Pilot Study: Correlation Between Increased Body Mass Index And Static Foot Posture In Children With Down Syndrome

Shaymaa Rushdy Mahmoud[1], Amira Mohamed El-Tohamy[2], MahaSaad Ali Zaki[3]

[1] *Physical Therapist In The Out-clinic Of College Of Physical Therapy, Cairo University, Egypt.*

[2] *Professor In The Of Department Of Physical Therapy For Pediatrics, Faculty Of Physical Therapy, Cairo University*

[3] *Professor Of Clinical Genetics Medical Division National Research Center*

ABSTRACT

Background: Children with Down syndrome have tendency to become overweight and obese. They have problems with collagen, which is the major protein that makes up ligaments, tendons and bones. This creates significant laxity from the feet up. The combination of this ligamentous laxity and low muscle tone contribute to orthopedic problems in them.**Purpose:**To identify the correlation between increasing the body mass index and the static foot posture in children with Down Syndrome. **Subjectsand Methods:** the study was carried out on 37 girls with Down Syndrome selected from the public schools of special needs and their ages ranged from 10 to 18 years old. They were classified according to their body mass index into (5 of healthy weight, 12 of overweight and 20 obese). Assessment of the foot posture was conducted by the foot posture index-6. **Results:** the study indicates that increased body mass index has a negative weak correlation ($r = -0.0615$; $p < 0.05$) to the value of the foot posture index-6 of right foot and also negative weak correlation ($r = -0.0118$; $p < 0.05$) to the value of the foot posture index-6 of left foot. **Conclusion:**Based on the findings of this study, it could be concluded that there was weak negative correlation between increased body mass index and static foot posture in children with Down Syndrome .

Keywords: *Down Syndrome, Children, Body Mass Index, Foot Posture..*

INTRODUCTION

Down syndrome is a chromosomal disorder that results from genetic changes on chromosome 21. Almost 95% of cases are caused by nondisjunction, meaning the chromosome 21 pair fails to separate during cellular division [(1)].

Children born with Down syndrome have tendency to become overweight and obese. Approximately 17.1% of them in the United States are obese [(2)].

Individuals with Down syndrometypically have problems withcollagen, which is the major proteinthat makes up ligaments, tendons,cartilage, bone, and the support structureof the skin. This creates significantlaxity from the feet up, thus beginningat a young age. 88%of the Down syndrome population ishypotonic, with ligamentous laxityand/or hyper-mobility of the joints**[(3)].**

Structural deviations in the ankle and foot complex predispose the individual to changes in weight bearing, muscle imbalance static as well as dynamic balance in ambulation resulting in compensatory strategies which often predispose the individual to overuse injuries [(4,5)].

The most common orthopedic disorders seen in Down syndrome consist of metatarsus primus varus, with or without hallux abducto valgus,subluxating or dislocating patella, severe pesplanus,atlantoaxialinstability, scoliosis, slipped femoral epiphysis, genu valgum, and acetabular dysplasia with or without subluxating hips [(6)].

An observational scoring system (FootPosture Index) for evaluating static foot posture has beendeveloped, which is based on measuring and rating anglesand positions of foot anatomical landmarks **[(7)].**

Purpose of the study: To identify the correlation between increasing the body mass index and the static foot posture in children with Down Syndrome.

Subjects: thirty sevengirls with Down Syndromeparticipated in this study. They were selected from public schools of special needs. Their ages ranged from ten to eighteen years old. All children were physically normal and performed all activities of daily living independently.They were able to follow instructions and understand commands given to them during the testing procedures to produce accurate and reliable measurement.They were cooperative to allow the proper position of both legs and feet during the examination.The subjects were excluded if they had degenerative bone and joint diseases,serious foot injury that could have morphologic alterations, obvious leg-length discrepancy, loss of balance, previous history of lower limb trauma or surgery, postural deviation and/or hip or knee deformity. The children were classified according to their body mass index into 5 of healthy weight, 12 of overweight and 20 obese.

Materials used for assessment included:

***Foot Posture Index(FPI-6)[7]:**Consists of a series of criterion-based observations of the six constituents measures required to assess overall foot posture (Talar head palpation, Inversion/eversion of the calcaneus, Bulge in the region of the talonavicular joint,Congruence of the medial longitudinal arch, Abduction/adductionof the fore foot on the rear foot).

