IOSR Journal of Nursing and Health Science (IOSR-JNHS)
e-ISSN: 2320–1959.p- ISSN: 2320–1940 Volume 8, Issue 4 Ser. IV. (July-Aug .2019), PP 01-06
www.iosrjournals.org

Anthropometric Measurement in Relation to Gait Parameters In Children With Down Syndrome

Lobna Ahmed El Ashmawy[a]*, GehanMosaadAbd El-Maksoud[b], Sahr Mohamed NourEl-Dinb[c],Amira Mahmoud Abd-Elmonem[d]

[a,*]*Physical therapist, Physical Therapy Department, Bassuoin GeneralHospital, Gharbya, Egypt.*
[b]*. Professor, Physical Therapy for Pediatrics Department, Faculty of Physical Therapy, Cairo University, Giza, Egypt*
[c]*Professor of Pediatric Genetics, Medical Genetic Center, Faculty Of MedicineAin Shams University, Cairo, Egypt*
[d]*Lecturer, Physical Therapy for Pediatrics Department, Faculty of Physical Therapy, Cairo University, Giza, Egypt*
Corresponding author: Lobna Ahmed El Ashmawy

Abstract :
Background:*Children with down syndrome are associated with several problems such as dysmorphic differences, gait dysfunctions compared to typically developing children.*
Aim:*The current study aimed to investigate the relation between anthropometric measurement and gait parameters in children with Down syndrome.*
Patients And Methods: *Thirty children with Down syndrome were selected randomly from the out-patient clinic of Faculty of Physical Therapy, Cairo University, their age was ranged from 8 to 12 years. Body mass index (BMI), lower extremities stature index (LESI), spatiotemporal gait parameters were assessed for all children participated in this study.*
Results: *The correlation between BMI and step length; speed; or cadence in the study group was weak negative non-significant correlation (r = -0.16, p = 0.38), (r = -0.08, p = 0.67), (r = -0.14, p = 0.44) respectively.*
Conclusion: *There was weak non significant correlation between anthropometric measurements and gait parameters in children with Down syndrome.*
Keywords:,*Body Mass Index, Down Syndrome, Lower Extremities Stature Index, Spatiotemporal Gait Parameters*

Date of Submission: 06-07-2019 Date of acceptance: 22-07-2019

I. Introduction

Anthropometric measurements is a systematic technique that uses reliable, valid and scientifically accepted measurements for sizing and classification of human body's physical features. In another words, it is a technique that determines the human body's physical measurements. Anthropometric measurements are currently regarded as the most important measurement criteria for the body composition [1].Anthropometry has much to offer in the clinical geneticist because it is simple and non-invasive, with minimal equipment. There is a widespread agreement that anthropometry is the technique of choice for the evaluation of dysmorphic features[2].

Gait is an important indicator of motor development in humans. It can affect cognition, sociality, and complicated motor abilities such as running and jumping. Independent walking in the development process of children depends on appropriate balance and effective driving force [3].Gait play a critical role in activities of daily living for humans, and can be affected by interior or exterior factors as the subject becomes older. [4].

Down syndrome (DS), is considered one of the most common types of genetic disorders in mild to moderate mental retardation. It is caused by the presence of all or part of an extra chromosome in the 21stchromosome pair [5].Down syndrome is associated with several problems such as mental retardation, developmental delay, hearing problems, vision problems and respiratory dysfunctions. In particular, disabilities related to motor function are extensive, for example abnormal gait patterns and postural control, dilatory response to environment alteration, lack of coordination, and concurrent contraction of agonists and antagonists [5].

Growth retardation in children with DS is observed throughout the growing period and particularly more noticed in the preschool children. This growth retardation is reflected in physical and mental development of those children. It is estimated that about 95% of patients who are suspected of DS can be categorized with 99.9% confidence by anthropometric measurements. One can thereby make a fast clinical diagnosis on the majority of suspects before karyotyping is complete [6].

Diagnosis of congenital anomaly like DS usually involves clinical observation of morphological findings and abnormal body proportions. Short stature is a recognized characteristic of most people with DS. Children with DS demonstrate deficient growth rate throughout the growing period. They have a tendency to be overweight beginning in late infancy and throughout the remainder of the growing years. Regular growth surveillance of children with DS should aid early identification both of pathological causes of growth retardation and incipient overweight or obesity [6].

