Original Artikel

Correlation Between Physical Activity Level and Flatfoot's Degree in Individual with Intellectual Disabilities and Obesity: Comparison Between Athletes and Non-Athletes

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ABSTRACT

Background: Increasing incident of obesity was also in the population of intellectual disability (ID). Some of them are an athlete. Obesity and high impact activity trigger weakness in the foot structure that cause flatfeet. The research aims to assess the correlation between level of physical activity and the degree of flatfoot on individual with intellectual disability and obesity. This research also provide data on the prevalence and degree of flatfoot.

Methods: This research was using analytic observational method in cross-sectional studies in groups of athletes and non-athletes with a total of 68 subjects. The data collected between July 2021 to October 2022. The data included subject characteristics, daily activities that converted to metabolic equivalent (MET) score of physical activity level (PAL), BMI, and footprints using the Harris Mat. The clinical outcomes were analysed using Spearman, Man Whitney, and Fisher's exact test.

Results: Flatfoot occurred in 97% of the samples based on Viladot criteria. All the non-athlete group had flatfoot and more severe degree of flatfoot, and there were 2 individuals with normal feet in the athlete group. There was correlation between the degree of flatfoot in special athlete - obesity groups and gender. No correlation between the degree of flatfoot in both groups with age, degree of intellectual disability, degree of obesity and PAL, type of sport or duration of active as an athlete.

Conclusions: There is no correlation between the degree of flatfoot and the PAL in the athlete and non-athlete groups of intellectual disability and obesity.

Keywords: flatfoot, physical activity level, intellectual disability, obesity, special athlete

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ABSTRAK

Latar Belakang: Meningkatnya kejadian obesitas juga terjadi pada populasi disabilitas intelektual dan di antaranya adalah atlet. Obesitas dan aktivitas berat memicu kelemahan struktur kaki dan menyebabkan kaki ceper. Penelitian ini bertujuan untuk menilai korelasi antara tingkat aktivitas fisik dengan derajat kaki ceper pada individu dengan disabilitas intelektual dan obesitas. Penelitian ini juga memberikan data tentang prevalensi dan derajat kaki ceper.

Metode: Penelitian ini menggunakan metode observasional analitik dalam studi potong lintang dengan total 68 subjek pada kelompok atlet dan non atlet yang memiliki disabilitas intelektual dan obesitas. Data dikumpulkan antara Juli 2021 hingga Oktober 2022, meliputi data karakteristik subjek, aktivitas harian yang dikonversi menjadi skor metabolik ekuivalen, tingkat aktivitas fisik, IMT, dan jejak kaki menggunakan Harris Mat. Hasil klinis dianalisis menggunakan uji Spearman, Man Whitney, dan Fisher.

Hasil: Kaki ceper terjadi pada 97% sampel berdasarkan kriteria Viladot. Semua kelompok non atlet memiliki kaki ceper dan derajat kaki ceper yang lebih berat, dan ada 2 individu dengan kaki normal pada kelompok atlet. Terdapat korelasi antara derajat kaki ceper pada kelompok atlet dengan jenis kelamin. Tidak terdapat korelasi antara derajat kaki ceper pada kedua kelompok dengan usia, derajat disabilitas intelektual, derajat obesitas dan tingkat aktivitas fisik, jenis olahraga atau lamanya aktif sebagai atlet.

Kesimpulan: Tidak terdapat korelasi antara derajat kaki ceper dengan tingkat aktivitas fisik pada kelompok atlet dan non atlet yang memiliki disabilitas intelektual dan obesitas.

