants to stand up from a lying position within 5 seconds and return to a standing position within 5 seconds. The 5-second rule was set based on the pilot testing conducted with 10 DS young individuals. The mechanics of the MBT were adjusted to accommodate the characteristics of the participants and minimize the potential for error (Podstawski et al., 2019). The end of the test was determined by the inability of the participant to comply with the 5-second rule. The result of the test was registered in minutes.

Data analysis

The data analysis was performed using the Statistical Package for Social Sciences (SPSS version 26). The level of significance was set at ($p<0.05$). Initially, the normality of the data was tested with the Kolmogorov-Smirnov, Histogram, and Q-Q Plots methods. The sample was divided into 2 age categories (15 -18 years old and > 18 years old). Since the data proved to be non-parametric and the criteria of the assumptions have not been assumed, the Independent-Samples Mann-Whitney U Test Summary was used to analyze gender differences. The analysis of region differences has been performed by using Kruskal-Wallis 1-way ANOVA (k-samples), all pairwise, while the mean and standard deviation have been performed by using the One-Way ANOVA (Tamhane-s T2) method. Ultimately, the absolute values of body composition features and fitness tests are presented in reference tables in percentiles according to sex and age group, divided in five groups (Very low, Low, High and Very high, and the middle fifty value).

RESULTS

Descriptive statistics for all anthropometric and physical fitness tests for both genders are presented in (Table 1). In particular, results denote that there were statistically significant differences between genders in the majority of body composition features, except BW, VF, and WC ($p>0.05$). Additionally, in terms of physical fitness results, the HG resulted to be significantly different in boys compared to girls ($p<0.05$).

In addition, region based of difference statistics for body composition features and fitness tests are shown in (Table 2). Statistically significant differences ($p < 0.05$) were found between regions of Kosovo, where the DS centers are located, in body composition features and physical fitness tests, except regions 01 and 02 in W, regions 05 and 06 in MM and BM, and region 05 in BM resulted to be statistically not different from other regions ($p>0.05$) (Table 4).

Table 3 and 4 presents the norm values of body composition features separated into four categories (Very low, Low, High and Very high), and the middle fifty value, expressed in percentiles, which is used to compare results instead of the average value. In (Table 5) are presented the norm values for HG and MBT categorized four categories (Very low, Low, High and Very high), and the middle fifty value, expressed in percentiles, which is used to compare results instead of the average value.

Table 1. Gender differences conducted by an Independent-Samples Mann-Whitney U Test

Variables	Gender	X̄ ±SD	Mean Rank	Mann-Whitney U	Wilcoxon W	Test Statistic	Sig.(2-sided test)
Height (cm)	♀	146.6±4.88	23.85	1506.0	2367.0	1506.0	.000
	♂	157.4±6.21	57.73				
Weight (kg)	♀	63.6±16.4	37.75	950.0	1811.0	950.0	.219
	♂	66.8±14.8	44.17				
Body Mass Index (kg/m2)	♀	29.3±7.0	45.15	654.0	1515.0	654.0	.117
	♂	26.8±5.3	36.95				
Fat Percentage (%)	♀	28.2±8.4	54.11	295.5	1156.5	295.5	.000
	♂	17.5±7.9	28.21				
Water Percentage (%)*	♀	52.2±6.0	20.18	738.5	1144.5	738.5	.000
	♂	61.6±8.7	40.88				
Muscle Mass (kg)*	♀	43.2±6.3	20.84	718.0	1124.0	718.0	.000
	♂	52.8±7.5	40.14				
Bone Mass (kg)*	♀	2.3±.3	20.56	726.5	1132.5	726.5	.000
	♂	3.8±5.5	40.45				
Kilocalories (J)*	♀	1425±208.7	22.21	675.5	1081.5	675.5	.000
	♂	1659±239.6	38.63				
Visceral Fat (level)*	♀	4.6±3.6	32.11	368.5	774.5	368.5	.314
	♂	4.1±4.0	27.66				
Waist Circumference (cm)	♀	86.8±16.1	40.41	843.5	1704.5	843.5	.824
	♂	86.4±13.9	41.57				
Handgrip Force (Right) (kg)	♀	13.6±9.5	31.94	1133.5	1994.5	1133.5	.001
	♂	18.7±8.6	48.65				
Handgrip Force (Left) (kg)	♀	12.8±4.8	30.18	1152.0	2013.0	1152.0	.000
	♂	18.8±7.7	49.10				
Modified Burpees (time)	♀	4.24±5.27	35.08	663.0	1293.0	663.0	.704
	♂	3.91±3.56	36.94				

♀: female ♂: male
*Tests are not performed in the population under 18 years old
H: Height (cm), W: Weight (kg), BMI: Body Mass Index (kg/m2), F%: Fat Percentage (%), W%: Water Percentage (%), MM: Muscle Mass (kg), BM: Bone Mass (kg), KCAL: Kilocalories (J), VF: Visceral Fat (level), WC: Waist Circumference (cm), HG: Handgrip Force (R, L) (kg), MB: Modified Burpees (minutes), SBJ: Standing Broad Jump (cm).