In children with DS, there have been a number of observed and measured motor characteristics such as hypotonicity, joint hypermobility, decrease in deep tendon reflexes, maintenance of primitive reflexes, and a delay in the appearance of reaction timing and equilibrium reactions that may have contributed to delayed development [7].

Compared to typically developing children, children with DS experience a delay of 12 to 18 months for independent gait and approximately 80% experience gait malfunctions due to insufficient strength. As a result, there is a difference in their gait patterns compared to typically developing children. Especially, the biological characteristics of DS associated with muscle hypotonia, excessive ligament laxity, postural instability, and lack of balance have a negative impact on the normal development of gait [8,9].

Children with DS experience multiple problems including delay motor development, weight gain, cognitive and behavioural problems. These problems are believed to influence child’s motor development and physical growth. Therefore, the current study was conducted to investigate the relation between anthropometric measurements and gait parameters in children with DS.

II. Methods

II.1. Study design and setting :

A correlation study was conducted from November 2017 to June 2018. The participants were selected from schools of handicapped children and Outpatient Clinic, Faculty of Physical Therapy, Cairo University. The assessment procedures were conducted at the Biodex Gait Trainer 2TM lab, Faculty of Physical Therapy, Cairo University, Egypt.

II.2. Ethical aspects

The study procedures were carried out following the Code of Ethics of the World Medical Association (Declaration of Helsinki). Ethical committee approval of the Faculty of Physical Therapy, Cairo University was obtained before starting the study. A signed an informed consent form which signed by the participant’s legal guardians giving their acceptance for participation in the study and publication of the results.

II.3. Study population

Thirty volunteer children(20 girls & 10 boys) were enrolled in the study if they, had been diagnosed as trisome 21, aged from 7 to 12 years (10.08 ± 1.38) years, IQ was more than 50% to be able to understand and follow instructions. Children with cardiac disorders, surgery in the lower limbs and/or history of recent fractures, sprain or strain injuries of the lower extremities,and signs of acute autitis media, were excluded.

II.4. Sample size estimation

A pilot study was conducted on 10 cases to calculate the appropriate sample size using the G*Power software version 3.1.2 for MS Windows, Franz Faul, Kiel University, Germany. The results indicated that coefficient of determination between Body Mass Index and walking speed and step length in the right lower limb were 0.20, and 0.18 respectively. If we assumed that this is the true population coefficient, the studying 27, 23, and 30 cases. Accordingly, it was decided to include 30 children with DS to be able to reject the null hypothesis with 80% power setting type I error probability to 0.05 .

II.5. Anthropometric measurements

Anthropometric measurements were conducted by using tape measurement and weight and height scale. The anthropometric measures was conducted as follows:

A. Weight : It is measured in kilograms (Kg) for each child by weight scale
B. Height: It was measured in meter for each child by height scale,
C. Lower extremities stature index: It was calculated based on the following formula:

- Lower extremities stature index = (Length of foot ÷ Height vertex) × 100
- Length of foot: It was measured as straight distance directly from pterion (pte) to acropodion (AP) using tape measurement.

D. Body Mass Index (BMI): It was computed from height and weight. BMI-for-age percentiles was computed from the growth charts of the WHO 2006 [6].

II.6.Kinematic gait parameters

The Biodex Gait Trainer 2TM was used to assess the gait parameters (box 2). It is a device that can be used for assessment and training walking capability in individuals with gait disorders. It consists of a treadmill with an instrumented deck that estimates several kinematic gait parameters. The assessment procedure was performed according to the standardized manual instructions. Before actual assessment step, familiarization to the device and the assessment procedures were explained for each child with a 3-minute unrecorded trial. Each child took a 3-minute rest before moving to the assessment phase during which the walking speed was to 0.3 meter/hour and was raised gradually allowing the child to accommodate the speed before changing to a higher speed. The data recording process was carried out as the child could walk comfortably without jogging or shuffling at maximum speed of 0.6 meter/hour. Repeating this procedure for three times with one-minute rest after between each trial. A printout for each trial was obtained then calculation and recording the mean of the three trials for data analysis.