Kata kunci: kaki ceper, tingkat aktivitas fisik, disabilitas intelektual, obesitas, atlet bertalenta khusus

INTRODUCTION

Riset Kesehatan Dasar (Riskesdas) Indonesia 2018 shows an increase in cases of obesity in the young adult and there are 28.3% overweight population in Sekolah Luar Biasa (SLB) / Special Schools throughout DKI Jakarta Province, Indonesia.[1,2] Wolan-Nieroda et al. 2018 research found that 53% of the intellectual disability population experienced flatfeet.[3] The pathophysiology is not yet clear but according to the hypothesis there are global developmental delay in ID individuals, increased body weight, high impact activity and weakness of the structures that cause the flatfoot.[4-6] ID individuals have actively participated in sport events, both at national and even world levels under the auspices of the Special Olympics organization. Indonesia has an organization called Special Olympics Indonesia (SOIna) to accommodate special athletes taking part in the field of sports.[7] Flatfeet can induce pain and activity will be affected.[5] ID individual have difficulty explaining about pain so a thorough examination including the shape of the foot is necessary.[8] Therefore, this study aims to assess the

correlation between the level of physical activity and the degree of flatfeet in population of athletes and non-athletes who have ID and obesity.

MATERIALS AND METHODS

This study used an analytical observational design with a cross-sectional method. This research was conducted during the Covid-19 pandemic by following health protocols in Indonesia and carried out at the SOIna DKI Jakarta Training Field and SLB Negeri 3 Jakarta. Research subjects were male and female aged 10 – 30 years, obesity, IQ < 70, complete limbs without structural abnormalities or history of lower limb surgery, able to walk independently and able to follow instructions, registered with SOIna DKI Jakarta for subject athletes and registered at SLB in Jakarta for the non-athlete group, and the group of athletes took part in the sports of football, futsal, volleyball, long jump, athletics and badminton. The subject's parents or legal guardians are known to carry out the research by filling out a consent form. Subjects were taken using nonprobability sampling, with the consecutive sampling method. The total subjects were 68 people that divided 34 subjects in each group.

Research tools and materials include explanation and consent form for participating, research form, daily activity form, adult and child compendium table, Omron HEM 6161 blood pressure monitor, Elitech Fox 2 pulse oximetry, thermometer, Omron HN 289 weight meter goniometer, Gea HT 72 height meter, mattress, Harris Mat Capron 1-foot podograph, paper, stationery, calculator, dark water-based ink, and tissue/cleaning cloth.[9,10]

The procedure begins with screening according to the inclusion criteria and continues with approval from parents or legal guardians. The status is filled in based on interviews, data from SOIna DKI Jakarta and SLB Negeri DKI Jakarta. IQ data will be divided to mild (50 – 69), moderate (31 – 50), severe (20 – 30), and very severe (<20) ID. Filling in the activity sheet is done by remembering activities for 3 days a week, 2 active days (during training for athletes and at school for non-athletes) and 1 day off. Basal Metabolic Rate was calculated using Harris Benedict and Schofield formula, depending on gender and age.[10] The results of the MET calculation are added up and divided into sedentary (< 1.4), low active (1.4 – <1.6), active (1.6 – <1.9), and very active (≥1.9).[11] Obesity class 1 and 2 were based on BMI Asia-Pacific classification and CDC tables. Footprints were taken on both feet and performed during the subject's walking process. Staheli index will be measured and will be converted to Viladot classification (Viladot 0 / Normal = < 0.7, Viladot 1 = 0.7 – 0.9, Viladot 2 = 0.9 – 1.15, Viladot 3 = > 1.15).[12] The highest ratio of the foot each subject will be added and analyzed. The data collection process was carried out in accordance with regulations during the Covid-19 pandemic. The statistical analysis was conducted using SPSS version 29. The normality variable was assessed using the Shapiro-Wilk test. Spearman and Man Whitney were utilized to comparison for non-normality distribution variable. Categorical variables were analysed using Fisher's exact test. Statistical significance was set at $p \leq 0.05$. The study complies with the Declaration of Helsinki. This study was approved by The Ethics Committee of Faculty of Medicine, Universitas Indonesia – Dr. Cipto Mangunkusumo National Centra Public Hospitals (KET-133/UN2.F1/ETIK/PPM00.02/2021).