***Digital Electronic Scale:** to measure the child's weight**.**

***Tape Measurement:** to measure the child's height.

***Body Mass Index (BMI) percentile chart:**BMI was calculated as weight in kilograms divided by the square of height in meters (kg/m^2)[8].Then the BMI should was plotted on a gender-specific BMI graphs, [9] illustrated in figures (1&2).

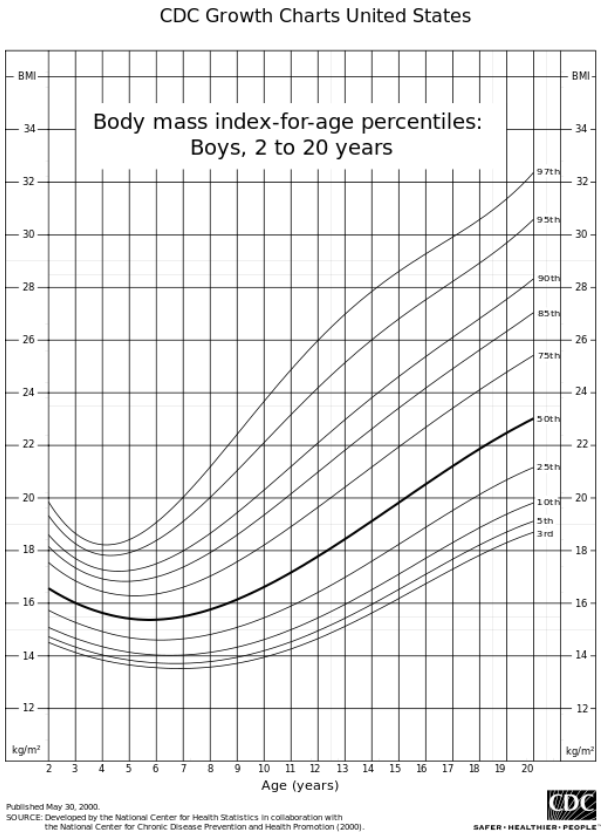
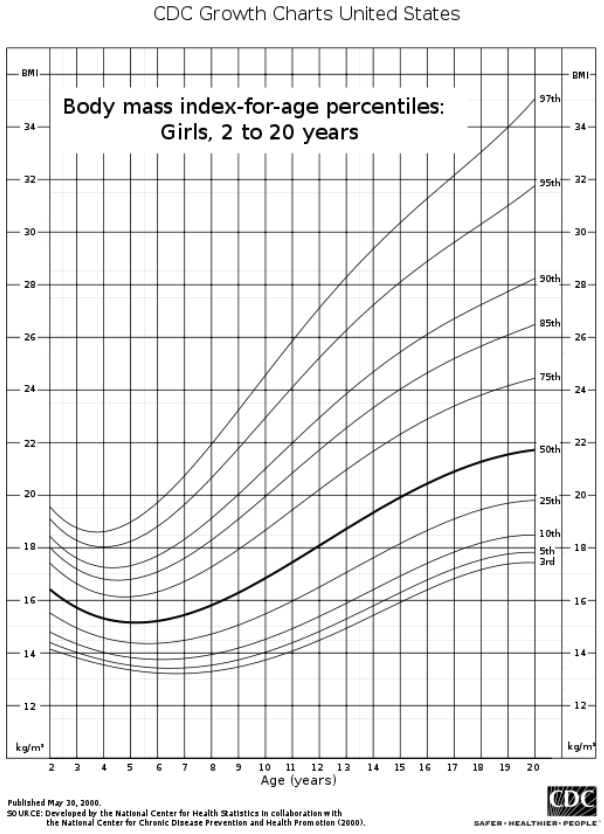


Figure (1):BMI percentile chart for boys from 2 to20 years



Figure(2):BMI percentile chart for girls from 2 to20 years

Procedures:

Thirty seven girlswith Down Syndrome were evaluated:

1-The weight of each child was measured by the digital electronic scale.

2-The height of each child was measured by the tape measurement.

3- The BMI was calculated for each child using slandered formula, (a person's weight in kilograms divided by the square of height in meters)[8].Then, the BMI was plotted on a gender-specific BMI graphs [9] (figure 1&2) to classify the children.A child with a BMI between the 5th and less than 85th percentile is considered healthy weight, the child with a BMI between 85th and 95thpercentile is considered overweight, while a BMI greater than the 95th percentile classifies the child as obese[10].

All measures were performed with children dressed, removing their shoes and socksremoved.