II.7.III. Statistical Analysis

Descriptive statistics in form of mean, standard deviation, minimum, maximum and frequency were conducted to present the measured variables, Pearson Correlation Coefficient was conducted to determine the correlation between BMI, LESI and spatiotemporal gait parameters. The level of significance for all statistical tests was set at $p < 0.05$.

All statistical tests were performed through the statistical package for social studies (SPSS) version 22 for windows. (IBM SPSS, Chicago, IL, USA).

III. Results

Descriptive statistics for the age, weight, height, IQ, BMI, LESI and spatiotemporal gait parameter are presented in table (1)

The correlation between BMI and step length; speed; or cadence was weak negative non-significant correlation ($r = -0.16$, $p = 0.38$), ($r = -0.08$, $p = 0.67$), ($r = -0.14$, $p = 0.44$) respectively. Table (2).

Table (2,3) and Figures (3-5) demonstrate the correlation between LESI and spatiotemporal gait parameters. The correlation between LESI and right step length was weak positive non significant correlation ($r=0.11$, $P=0.54$) and correlation between LESI and speed was weak negative non significant correlation ($r = -0.22$, $p = 0.23$). The correlation between LESI and cadence was weak negative non-significant correlation ($r = -0.26$, $p = 0.16$).

IV. Discussion

The purpose of this study was to investigate anthropometric measurements in relation to gait parameters in children with DS**.**

The results of this study revealed that there was weak non-significant correlation between anthropometric measurements and gait parameters in children with Down syndrome.

Down syndrome children have ligamentous laxity, weakness of muscles and less stability and inefficient gait patterns. DS children perform poorly in measures of running speed, balance, visual motor control, strength and overall gross motor and fine motor skills in comparison to children with typical development at the same age; also they have shorter step length, shorter stride length, high cadence and slower velocity than normal children **[10]**.

Increased body fatin obese children has a negative influence on children's physical performance that there is an inverse relationship between body fat and the ability to move total body weight. This is due to the fact that body fat adds to the mass of the body without making a contribution to force generating capacity, subsequently becoming additional weight to be moved during tasks like walking and running [11]. Increased body weight has been shown to be inversely associated with lower limb range of motion which leads to reduced level of activity [12]**.**In DS patients, shortness of lower extremities is one of the features. DS patients are characterized by broad and short foot [13]**.**

Upon analysis of the correlation between the kinematic and anthropometric variables, **Mancini et al. [13]** reported that the time variable had its greatest correlation value with the leg circumference variable. This also demonstrates that with an increase in calf circumference, there was also an increase in stride time. This behavior probably demonstrates that the child after 5 years of age begins another stage in musculoskeletal development, which enables demonstration of a differentiated motor pattern. This characteristic corresponds with the age of initiation in the process of language learning and expansion of social relationships**.**

The results of the present study agree with **Proto et al.[14]** who reported that both obese DS and non-genetically obese groups are characterized by different gait patterns with regard to spatio-temporal parameters. Both obese and DS children walked for a short distance with reduced step length and lower velocity of progression when compared to the control group. These parameters indicate a cautious, abnormal gait in both groups, aiming at balance and stability in individuals who bear an excessive body weight**.**

The slow speed of walking for children with DS also could be due to a hypotonic leg action, problems of balance and a wide-legged gait with exorotated and abducted hips without trunk rotation. This leads to lack of stabilizing co-contractions as a result of which inadequate postural control, insufficient trunk rotation and balance developed. Relative muscle weakness inducing earlier fatigue has also been described in obese Down patients [11]**.**

The results of the present study agree with**Galli et al.[19]** who stated that DS children need to compensate for their muscle and ligament dysfunction in order to cope with daily activities and maintain function. Gait becomes unsteady, and the increased cautiousness during walking may lead to low velocity and short strides.

Children with DS showed less ability to adjust the stride frequency and some difficulty in adapting the movement speed of their stride. This finding may be attributed to increased body weight which is correlated with anterior displacement of the center of mass (COM). This places DS children closer to their boundaries of stability and at a greater risk of falling during walking. At lower step cycles subjects may feel that they are moving sufficiently and more safe [11].