RESULTS

The characteristics of the research subjects are in accordance with Table 1. The group of special athletes with obesity

consist of an average age of 19.5 years, mostly male, mild ID, obesity 1, active physical activity, athlete of athletics, and active as an athlete for an average of 5.5 years. The results indicate that there was no statistically significant difference between groups based on age, gender, and obesity classification. The characteristics of the non-athlete group with ID and obesity consist of mean age 15 years, male, moderate ID, obesity 1, sedentary physical activity. The incidence of flatfoot in athletes was 94.1% and all non-athletes experienced flatfoot with Viladot grade 3 being the most common.

Table 1. Characteristics of subjects

	Athlete (n=34)	Non athlete (n=34)	p-value
Age (year)	20.4 ± 5	16 (10 – 20)	0.458*
Male (%)	28 (82.4)	24 (70.6)	0.584‡
Obesity class 1	23 (67.6)	26 (76.5)	0.519‡
IQ – ID			
Mild (%)	29 (85.3)	12 (35.3)	
Moderate (%)	5 (14.7)	19 (55.9)	
Severe (%)	0	2 (5.9)	
Very severe (%)	0	1 (2.9)	
PAL			
Sedentary (%)	2 (5.9)	33 (97.1)	
Low active (%)	12 (35.3)	1 (2.9)	
Active (%)	13 (38.2)	0	
Very active (%)	7 (20.6)	0	
Viladot classification			
Grade 0 (%)	2 (5.9)	0	
Grade 1 (%)	10 (29.4)	4 (11.8)	
Grade 2 (%)	6 (17.6)	4 (11.8)	
Grade 3 (%)	16 (47.1)	26 (76.5)	
Sports			
Athletic (%)	25 (73.5)		
Soccer (%)	2 (5.9)	-	
Futsal (%)	4 (11.8)		
Volleyball (%)	2 (5.9)		
Badminton (%)	1 (2.9)		
Active period in sport (year)	5.5 (1 – 15)	-	

IQ-ID (IQ intellectual disability), PAL (physical activity level)
*Spearman
‡Fisher

Table 2 and Table 3 inform the data about prevalence of flatfoot on the individual with ID and obesity. There was no severe – very severe ID in athlete group nor Viladot 0 in non-athlete group. Viladot 3 flatfoot were the most common condition, both in athlete and non-athlete group.

Table 2. The incidence of flatfoot in athletes with ID and obesity.

	Athlete			
	Mild ID		Moderate ID	
	Obesity 1 (n=19)	Obesity 2 (n=10)	Obesity 1 (n=4)	Obesity 2 (n=1)
Viladot 3 (%)	8 (42.1)	6 (60)	2 (50)	0
Viladot 2 (%)	3 (15.8)	1 (10)	1 (25)	1 (100)
Viladot 1 (%)	6 (31.6)	3 (30)	1 (25)	0
Viladot 0 (%)	2 (10.5)	0	0	0

Table 3. The incidence of flatfoot in non-athletes with ID and obesity

	Non-Athlete							
	Mild ID		Moderate ID		Severe ID		Very severe ID	
	Obesity 1 (n=10)	Obesity 2 (n=2)	Obesity 1 (n=15)	Obesity 2 (n=4)	Obesity 1 (n=1)	Obesity 2 (n=1)	Obesity 1 (n=0)	Obesity 2 (n=1)
Viladot 3 (%)	8 (80)	1 (50)	11(73.4)	3 (75)	1 (100)	1 (100)	0	1 (100)
Viladot 2 (%)	1 (10)	0	2 (13.3)	1 (25)	0	0	0	0
Viladot 1 (%)	1 (10)	1 (50)	2 (13.3)	0	0	0	0	0

Table 4 and Table 5 give the correlation data between the degree of flatfoot and each characteristic. There was correlation between the classification of flatfoot in the group of ID-obese athletes and gender, but no correlation between the classification of flatfoot in the group of ID-obese athletes with age, gender, degree of ID, degree of obesity, level of physical activity, sport, and length of time active as an athlete. There was no correlation between the classification of flatfoot in the ID-obese non-athlete group with age, gender, degree of ID, degree of obesity, and level of physical activity.

