ORIGINAL ARTICLE

EFFECTS OF BALANCE TRAINING EXERCISES FOR IMPROVING STATIC AND DYNAMIC BALANCE IN DEAF POPULATION: A RANDOMIZED CONTROLLED TRIAL

Nimra Arshad
Lecturer
Department of Rehabilitation Sciences
The University of Faisalabad, Pakistan
ORCID ID: 0000-0003-4020-1221

Aimen Ghulam Rasool
Physiotherapist
Department of Physiotherapy
Madina Teaching Hospital Faisalabad, Pakistan
ORCID ID: 0000-0003-4771-8303

Maryam Ashfaq
Physiotherapist
Department of Physiotherapy
Allied Hospital, Faisalabad, Pakistan
ORCID ID: 0000-0001-8926-558X

ABSTRACT

BACKGROUND AND AIM
Physical therapy exercises can play a vital role in improving static and dynamic balance. Our current research aims to determine balance training exercises' effects on improving static and dynamic balance in the deaf population.

METHODOLOGY
A randomized controlled trial(IRCT20200625047922N1) witha sample size of 28 deaf children was conducted. Congenitally deaf children aged 6 to 11 years without cochlear implantation andcould walk independentlywere chosen from Special Education School, Faisalabad, Pakistan. Exclusion criteria were those with mental illness, unilateral hearing, Visual, Cognitive,and Physical impairment. After taking the informed consent from parents and students,theparticipants were divided into a control and a balance training exercisesgroup. Data was collected through the Berg Balance scale (BBS), including static and dynamic balance tests. Statistical analysis was directed by utilizing SPSS version 20.

RESULTS
The mean value for Pre-treatment BBS in the experimental group is 32.71±4.58, and inthe control group is 34.50±3.93. The P-value of Pre-treatment BBS is 0.28 and in post-treatment is 0.00, which shows statistically significant variance among the treatment and control groups.

CONCLUSION
Our study has shown that static and dynamic balance training exercises effectively improve the balance of the deaf population.

KEYWORDS
Deafness, Postural Balance,Hearing Loss,Vestibular Diseases,Persons with Hearing Impairments,Exercise Therapy,Bilateral Vestibulopathy.

[Arshad N, Rasool AG, Ashfaq M. Effects of Balance Training Exercises for Improving Static and Dynamic Balance in Deaf Population: A Randomized Controlled Trial Pak.j.rehabil. 2022; 11(1):110-116] DOI:10.36283/pjr.zu.11.1/020

INTRODUCTION

Hearing loss is generally identified initially in life leading to difficulties incommunication[1].In children, vestibular dysfunctions can cause a deficit in gross motor development and balance stability. At an early age, delayed gross motor development can cause impairment in the bilateral vestibular system and sensorineural hearing[2]. The children with balance impairment cannot usually participate in physical activities (Running, cycling, hoping), leading to social isolation[3].

In Pakistan, 2.49% of the population suffers from some disability; the hearing loss population is 7.4%. In Pakistan, hearing loss is more reported in males as compared to females[4].According to the non-official data, nearly 1.2 in every 1000 Pakistani children suffer from moderate to severe bilateral hearing loss[5].In this, 15% population is suffering from profound and nearly 85% from moderate to severe hearing loss[6].

Children who have vestibular dysfunctions may experience many disorders of the vestibular system. Acute unilateral vestibular loss (AUVL) is the most frequent vestibular dysfunction. The etiology of acute unilateral vestibular loss is unknown, but the studies say it may be due to genetic and acquired causes (inflammatory and viral infections). The symptoms include static and dynamic balance disturbance, including rotatory vertigo[7].

Hearing impairment is termed a problem in communication. Children with problems in the communication level can also affect the child's participation in physical activities, resulting in isolation. A recent systemic review of research shows that problems in the vestibular and sensorineural systems can cause a balance control deficit. The school teachers complain of balance instability, incoordination, and inelegance in these children that restricts their peak physical activities[8].Deaf children show delayed language developments as well thus face communication problems leading to mental inactivity. These deafness-associated problems prevail life span of a deaf child. This experience can be emotionally traumatic for deaf child and their family[9].

A major key component is gross motor skills that are necessary for children to perform at a sufficient level for the activities of daily livings. Due to vestibular impairment, deaf children show a problem in motor development that affects their cognitive, language, motor, social, and emotional development. Impaired motor skills reflect a deficiency in physical activity and a lack of dynamicbehavior in deaf children. Body balance is of two types: Static Balance and Dynamic balance. Static balance is the fixed base of the body and supports the body equilibrium while an individual is not moving. In this, the balance center of mass and base of the body is maintained by feet. In dynamic balance,the body's base is not fixed; both together, the base of gravity and center of mass is in motion[10].