Increased levels of oxidative stress lead to dampening and decelerating capability of the lower limb musculature. Consequently DS children cover less ground with each stride and are likely to use higher metabolic energy similar to adults with DS during treadmill walking [18]**.**

The results of the present study come in agreement with **Rowland et al.** [22] who reported significant differences in the measured gait parameters in the obese as compared to the control might be attributed to various factors. Significant decrease in the total distance that the obese children walked might be due to the increase in oxygen consumption and energy expenditure as a result of greater body mass which leads to decreased distance of walking. Obese children usually require higher oxygen uptake to perform submaximal tasks such as walking or running. The high cost of locomotion may reflect a wasteful walking style.

There was also a decrease in the average step cycle for obese children. Obese children have been consistently slower with a reduction in step cycle. Also, obese individuals showed slower speed of walking as represented by longer cycle duration and lower relative velocity. These results confirm the commonly held subjective view of a slower, safer and more tentative walking gait in obese and overweight children relative to normal weight children [11].

V. Conclusion

Upon the finding of the present study it could be concluded that anthropometric measurements correlate with gait parameters in children with Down syndrome

Acknowledgments

The authors express their appreciation and thanks to all children and parents for their confidence and collaboration in this study.

Conflicts of interest

No potential conflict of interest relevant to this study was reported.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for- profit sectors.

References

[1]. Koc H, Elioz M, &Cebi M. (2012). Impact of participation in physical education courses on anthropometric characteristics of children. World Journal of Sport Sciences, 7(2), 109-113.

[2]. Jankowicz-Szymanska A, Mikolajczyk E. and Wojtanowski W. (2012): The effect of physical training on static balance in young people with intellectual disability. Research in Developmental Disabilities; 33(2):675–81.

[3]. Ricken AX, Savelsbergh GJ, Bennett SJ (2004): Coordinating degrees of freedom during interceptive actions in children. Exp Brain Res, 156: 415–421.

[4]. Shumway-Cook A, Woollacott MH. Dynamics of postural control in the child with Down syndrome. PhysTher 1985;65:1315–22.

[5]. Jung H PT, Chung E. and Lee B. (2017): A comparison of the balance and gait function between children with Down syndrome and typically developing children. J. Phys. Ther. Sci. 29: 123–127.

[6]. Asha KR, Vinay Kumar K, Subhash LP (2012): Analysis of Anthropometric Indices in Down Syndrome Children. scientific reports;1 (11): 1:522.

[7]. Uyanik M, Bumin G. and Kayihan H. Comparison of different therapy approaches in children with Down syndrome. PediatrInt 2003;45(1):68–73