Table 4. Correlation between the Viladot classification of flatfoot and age, gender, class of obesity, IQ – ID, PAL, sport, and length of time active in sport in the athlete group

	Athlete		
	Normal & Viladot 1 (n=12)	Viladot 2 & Viladot 3 (n=22)	p-value
Age	20.5 (12 – 29)	19 (12 – 31)	0.626*
Gender (male, %)	7 (58)	21 (95.4)	**0.014**‡
Obesity class 1 (%)	9 (75)	14 (63.6)	0.635‡
Mild ID (%)	11 (91.7)	18 (81.8)	0.705‡
Active – Very active PAL (%)	10 (83.3)	10 (45.4)	0.070‡
Athletic (%)	9 (75)	16 (72.7)	0.610‡
Active period in sport (year)	6 (3 – 13)	5.5 (1 – 15)	0.814*

ID (IQ intellectual disability), PAL (physical activity level)
*Man Whitney
‡Fisher

Table 5. Correlation between the Viladot classification of flatfoot and age, gender, class of obesity, IQ – ID, PAL in the non-athlete group

	Non-athlete		
	Viladot 1 (n=4)	Viladot 2 & Viladot 3 (n=30)	p-value
Age	17.5 (14 – 20)	16 (10 – 20)	0.359*
Gender (male, %)	4 (100)	20 (67.7)	0.296‡
Obesity class 1 (%)	3 (75)	23 (76.7)	0.678‡
Mild – Moderate ID (%)	4 (100)	27 (90)	0.678‡
Sedentary PAL (%)	4 (100)	29 (96.7)	0.882‡

ID (intellectual disability), PAL (physical activity level)
*Man Whitney
‡Fishe

DISCUSSON

The average age of the special athlete's group was 19.5 years old. Mharada et al. show that 26% of Special Olympics (SO) athletes are in the range 11 – 20 aged and 13% are over the age of 21 years old.[13] ID individuals are directed by the family to interact socially in that age range and the interests of ID individuals in interacting causes them to want to take part in SO activities. Usually in the older age range, they will not participate in SO because they are busy in the world of work. The gender of athletes who experienced ID and obesity was mostly man, amounting to 82.4%. Temple et al. reported that proportion of SO athletes of Asian - Pacific ethnicity with a BMI ≥ 25 were 37% of men and 39.6% of women.[14] The literature states that ID occurs more often in men, with a ratio of 2:1 in mild ID, and 1.5:1 in ID is severe and this is related to x chromosome abnormalities.[15]

Obesity class 1 has a proportion of 67.6% in the athlete group. The results of research on the ID athlete group are in accordance with the research of Cherif M et al. which stated that the average BMI of ID athletes was around 25.72.[16] Gomez-Hixson et al. reported that ID athletes with a BMI ≥ 25 were 75.4% USA athletes and 49.7% non-USA athletes.[17] Temple et al. explained that increasing PAL in ID athletes does not reduce the risk of obesity.[13] Tamin TZ also explains that there is no significant correlation between increasing PAL and body fat mass.[18] The pandemic has forced athletes to take a break from routine training which is usually done every week at the SOIna DKI Jakarta training center. Even after adapting to online training regulations, it may not provide as optimal results as face-to-face training, and as a result, athletes are limited to independent training around the house. The IQ level in the group of ID athletes with obesity was divided into mild ID at 85.3% and moderate ID at 14.7%. Individuals with mild - moderate ID are included in the category of those who are able to learn - able to train.[18] The athlete's performance in sports when compared to cognitive ability will be directly proportional, because the higher the IQ, the better the individual's ability to carry out a goal.

The PAL of athletes in this study was higher than non-athletes. This is similar to Walsh et al which shows that the activity level of SO athletes is higher than non-athletes.[19] Athletes are required to stay fit and active to maintain their performance. Athletics is the sport most frequently participated in by ID athletes, accompanied by obesity. Mild and moderate ID conditions are conditions that allow ID individuals to be educated - trained so as to enable mild - moderate ID children to take part in a competition.[18] Athletic sports with dominant running activities are not carried out in groups, such as football/badminton and other sports which require fast responses and adaptation from athletes. The SOIna athlete selection process and the types of competitions that athletes can participate in are based on individual performance abilities. The combination of low cognitive function and lack of fitness ability in obesity is maybe the reason many ID athletes with obesity participate in athletics.