The adjustment of the stable body position depends upon vestibular, proprioceptive, and visual stimulations. Static balance can be measured in children to maintain an unchanged position while standing unilaterally or bilaterally. However, the dynamic balance might be calculated by limiting the focal point of gravity unilaterally while another limb reaches themost significant limit. The test used for dynamic balance has the highest demand on both the neuromuscular control system and balance. A tremendous difference in balance ability exists when children with cochlear implants are compared with age match[11].

Hearing impairment in childhood alsohas a significant role in public health. Researches reveal that individuals with hearing dysfunction have a balance or postural control issues, specifically related to vestibular system deficiency. In clinical practice, it is a significant challenge for the therapist to improve the balance in the deaf population as motor and balance assessment in children with hearing dysfunction is not a practical choice. Neuromuscular training related to the vestibular system significantly enhances motor skills, which helps balance and postural control[12].

Physical educators can help these children improve their balance in special education schools by utilizing games specifically designed to enhance balance and postural control. Different balance assessment tests are used to appraise the balance in children or adults. Pre and post-balance assessments are necessary to see the outcomes of intervention[13].

Hearing loss is generally identified or diagnosed in the early years of life.Delayed and abnormal motor development in the deaf population is common. If balance training is initiated early in life, it is beneficial for deaf children to enhance their motor development. Static balance exercises and dynamic balance exercises or activity-based programs are arranged to improve balance and postural control. Physical therapy interventions are beneficial for children with hearing deficits. Most of the children with vestibular deficits have postural and balance deficits too. Different games like table tennis training also help in improving postural or balance control[14].

Core stabilization training for the deaf population is alsofavorable[12]. For static and dynamic balance training, core stabilization training exercises can be used. These exercises are beneficial in the lower extremity or low back pain balance training[12].

The balance mechanism of the vestibular system of the inner ear functions with the help of muscles of the visual system as well. The brain sends the signals to guide the muscles to work and create the modifications to the body positions that will preserve the body alignment, balance, and coordination[15]. Vestibular system functions in controlling head movement and balance that is important for coordination, balance, developing motion tolerance, and protective reflex of the body[16]. Balance training exercises are carried out as a rehabilitation program to decrease the risk of falls in the deaf population to improve static and dynamic balance [17].In all sportsevents, balance plays an important role. Vigorous sports require movement and quickness in conjunction with the greatest stability for performing wrestling and gymnastic. Success and failure in these games are a role of stability[18].

Postural control is the main key point to assess the child's motor development in the accurate evaluation to predict the postural instability. When comparing the deaf children with theirnormally developing peers, the deaf population is at higher risk of loss of gross motor skills and balance deficits[19].The prime aim of postural stability is to make sure the position of the focal point of the body is ideal relative to the plane on which the child is standing upright to maintain adequate stability control under various conditions[20].

Deaf children with bilateral vestibular dysfunction and early SNHL (sensorineural hearing loss) mostly present with balance deficits and delayed gross motor skills[21].Evidence shows 20-70% occurrence of vestibular impairment revealed in those children with SNHL (sensorineural hearing loss). Ebrahimi et al.aimed to differentiate the static and dynamic balance in hearing-impaired children aged 7-12 years with and without cochlear implants.His research suggested that deaf children with cochlear implants show a greater risk for balance and motor problems[22].

Hearing deficit is a serious problem in children that are linked with communication and physical impairment. Evidence reveals that vestibular system deficits cause balance problems in every age of life, and balance training in vestibular deficits gives positive results[23].

The brain detects the movement and direction of the head through the balancing output between the two vestibular systems. And due to the failure of coordination and interpretation, this can cause balance impairment-related static and dynamic stability and motion perception[24].

The rationale of this study was, as, in the deaf population, balance issues are predominantly present. There is evidence on individual effects of static and dynamic balance exercises, but little evidence is present on their combined effects. So, the objective of this research was to investigate the combined impact of results by training with static and dynamic balance exercises.

METHODOLOGY

A randomized controlled trial (IRCT registration no: IRCT20200625047922N1) witha sample size of 28 deaf children was conducted.All participants were selected from Children Special Education School Millat Town, Faisalabad.Subjects were divided into two groups by lottery method of randomization, and each group had 14 participants. Group A was the experimental groupthat performedbalance training exercises, and group B was the control group (Figure 1).