Table 2. Regional differences conducted by an Independent-Samples Kruskal-Wallis Test

Variables	Regions	X̄ ±SD	Mean Rank	Test statistics	Asymptotic Sig.(2-sided test)	Pairwise comparisons
W	Prishtine (01)	61.3±12.1	36.24	10.626a	.031	05-04 (sig .022) 05-06 (sig .007) 01-06 (sig .022)
	Mitrovice (02)	64.3±15.6	39.14			
	Prizren (04)	69.7±14.6	49.06			
	Ferizaj (05)	55.5±11.3	26.89			
	Gjilan (06)	78.7±20.6	56.20			
BMI	Prishtine (01)	27.2±5.6	38.43	15.115a	.004	05-04 (sig .010) 05-06 (sig .000) 02-06 (sig .010) 01-06 (sig .009)
	Mitrovice (02)	26.8±5.1	37.28			
	Prizren (04)	29.1±5.6	47.06			
	Ferizaj (05)	23.5±5.2	22.17			
	Gjilan (06)	34.5±7.8	61.30			
MM*	Prishtine (01)	43.4±6.9	21.14	10.053a	.040	01-02 (sig .026) 01-04 (sig .004)
	Mitrovice (02)	50.8±10.2	34.65			
	Prizren (04)	94.3±151.4	38.83			
	Ferizaj (05)	49.2±5.6	35.00			
	Gjilan (06)	48.1±9.3	29.94			
BM*	Prishtine (01)	2.3±.3	21.17	10.028a	.040	01-02 (sig .020) 01-04 (sig .005)
	Mitrovice (02)	4.9±8.1	35.23			
	Prizren (04)	2.7±.3	38.42			
	Ferizaj (05)	2.6±.2	34.88			
	Gjilan (06)	2.5±.5	29.67			

WC	Prishtine (01)	84.0±13.6	37.70	14.414a	.006	05-04 (sig .008) 05-06 (sig .001) 02-06 (sig .014) 01-06 (sig .012)
	Mitrovice (02)	83.4±11.7	36.72			
	Prizren (04)	91.3±13.5	49.24			
	Ferizaj (05)	77.0±13.5	23.39			
	Gjilan (06)	100.0±18.4	59.45			
MB	Prishtine (01)	6.63±6.17	47.63	17.251a	.002	06-01 (sig .002) 02-01 (sig .000) 04-01 (sig .040)
	Mitrovice (02)	2.09±2.00	24.50			
	Prizren (04)	2.94±1.76	33.27			
	Ferizaj (05)	3.97±2.75	40.57			
	Gjilan (06)	1.98±1.64	23.22			

a. The test statistic is adjusted for ties.
b. Multiple comparisons are not performed because the overall test does not show significant differences across samples.
*Test is not performed in the population under 18 years old
H: Height (cm), W: Weight (kg), BMI: Body Mass Index (kg/m2), F%: Fat Percentage (%), *W%: Water Percentage (%), MM: Muscle Mass (kg), BM: Bone Mass (kg), *KCAL: Kilocalories (J), *VF: Visceral Fat (level), WC: Waist Circumference (cm), DG: Handgrip Force (R, L) (kg), MB: Modified Burpees (minutes), SBJ: Standing Broad Jump (cm).

Table 3. Norm values on body composition features based on age and genders valid for DS people of Kosovo

Reference table	H: Height (cm)				W: Weight (kg)				BMI: Body Mass Index (kg/m^2)				F%: Fat Percentage (%)			
	15-18 years old		Over 18 years		15-18 years		Over 18 years		15-18 years		Over 18 years		15-18 years		Over 18 years	
	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂
Very Low	150.3	150.3	141.2	153.0	46.8	56.4	52.3	55.0	21.7	23.3	24.4	21.9	18.1	11.5	21.1	6.8
Low	155.0	155.0	144.0	156.0	57.0	59.7	56.3	61.9	25.1	25.7	27.6	24.7	22.6	17.8	26.3	13.6
Middle Fift	155.5	155.5	145.0	158.0	58.3	65.3	65.3	65.2	25.8	26.2	29.8	25.7	23.9	20.1	29.7	14.5
High	159.0	159.0	147.8	158.5	59.2	71.2	68.5	67.8	27.2	28.7	32.3	26.7	28.2	23.7	33.2	16.4
Very High	162.0	162.0	150.9	164.4	71.0	79.4	80.2	76.2	32.0	31.4	38.7	29.6	31.8	27.4	38.5	19.2