Based on the data, the average of non-athlete's age was 16 years old. The results of Tamin TZ et al. which assessed the prevalence of DI found at ages 10 – 13 years old was 41.8% and 14 – 16 years old was 24.3%.[2] Non-athlete data collection was carried out at public special schools at the level elementary – high school education so that the average obtained is in the adolescent. The largest non-athlete group was in obesity class 1 at 70.6%. Segal et al. also reported that 68.4% of children aged 10 – 17 years old are obese, 2 times higher than children with good

IQ.[20] One of the conditions of obesity occurs due to children's habits and lack of parental control over children's diets. Apart from that, the composition of the food served is also a concern and usually these foods are obesogenic. Behavioral factors are also the cause of high obesity rates. The research that assessing dysfunctional eating habits in ID provides a lot of information, including the proportion of dysfunctional eating habits of 64.3% with 18.3% having excessive eating habits.[21] ID individuals are also very picky about food, uncooperative during eating (17%) and like to dominate a food (25.1%). Disorders of the hypothalamus, especially the posterior area, may occur in ID individuals with aggressive behavior patterns.[22] Disorders of the hypothalamus also disrupts its function as a food regulation center due to impaired regulation of ghrelin and leptin.[23]

The results of this study showed that the entire non-athlete group experienced flatfoot. Bibro M et al. reported that the incidence of flatfeet in ID individuals with diagnoses other than Down Syndrome is quite high when compared to cognitively normal individuals.[24] Flatfeet occur in individual with obesity.[25] The high incidence of flatfoot in this study could be due to the condition of ID with obesity. The description of the degree of flatfeet in non-athletes is more severe than in athletes. Low physical activity is a factor that influences the decrease in medial arch in the non-athlete group.

The result showed that there was a correlation between the degree of flatfoot and gender. Xu et al. reported different results in that boys under 9 years old were at risk of experiencing flatfeet.[26] In accordance with growth and development, children get older and more active. The fatty structure of the legs will disappear, and the medial arch will begin to appear clearly. Other studies also say that boys experience flatfeet more often than girls because the development of boys was slower. There was no correlation between the degree of flatfoot and age, class of obesity, classification of IQ-ID, and PAL in athletes and non-athletes who experienced ID and obesity. This analysis provides information that the incidence of flatfoot in the athlete group and non-athlete group with ID and obesity is the same. This incident is similar to the research of Pourghasem et al. which showed the results of a positive correlation between increasing BMI and the incidence of flatfeet.[27] This is also informed that flatfeet not only in normal-activity group but also in athlete group. The absence of this correlation could be because the entire groups are obese. Genetically and clinically ID is very diverse, and Down Syndrome is a medical problem with ID being the most common and having ligamentous laxity and joint hypermobility conditions.[28] Medical conditions can influence the incidence of flatfeet due to the inability of the organs to fix the shape of the foot on medial arch. Difficulty in carrying out genetic examination makes it difficult to detect ID with ligamentous laxity problems, especially in Indonesia.[29] Xu et al. explained that doing a little exercise/physical activity increases the risk of flat feet.[26] Zhao et al. reported that regarding gradual increases in physical activity over 12 weeks showed improvements in medial arch and BMI.[30] Meanwhile, a 6 months intervention using the method of modifying dietary habits and increasing PAL by walking showed a reduction in body weight in obese adult individuals but did not show changes in the structure of flatfeet. The stiffness of the subject's foot structure is thought to be the reason why dietary intervention and walking training did not change the foot structure.[31]