After taking the data collection permission from the university's ethical committee, a consent form was filled by the participant's parents and an assent form from participants. It was ensured to them that their data would be kept confidential & utilized just for research purposes. Provision of all information and description of the study had been given to the participants related to this research effectively, like the benefits and no harm during the treatment.

Inclusion criteria were congenitally deaf children ages 6 to 11 years, of both genders, who could understand simple instructions, those without cochlear implantation, and those who couldwalk independently. Exclusion criteria were those with Mental illness, unilateral hearing impairment, Visual impairment, Cognitive Impairment, and anyphysical impairment. Participants with any neurological and cardiovascular conditions were also excluded.

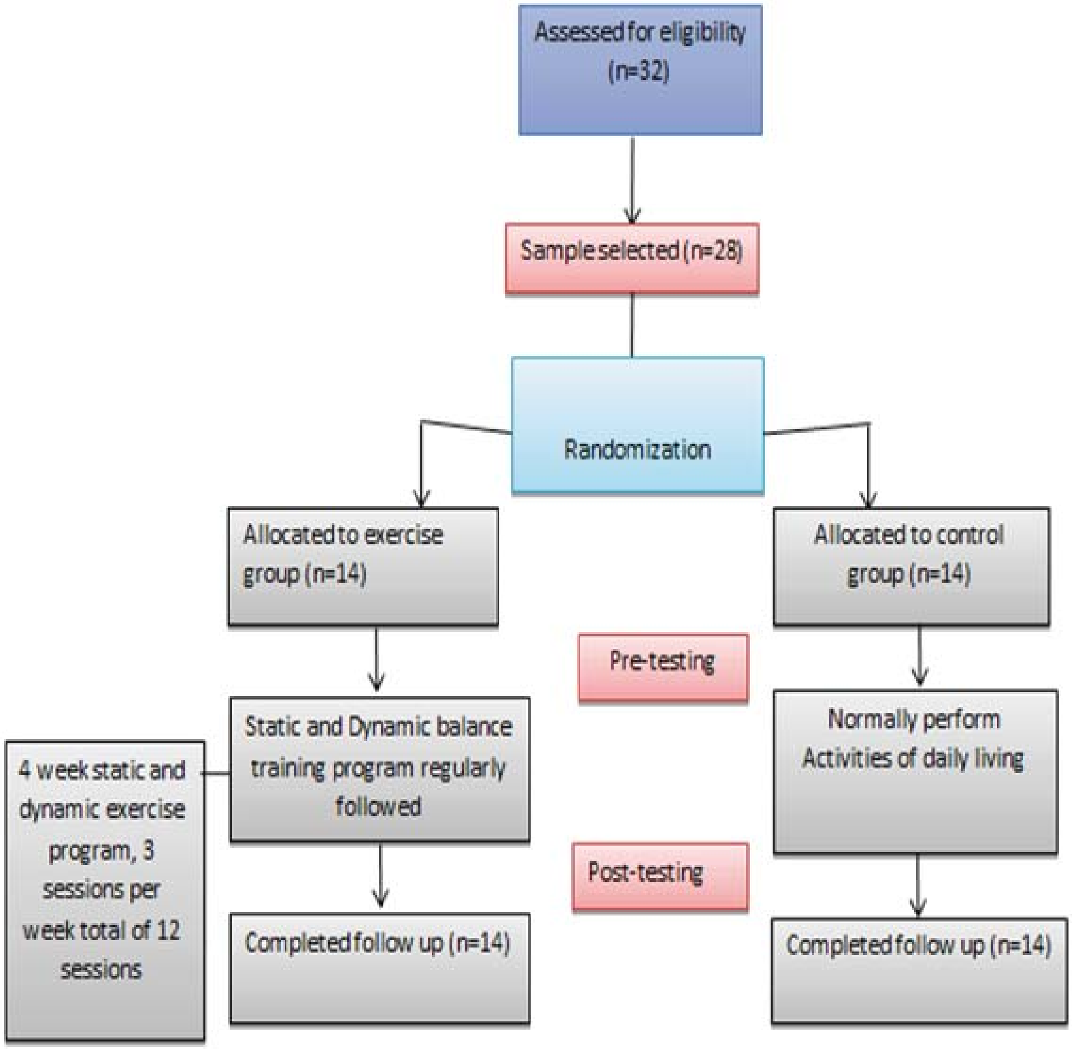

FIGURE 1: FLOW DIAGRAM SHOWING SUBJECTS' PROGRESS FROM TRIAL TO FOLLOW-UP

Group A was an experimental group that followed balance training exercises (5sets/20 reps, all exercises to be held for 30 sec before returning to starting position), and group B was the control group that received no treatment, only the routine activities. Following exercises were performed for 3 days per week for 4 weeks. Data was collected through the Berg Balance Scale, which includes static and dynamic balance tests.