Table 4. Norm values for body composition features based on age and gender valid for DS people of Kosovo

Reference table	W%: Water Percentage (%)		MM: Muscle Mass (kg)		BM: Bone Mass (kg)		KCAL: Kilocalories (J)		VF: Visceral Fat (level)		WC: Waist Circumference (cm)			
	Over 18 years old										15-18 years old		Over 18 years old	
	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂
Very Low	46.0	57.4	37.1	45.6	2.0	2.4	1229	1440	1.5	1.0	69.0	75.0	74.8	73.2
Low	49.7	61.6	40.5	50.7	2.1	2.7	1327	1565	3.0	2.1	78.0	83.0	84.4	82.4
Middle Fifty	51.5	62.5	41.9	52.5	2.2	2.8	1376	1635	4.0	2.7	78.0	91.0	88.0	85.0
High	54.5	64.0	42.4	55.6	2.3	2.9	1426	1734	5.5	3.5	82.8	93.0	93.0	86.0
Very High	58.1	69.5	47.9	60.4	2.5	3.2	1583	1870	9.6	6.5	90.7	99.0	108.4	96.0

Table 5. A norm values on motor abilities based on age and gender valid for DS people of Kosovo

Reference table	HG: Handgrip Force (kg)								MB: Modified Burpees (minutes)			
	15-18 years old				Over 18 years old				15-18 years old		Over 18 years old	
	♀		♂		♀		♂					
	R	L	R	L	R	L	R	L	♀	♂	♀	♂
Very Low	3.4	5.5	8.4	11.2	9.0	8.6	10.4	10.4	1.20	0.70	1.08	1.28
Low	8.4	12.4	13.8	17.0	13.7	11.7	20.2	20.0	2.15	1.38	2.52	2.55
Middle Fifty	11.4	13.5	16.0	17.8	14.4	14.7	20.6	21.7	2.40	2.57	3.30	4.17
High	13.5	14.7	19.4	19.1	15.0	15.9	22.3	23.3	2.50	4.08	3.54	4.43
Very High	18.0	16.3	21.3	24.0	19.3	18.2	28.6	25.5	5.28	5.77	7.53	6.59

DISCUSSION

The current study is the first to present reference values for body composition features and fitness for DS individuals in the Republic of Kosovo. More specifically, this study aimed to: a) create the national norm values of body composition and fitness level of individuals with down syndrome and b) investigate gender differences in body composition features and fitness parameters; c) analyze the effect of the region the DS individuals leave in, on body composition characteristics and fitness parameters; d) compare their fitness level with international peers. The main findings of this study demonstrated that there are significant gender differences in some body composition characteristics and fitness parameters (muscle strength), but no significant gender differences were found on MBT. Additionally, significant differences between regions were found on body composition characteristics and fitness parameters.

Regarding gender differences, this study demonstrated significant gender differences in body composition characteristics and fitness parameters, where male DS participants showed better values in body composition characteristics and fitness parameters (HG). Body composition characteristics such as height, body fat, water percentage, fat percentage, bone mass, showed a tendency of being more positive among male participants compared to female DS participants. The results of the current study are in complete agreement with the results previously reported in a study by Jacinto et al. (2023), where significant differences between sexes were in the total body water, fat mass. On the contrary, no significant differences between genders were found on weight, BMI, visceral fat, and waist circumference. These results are not in agreement with the findings of Jacinto et al. (2023), where significant gender differences were reported in both BMI, and waist circumference, with DS female participants showing higher values (Jacinto et al. 2023). Nevertheless, based on the current findings, it can be speculated that both boys and girls are exposed to the same health-related risk level. Based on the Ungurean et al. (2022) the prevalence of excess weight and obesity among persons with intellectual disabilities was similar among the male and female participants. The results showed an increasing trend by age (Ungurean et al., 2022). In other words, both male and female individuals with Down syndrome have an increased risk of obesity compared to the general population. Factors such as reduced physical activity, dietary habits, and metabolic differences may contribute to this risk (Zemel et al., 2024).