4-The static foot posture was assessed by the Foot Posture Index [7].

a-asking the child to take several steps in-place, prior tosettling into a comfortable stance position andensured that the child is not swivel.

b-while eachchild stood in her relaxed stance position with her arms by her side and looking straight ahead, each of the 6 clinical criteria of the FPI was assessed and a scored on a 5-point scale from -2 to +2 by the same individual with a negative score indicated "supination" and a positive score indicated "pronation".

c-The six criteria were position of the head of the talus, observation of the curves above and below the lateral malleoli, the extent of calcaneal inversion / eversion, the extent of the bulge in the region of the talonavicularjoint, the congruence of the medial longitudinal arch and the extent of abduction/adduction of the forefoot on the rear foot.

d-the 6 scores were then summed to give each subject a composite score ranging from -12 to +12.The foot was considered in normal position when the reference value of the FPI was (from 0 to +5), Pronated (from +6 to +9), highly pronated (10+), Supinated (from -1 to -4) and highly supinated (from -5 to -12).

Statistical analysis: statistical analysis of the data including data coding entry,sorting and statistical manipulations were performed. The collected data were tabulated and analyzed statistically. Statistical Package for the Social Sciences (SPSS) program version 22.

The correlation between increasing the body mass index and static foot posture in children with Down Syndromehad been done by using Pearson's correlation coefficient in order to determine if there was any significant relation. The level of significance was ($P<0.05$).

RESULTS

As presented in table (1) and illustrated in figure (3) and (4), The correlations between body mass index and foot posture index were studiedfor Down Syndrome children through the Person correlation coefficient, as shown in table (1) and illustrated in figures (3&4) it revealed there is a weak negative correlation between the body mass index and the foot posture index for theright and left feet of girls with Down Syndrome.The result is not significant at $p<0.05$.

Table (1): Correlation between Body Mass Index and Foot Posture Index for both feet in children with Down Syndrome.

	Foot posture index (right foot)	Foot posture index (left foot)
Body mass index	*R=-0.0615 **p=0.717 ***n=37	R=-0.0118 P=0.945 N=37

*Pearson correlation coefficient.

**The significant level Correlation is significant at the 0.05 level (2 tailed).

***Number of girls with Down Syndrome participating in the study.

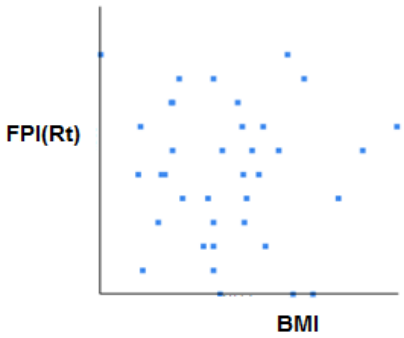


Figure (3):Correlation between Body Mass Index & Foot Posture Index of the right foot.

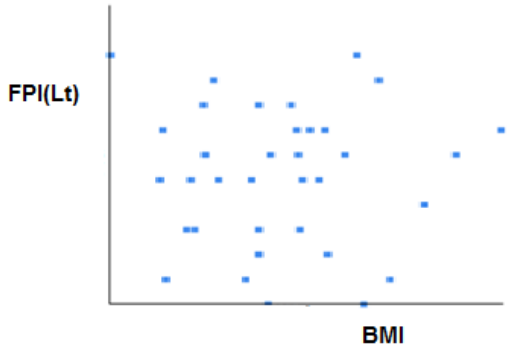


Figure (4):Correlation between Body Mass Index & Foot Posture Index of the left foot.

DISCUSION

Approximately 17.1% ofChildren born with Down syndrome in the United States are obese [(2)].Around 88%of the Down syndrome population ishypotonic. They have ligamentous laxityand/or hyper-mobility of the joints**[(3)].**

The most common orthopedic disorders seen in Down syndrome consist of metatarsus primus varus, subluxating or dislocating patella, severe pesplanus,atlantoaxialinstability, scoliosis, slipped femoral epiphysis, genu valgum, and acetabular dysplasia with or without subluxating hips [(6)].

This study revealed that there is a weak negative correlation between increasing the body mass index and the static foot posture in girls with Down Syndrome . Their ages ranged from ten to eighteen years old.

No available previous studies evaluated the relation between increasing the body mass index and the static foot posture in children with Down Syndrome.