Statistical Analysis was done using SPSS and dispensed through the descriptive and inferential statistics with the help of tables, graphs,and tests, respectively. An independent sample T-test was used to evaluate differentiation between pre and post-treatment values within the same group. Paired sample T-test was used for evaluation and comparison between pre and post-treatment values between two different groups.

RESULTS

The mean age of participants in the experimental group was 8.57±1.60 years and 9.43±1.95 years in the control group. The mean weight of participants in the experimental group was 28.35±3.92 kg compared to 29.89±4.80 kg in the control group. The participant's mean height in the experimental group was 4.17±0.35 feet compared to 4.24±0.35 feet in the control group. The mean BMI of participants in the experimental group was 18.15±1.01 kg/m^2compared to the 18.57±1.33 kg/m^2in the control group (Table 1).

An Independent T-test was used to evaluate the Berg Balance Scale scoring between the two groups, and the results were statistically significant. It showed that the mean value for pre-treatment BBS in the experimental group was 32.71±4.58 and the control group was 34.50±3.93. Between-group analyses showed that the P-value of the pre-treatment Berg balance scale was 0.28 and post-treatment was 0.00, which indicated that there was a statistically significant difference between the treatment group and the control group (Table 2).In the experimental group, the balance was improved from 32.71±4.58 pre-treatment to 46.21±3.21 Post-treatment. In the control group, the pre-treatment balance was 34.50±3.93, which changed post-treatment to 34.86±4.29. A clustered bar chart showed significant improvement in the balance of the experimental group compared to the control group (Figure 2).

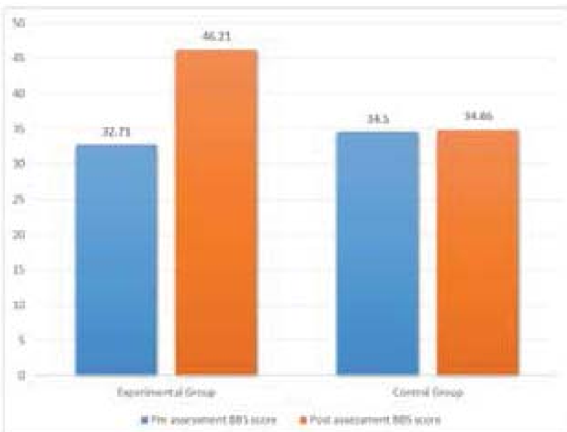

Figure 2: Cluster Bar Chart showing Berg Balance Scale Score of pre and post-treatment values of both groups.

Table 1: Socio-Demographic characteristics of both groups.

Study Group		N	Minimum	Maximum	Mean	Std. dev
		Descriptive Statistics				
Experimental Group	Age	14	6	11	8.57	1.60
	Weight in kg	14	21.0	34.0	28.35	3.92
	Height in feet	14	3.8	4.7	4.17	0.35
	Body Mass Index	14	17.0	19.9	18.15	1.01
Control Group	Age	14	6	11	9.43	1.95
	Weight in kg	14	21.0	35.5	29.89	4.80
	Height in feet	14	3.7	4.8	4.24	0.35
	Body Mass Index	14	16.4	21.5	18.57	1.33

Table 2: Between Group Comparisons of pre and post-treatment Berg Balance Scale assessment.

		Groups		P-value
		Experimental Group(n=14)	Control Group(n=14)	P-value
Berg Balance Scale	Pre-treatment (Mean±SD)	32.71±4.58	34.50±3.93	0.28
	Post-treatment (Mean±SD)	46.21±3.21	34.86±4.29	0.00

DISCUSSION

Deaf children face many problems in their day-to-day lives. Hearing impairment is typically considered a significant communication deficit. Along with the hearing impairment, deaf children also face difficulties in static and dynamic balance. Congenitally deaf children have a vestibular impairment that leads to balance impairment. Static and dynamic balance deficits can act negatively on the motor skills of deaf children. So, this research was done to improve balance impairments among children having a hearing impairment. Different balance training programs were designed to enhance balance, coordination, and gross motor skills in literature. Capoeira exercise training helps develop coordination in the muscles by increasing the flexibility and strength of the deaf population. Pre and post-values were compared to find out the results by using the berg balance scale. According to research, Capoeira exercises significantly improve the balance of deaf children[25].