The strength of the research was the first research in Indonesia to compare the level of physical activity with the

degree of flatfoot in individuals with ID and obesity, also in groups of athletes and non-athletes. This study assesses individuals based on degree of ID without assessing underlying medical conditions. There are many causes of ID and genetic testing will be expensive, so research focusing on ID conditions, and it will provide a more global picture, especially regarding flatfoot. However, it is also important to consider the limitations. Our study was cross sectional design. The Covid-19 is the main obstacle. During pandemic, with reduced activity levels and normal diet patterns, this causes the risk of increasing BMI. Online training modifications based on SOIna DKI Jakarta may be less effective than offline. Limitations of this research include 68 subjects, foot sampling was carried out once, considering that research subjects with ID will find it difficult to adapt and follow orders from people they have just met. Assessing the walking process and seeing intact footprints is a reference for footprints worthy of being used as research data. It was hoped that collecting subject activity data for 3 days a week will provide a clearer picture of subject activity. The absence of data on flatfoot's type, parent demographics, and the absence of a non-obese group as a comparison are also weaknesses of this research.

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CONFLICTS OF INTEREST

The author(s) declared no potential conflicts of interest.

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REFERENCES

1. Kementerian Kesehatan Republik Indonesia. Hasil utama Riskesdas 2018 Indonesia: Lembaga Penerbit Badan Penelitian dan Pengembangan Kesehatan. 2018; 67-70. Available from: https://kesmas.kemkes.go.id/assets/upload/dir_519d41d8cd98f00/files/Hasil-riskesdas-2018_1274.pdf. Accessed September 9, 2019.
2. Tamin TZ, Idris F, Mansyur M, Rusli Sjarif D. Prevalence and determinants of obesity in students with intellectual disability in Jakarta. Medical Journal of Indonesia. 2014;23:106.
3. Wolan-Nieroda A, Guzik A, Bazarnik-Mucha K, Rachwał M, Drzał-Grabiec J, Szeliga E, et al. Assessment of Foot Shape in Children and Adolescents with Intellectual Disability: A Pilot Study. Medical science monitor : international medical journal of experimental and clinical research. 2018;24:2149-57.
4. Chen KC, Yeh CJ, Tung LC, Yang JF, Yang SF, Wang CH. Relevant factors influencing flatfoot in preschool-aged children. Eur J Pediatr. 2011;170(7):931-6.
5. Raj MA, DeCastro A, Seaman TJ, Kiel J. Pes Planus: StatPearls Publishing LLC; 2020. Available from: https://www.ncbi.nlm.nih.gov/books/NBK430802/.
6. Shapiro BK, O'Neill ME. Developmental delay and intellectual disability. In: Kliegman RM, Geme JS, editors. Nelson textbook of pediatrics. Vol 1. 21st ed. Philadelphia: Elsevier; 2019. p. 283-94.