Furthermore, surprisingly, higher muscle mass relative to their body features was found to be present among female DS participants. This result showed a different trend compared to the results of Jacinto et al. (2023), where higher muscle mass was reported among male DS individuals (Jacinto et al., 2023). This difference may be attributed to a myriad of factors such as hormonal influence, nutritional status and the physical activity level of DS participants. In this regard, it was demonstrated that application of physical activity programs in DS population increased bone mass and also lean muscle mass (Ferry et al., 2014; Gonzales et al., 2012).

While not specifically focused on body composition, a study by Giménez et al. (2019) found that males with Down syndrome tended to have greater muscle strength compared to females (Giménez et al., 2019). The results of the current study showed the same pattern, where males with DS demonstrated better results in handgrip strength on both left and right hands compared to female DS participants. These results seem to be in line with the current literature where significant differences have been observed for levels of absolute and relative handgrip strength (Hernández et al., 2023). Furthermore, when the MBT results were compared based on gender, surprisingly, no statistically significant differences were detected. This might be attributed to a poor general physiological capacity of participants with DS to perform a sustained physical work for a long period of time. This aspect is directly related to the inability of individuals with DS to perform daily living tasks (Cowley et al., 2010).

When results were analyzed based on the regional DS centers where the DS participants are registered in, statistically significant differences were found in certain body composition characteristics and physical fitness parameters. DS participants registered in the DS center in Pristina region (01), which is the oldest DS center in Kosovo, demonstrated to have the best condition regarding body composition characteristics and physical fitness. The DS participants from Pristina (01) lead in the general cardiovascular and local endurance (lover body, trunk, and upper body

muscles), and body composition features such as bone mass, add other features etc. On the other hand, DS participants from Prizren (04) region demonstrated worse results compared to the other regions such as Ferizaj (07) in body composition characteristics such as body mass index and waist circumference. Furthermore, DS participants from the DS center in Gjilan (06), being the last established DS center in Kosovo, demonstrated the lowest physical fitness level and the worst body composition characteristics compared to DS participants part of other DS regional centers. Thus, based on these findings, it was demonstrated that the older the DS centers are, the better the physical fitness and body composition characteristics of the DS participants is, and vice versa. These differences could be related to the barriers and facilitators aligned with the various levels of the ecological model of health behavior, such as: (a) intrapersonal, (b) interpersonal, (c) community (availability of programs), (d) organizational (school systems), and (e) policy (education) (Schultz et al., 2023).

Since the current literature lacks the information about the regional differences in physical fitness and body composition characteristics of people with DS, it is difficult to identify the reasons for the regional differences regarding the DS people living in Kosovo. Therefore, the current findings, could be considered as a starting point, and could pave the way for studies studies to identify regional differences and work on eliminating the features caused by the regional differences. Moreover, the results of the current study can be used to develop personalized physical activity programs and interventions customized for different age-groups, genders, and syndrome severity. Additionally, seeing the relevance of these results, the establishment of an ongoing monitoring system using the validated and reliable testing protocols such as ALPHA protocol is of urgent need to ensure the effectiveness of physical activity interventions and early detection of health issues.

Conclusions

It can be concluded that significant gender differences exist in body composition characteristics and physical fitness parameters, with male DS participants showing better results compared to females, excluding muscle mass. Additionally, significant differences were shown to be present also between regional DS centers, with the DS participants of older DS center demonstrating better results in fitness parameters and body composition characteristics compared to the participants of newly established DS centers. Finally, these results highlight the urgent need of establishment of DS centers in the region of Peja (03) and Gjakova (07), where such centers have not been established yet. Furthermore, future studies are encouraged to investigate in more details the physical fitness level and body composition characteristics of DS population in the Republic of Kosovo and try to determine possible regional barriers affecting the general health of DS population, Furthermore, physical activity (PA) should have a crucial role in enhancing health and motor capacity performances among individuals with Down syndrome (DS). Therefore, tailored strategies, implemented by professionals, need to be devised to maintain and enhance physical fitness levels of DS population.

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Conflicts of interest

We affirm that the article we have authored does not involve any conflict of interest.

Ethics Statement

This research followed ethical standards and received approval from the Institutional Review Board at the University for Business and Technology (UBT) dated 13.10.2023 and number (12334/45).

Author Contributions

Design of the Study, MB, TA, AB and AT; Data Gathering, MB and AT; Statistical Evaluation, MB and AB; Data interpreting MB, AB and AT; Writing of the Manuscript, MB, AB and AT; and Search of the Literature, MB, TA and AT. Each author has reviewed the final draft of the manuscript and given their approval.

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