Many other studies [(11,12,13)] evaluatedthe relationship between the body mass index and static foot posture in normal children. **Evans,(2011)**[(11)] found thatthere was no positive relationship between increased body weight and flatter foot posture.**Evans and Karimi, (2015)**[(12)]stated that there is no association between increased body mass and flatfeet in children.**Gijon et al, (2017)**[(13)]added that, in

children aged between 6 and 12 years, body mass does not appear to have an important bearing on static foot posture.

On the other hand, studies for**Riddiford-Harland et al.(2000)**[14] reported a relationship between overweight and foot structure in primary school children (age 8.5±0.5 years), by means of footprint parameters. The study showed that obese children had significantly longer and "fatter" feet compared with their normal-weight children.

In other study for **Dowling et al. (2004)**[15],whenstudying plantar pressure distribution in obese children aged 8.8±2 years, stated that obese children are at an increased risk of developing foot discomfort and/or foot pathologies due to increased plantar loads being borne by the small forefoot bones. Furthermore, continual bearing of excessive mass by children appears to flatten the medial midfoot region during walking.

Mickle et al. (2006)[16], studying overweight and obese preschool children, indicated that this relationship exists and that it is probably due to structural changes in the foot anatomy.

CONCLUSION

Based on the findings of this study, it could be concluded that there was weak negative correlation between increased body mass index and static foot posture in children with Down Syndrome .

References

1.Nehring, W. (2010): Down syndrome. In P.J. Allen, J.A. Vessey, & N. Shapiro, (Eds.), *Child with a chronic condition*/5th ed/pp. 447–469. St. Louis, MO: Mosby.

2.Ogden, C., Carroll, M., Curin, L., McDowell, M., Tabak, C. and Flegal, K. (2006): Prevalence of overweight and obesity in the United States1999–2004. *The Journal of the American Medical Association, 295*, 1549–1555.

3.Rogers, C. (2002): Carers Knowledge ofcommon foot problems associatedwithpeople with Down's Syndrome. UniversityCollege Northampton.

4.Murphy, D., Connolly, D. andBeynnon, B. (2003): Risk factors for lowerextremity injury: a review of the literature. Br J Sports Med ; 37(1):13-29.

5.Cote, K., Brunet, M., Gansneder, B. and Shultz, S. (2005): Effects of pronated and supinated foot postures on static and dynamic postural stability. JAthl Train.; 40:41-46.

6.Diamond, L., Lynne, D. and Sigman, B. (1981): Orthopedic disorders in patientswith Down's syndrome. OrthopClin North Am 12: 57.

7.Redmond, A., Crosbie, J. and Ouvrier, R. (2006): Development and validation of a novel rating system for scoring standing foot posture: theFoot Posture Index. Clin Biomech;21(1):89-98.

8.Barlow, S. and Expert, C. (2007): Expert committee recommendations regarding the prevention, assessment, and treatment of child and adolescent overweight and obesity: Summary report. Pediatrics, 120, S164-S192.

9.National Center for Health Statistics in collaboration withthe National Center for Chronic Disease Prevention and Health Promotion (2000).

10. Elliott, V. (2007): Expert panel gives very heavy children a new label-Obese.Retrieved February 15, 2008, from http://www.amaassn.org/amednews/2007/07/09/hlsd0709.

11.Evans, A. (2011): The paediatric flat foot and general anthropometry in 140 Australian school children aged 7–10 years. J FootAnkle Res 4(1):12.

12.Evans, A. and Karimi, L. (2015): The relationship between paediatic foot posture and body mass index: do heavier children really have flatter feet? J Foot Ankle Res. Aug 27;8:49.

13.Gijon, g., Montes, J., Tartinez, A., Alfegeme, P.,Cervera, J. and Morales, J.(2017): Overweight, Obesity and foot posture in children: Across-sectional study JPaediatr. Child Health.Jan;53(1):33-37.

14.Riddiford-Harland, D., Steele, J.andStorlien, L. (2000): Does obesity influence foot structure in prepubescent children? Int J Obes Relat Metab Disord 24(5):541–544.

15.Dowling, A., Steele, J.andBaur, L. (2004): What are the effects ofobesity in children on plantar pressure distributions? Int J Obes Relat Metab Disord 28(11):1514–1519.

16.Mickle, K., Steele, J. and Munro, B. (2006): The feet of overweight and obese young children: are there flat or fat? Obesity (Silver Spring)14:1949–1953.