7. Special Olympic Indonesia. Program Olahraga 2019 [updated 2018. Available from: http://www.soina.id/pages/olahraga/id. Accessed April 19, 2020.
8. Lotan M, Icht M. Diagnosing Pain in Individuals with Intellectual and Developmental Disabilities: Current State and Novel Technological Solutions. Diagnostics (Basel). 2023;13(3).
9. Ainsworth BE, Haskell WL, Whitt MC, Irwin ML, Swartz AM, Strath SJ, et al. Compendium of physical activities: an update of activity codes and MET intensities. Med Sci Sports Exerc. 2000;32(9 Suppl):S498-504.
10. Butte NF, Watson KB, Ridley K, Zakeri IF, McMurray RG, Pfeiffer KA, et al. A Youth Compendium of Physical Activities: Activity Codes and Metabolic Intensities. Medicine and science in sports and exercise. 2018;50(2):246-56.
11. McComb J, Carnero E, Iglesias-Gutiérrez E. Estimating Energy Requirements. 2014. p. 411-49.
12. Riccio I, Gimigliano F, Gimigliano R, Porpora G, Iolascon G. Rehabilitative treatment in flexible flatfoot: a perspective cohort study. La Chirurgia degli organi di movimento. 2009;93:101-7.
13. Mharada CM, Siperstein GN. The sport experience of athletes with intellectual disabilities: a national survey of special olympics athletes and their families. Adapt Phys Activ Q. 2009;26(1):68-85.
14. Temple VA, Foley JT, Lloyd M. Body mass index of adults with intellectual disability participating in Special Olympics by world region. J Intellect Disabil Res. 2014;58(3):277-84.
15. Selikowitz M. Down syndrome. 3rd ed. United States: Oxford University Press; 2008. 27 p.
16. Cherif M, Said MA, Bannour K, Alhumaid MM, Chaifa MB, Khammassi M, et al. Anthropometry, body composition, and athletic performance in specific field tests in Paralympic athletes with different disabilities. Heliyon. 2022;8(3):e09023.
17. Gomez-Hixson K, Batista N, Brown M. Retrospective analysis of the Special Olympics Health Promotion database for nutrition-specific variables. Heliyon. 2021;7(12):e08586.
18. Tamin TZ. Model dan Efektivitas latihan endurans untuk peningkatan kebugaran penyandang disabilitas intelektual dengan obesitas (dissertation). Jakarta: Universitas Indonesia; 2009.
19. Walsh D, Belton S, Meegan S, Bowers K, Corby D, Staines A, et al. A comparison of physical activity, physical fitness levels, BMI and blood pressure of adults with intellectual disability, who do and do not take part in Special Olympics Ireland programmes. Journal of intellectual disabilities : JOID. 2017;22:1744629516688773.
20. Segal M, Eliasziw M, Phillips S, Bandini L, Curtin C, Kral TV, et al. Intellectual disability is associated with increased risk for obesity in a nationally representative sample of U.S. children. Disabil Health J. 2016;9(3):392-8.
21. Hove O. Survey on dysfunctional eating behavior in adult persons with intellectual disability living in the community. Research in developmental disabilities. 2007;28:1-8.

22. Rizzi M, Gambini O, Marras CE. Posterior hypothalamus as a target in the treatment of aggression: From lesioning to deep brain stimulation. Handb Clin Neurol. 2021;182:95-106.

23. Klok MD, Jakobsdottir S, Drent ML. The role of leptin and ghrelin in the regulation of food intake and body weight in humans: a review. Obes Rev. 2007;8(1):21-34.

24. Bibro M, Jankowicz-Szymańska A, Wódka K, Łaczek-Wójtowicz M. Impact of intellectual disability on longitudinal arch and symmetry of the lateral and medial load of the foot. Health Promotion & Physical Activity. 2019;6(1):28-32 (29-34).

25. Stolzman S, Irby MB, Callahan AB, Skelton JA. Pes planus and paediatric obesity: a systematic review of the literature. Clin Obes. 2015;5(2):52-9.

26. Xu L, Gu H, Zhang Y, Sun T, Yu J. Risk Factors of Flatfoot in Children: A Systematic Review and Meta-Analysis. Int J Environ Res Public Health. 2022;19(14).

27. Pourghasem M, Kamali N, Farsi M, Soltanpour N. Prevalence of flatfoot among school students and its relationship with BMI. Acta Orthop Traumatol Turc. 2016;50(5):554-7.

28. Maia N, Nabais Sá MJ, Melo-Pires M, de Brouwer APM, Jorge P. Intellectual disability genomics: current state, pitfalls and future challenges. BMC Genomics. 2021;22(1):909.

29. Ariani Y, Soeharso P, Sjarif DR. Genetics and genomic medicine in Indonesia. Mol Genet Genomic Med. 2017;5(2):103-9.

30. Zhao X, Tsujimoto T, Kim B, Katayama Y, Wakaba K, Wang Z, et al. Effects of increasing physical activity on foot structure and ankle muscle strength in adults with obesity. J Phys Ther Sci. 2016;28(8):2332-6.

31. Song J, Kane R, Tango DN, Veur SS, Furmato J, Komaroff E, et al. Effects of weight loss on foot structure and function in obese adults: a pilot randomized controlled trial. Gait Posture. 2015;41(1):86-92.