[8]. Gontijo A, Mancini M. and Silva P, (2008): Changes in lower limb co-contraction and stiffness by toddlers with Down syndrome and toddlers with typical development during the acquisition of independent gait. Hum MovSci, 27: 610–621
[9]. Chang C, Kubo M, and Ulrich B. (2009): Emergence of neuromuscular patterns during walking in toddlers with typical development and with Down syndrome. Hum MovSci, 2009, 28: 283–296.
[10]. Ulrich B, Haehl V, Buzzi U., Kubo M. and Holt K. (2004). Modelling dynamic resource utilization in populations with unique constraints: Preadolescents with and without Down syndrome. Human Movement Science, 23(2), 133–156.
[11]. Elshemy, S. A. (2013). Comparative study: Parameters of gait in Down syndrome versus matched obese and healthy children. Egyptian Journal of Medical Human Genetics, 14(3), 285-291.
[12]. Jones C, Spodek B, Gallahue D. and Saracho O. Handbook of research on the education of young children. Motor Dev Young Child 2003:105–18.
[13]. Mancini M, Gontijo A. and Silva P. (2008): Changes in lower limb co-contraction and stiffness by toddlers with Down syndrome and toddlers with typical development during the acquisition of independent gait. Hum MovSci, 27: 610–621
[14]. Proto C, Romualdi D, Cento RM, Romano C, Campagna G. and Lanzone A. (2007): Free and total leptin serum levels and soluble leptin receptors levels in two models of genetic obesity: the Prader-Willi and the Down syndromes. MetabClinExp; 56:1076–80.
[15]. Hedberg A. and Carlberg B. (2007): Development of postural adjustment in sitting position during the 1st half year of life. Developmental medicine and child neurology,47: 312-320.
[16]. Cuevas R. (2004): CME-Cuevas Medek Exercise. Cerebral Palsy Magazine, 23(4): 42-45.
[17]. Browning RC, Kram R. (2007): Effects of obesity on the biomechanics of walking at different speeds. Med Sci Sports Exerc; 39:1632–41.
[18]. Browning RC. (2012): Locomotion mechanics in obese adults and children. CurrObes Rep;1:152–9.
[19]. Galli M, Rigoldi C, Brunner R, Virji-Babul N. and Albertini G. (2008): Joint stiffness and gait pattern evaluation in children with Down syndrome. Gait Posture;28:502–6.
[20]. Carratelli M, Porcaro L, Ruscica M, De Simone E, Bertelli AA. and Corsi MM. (2001): Reactive oxygen metabolites and prooxidant status in children with Down's syndrome. Int J of Clinic Pharmacol Res;21(2):79–84.
[21]. Agiovlasitis S, Pitetti KH, Guerra M, Fernhall B. Prediction of VO2peak from the 20-m shuttle-run test in youth with Down syndrome. Adapt PhysActiv Q 2011;28:146e56.
[22]. Rowland TW. (2004): The childhood obesity epidemic: putting the dynamics into thermodynamics. PediaExer Sci;16:87–93.

Box 1. The Biodex Gait Trainer 2TM parameters

1- Total Distance (meter): This is the total distance traveled by the belt, which is in essence the distance traveled by the patient.
2- Average Walking Speed (meter/second): Normative values have been established and are dependent on age and sex. The norms are expressed next to the real time value.
3- Average Step Cycle (cycle/second): This is calculated by taking an average for the step cyclesduring the exercise bout.
4- Average Step Length (meter): This number is calculated by taking an average for all of the step lengths.
5- Coefficient of Variance: This is calculated as the amount of variation occurring between footfalls.
6- RT/LT time distribution: This is the actual time spent on the mentioned limb. The time spent oneach limb should be equally distributed between right and left. Should they be different, the patient isspending more time on one leg than the other.
7- Ambulation Index: This is a composite score relative to 100 based on foot-to-foot time distribution ratio and average step cycle. The goal is 100.

Table 1: Descriptive statistics for the age, weight, height, IQ, body mass index, lower extremities stature index and spatiotemporal gait parameter

	$\overline{X}$ ±SD	Maximum	Minimum	Range
Age (years)	10.08 ± 1.38	12	7	5
Weight (kg)	36.23 ± 13.6	77	19	58
Height (cm)	128.06 ± 11.42	158	111	47
IQ	63.7 ± 7.87	82	55	27
Body mass index (kg/m²)	21.75 ± 6.34	15.42	42.4	26.98
Lower extremities stature index (%)	151.4 ± 9.7	131	166	35
Right step length (m)	0.78 ± 0.22	0.48	1.2	0.72
Left step length (m)	0.73 ± 0.13	0.48	0.9	0.42
Speed (m/sec)	1 ± 0.1	0.7	1.06	0.36
Cadence (steps/min)	55.06 ± 10.85	22.2	63.6	41.4

$\overline{X}$: Mean SD: Standard Deviation

Table 2. Correlation between Body mass index and spatiotemporal gait parameters of the study group:

	Spatiotemporal gait parameters	r value	p value	Sig
Body mass index (kg/m²)	Right step length (m)	-0.39	0.03	S
	Left step length (m)	-0.16	0.38	NS
	Speed (m/sec)	-0.08	0.67	NS
	Cadence (steps/min)	-0.14	0.44	NS

r value: Pearson correlation coefficient   p value: Probability value   S: Significant   NS: Non significant

Table 3. Correlation between lower extremities stature indexand spatiotemporal gait parameters of the study group:

	Spatiotemporal gait parameters	r value	p value	Sig
lower extremities stature index(%)	Right step length (m)	0.11	0.54	NS
	Left step length (m)	0.42	0.01	S
	Speed (m/sec)	-0.22	0.23	NS
	Cadence (steps/min)	-0.26	0.16	NS

r value: Pearson correlation coefficient   p value: Probability value   S: Significant   NS: Non significant

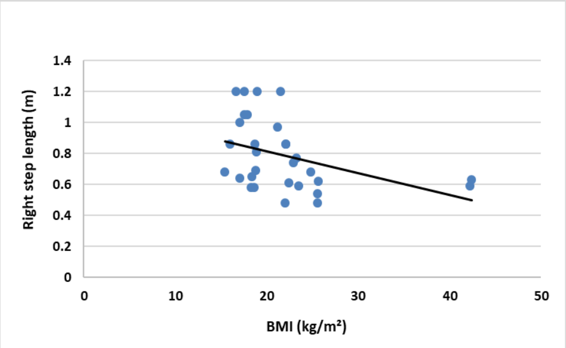

Figure (1). Correlation between Body mass index and right step length in study group.

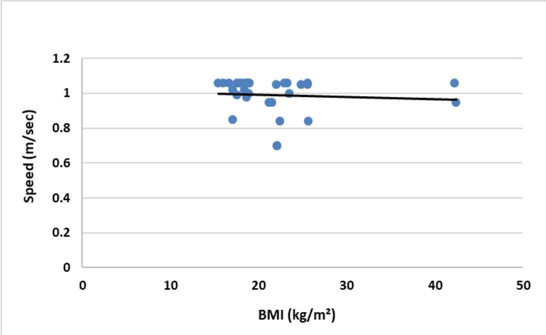

Figure (2). Correlation between Body mass index and speed in study group.

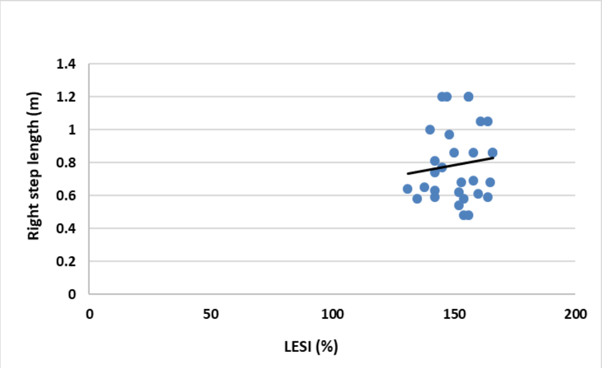

Figure (3). Correlation between lower extremities stature index and right step length in study group.

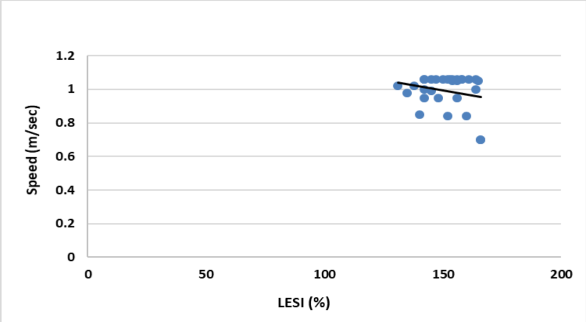

Figure (4). Correlation between lower extremities stature index and speed in study group

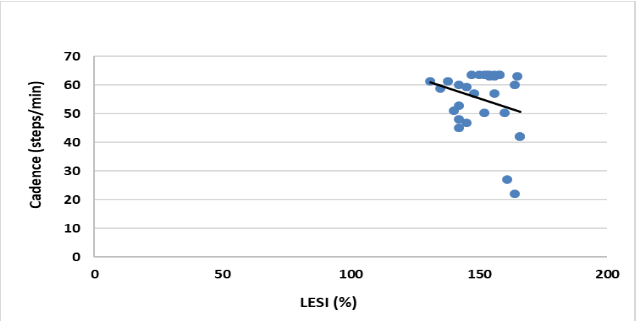

***Figure (5).** Correlation between LESI and cadence in study group*