Similarly, another research was conducted on static and dynamic balance training by applying Romberg and one-leg stance test for static balance and star
excursion, time up and go test for dynamic balance training. The findings of the research suggested that the vestibular-related neuromuscular exercise program was helpful in the enhancement of motor skills, coordination, balance, and improved well-being in deaf children[26].

In a scoping review by Sibley, all subjects performed balance exercises for 45 minutes 3 times per week, consisting of 14 exercises with variations.The purpose of the study was to reduce postural sway by performing balance exercises in the deaf population, and results showed a significant decrease in postural sway.The limitation of this research was that the sample size was too small, and girls were not included in this research[27]. The static and dynamic balance exercises that we used in our study were referenced from research conducted by Bozkurt et.al. The followed research showed effective results of static and dynamic balance exercises in the deaf children age group of 10 to 12 years, but in our study,we took the younger age participants of age between 6 to 11 years. Hence it proved that these static and dynamic balance exercises are significant in both age groups[13].

According to research conducted by Vernadakis, thedata analysis supported the effectiveness of the gaming-based exercise program.This regime was proved to be a better choice of intervention for the balance ability of children with a vestibular problem with deafness[28].

Hearing impairment influences the person's mental, physical, and psychological health. Evidence shows many types of research regarding balance training on the hearing impaired or deaf children and adults population. In deaf people, balance control and muscle coordination are frequently disturbed. Evidence shows that using balance training exercises has good outcomes. In the research study byWalowska et al., the primary purpose was to determine the effects of Pilate exercises (in 13-24 aged students) compared with physical education on body postural control in the hearing-impaired population. The result showed that Pilate exercises improve body balance control in the static position[29].

The strength of our study is that it will provide an evidence-based protocol for children with vestibulocochlear dysfunction that causes balance impairment. We took the younger children population in our study as limited literature was available for the younger age deaf children in Pakistan.

Multiple factors can add limitations in the data significance. First of all, the sample size of 28 deaf children cannot represent the whole deaf children population with balance impairment. Secondly COVID-19 pandemic had a significant impact on the study conduct due to deaf schools shutting down during data collection. Lastly, the duration allowed for a treatment session in school timings was short, so the deaf children could not gainfully control each activity before proceeding to the next one.

For the future conductance of further research, we recommend dividing the Berg Balance Scale scoring according to the balance deficit severity to see how much improvement can be seen in each category of severity. Secondly, it is better if deaf participants from more than one settingare added to research for diversity. Lastly,more studies needto be conducted on deaf children using cochlear implants and unilateral vestibular impairment.

CONCLUSION

The current study has shown that static and dynamic balance training exercises effectively increase balance among the deaf population.

REFERENCES

[1] Khodashenas E, Moradi H, Asadi Ghaleni M, Heydari E, Shams A, Enayati A, et al. The effect of selective training program on the static and dynamic balance of deaf children. medical journal of mashhad university of medical sciences. 2017;60(1):383-91.

[2] Ebrahimi A-A, Movallali G, Jamshidi A-A, Rahgozar M, Haghgoo HA. Postural control in deaf children. Acta Medica Iranica. 2017:115-22.

[3] Ebrahimi AA, Jamshidi AA, Movallali G, Rahgozar M, Haghgoo HA. The effect of vestibular rehabilitation therapy program on sensory organization of deaf children with bilateral vestibular dysfunction. Acta Medica Iranica. 2017:683-9.

[4] Saleem S, Sarwar A, Mahmood Z. Psychosocial issues of hearing impaired school children: a psychometric approach. Innovation. 2021;71(1).

[5] Lynch P, Terlektsi E. Provision of distance learning for deaf children in Pakistan. 2021.

[6] Ahmed S, Sheraz S, Malik SA, Ahmed NR, Farooq S, Raheem A, et al. Frequency Of Congenital Hearing Loss In Neonates. Journal of Ayub Medical College, Abbottabad: JAMC. 2018;30(2):234-6.

[7] Stewart V. Improving Screening and Physiotherapy Management of Vestibular Disorders in the Hospital Setting: ACU Research Bank; 2018.

[8] Rine RM, editor Vestibular rehabilitation for children. Seminars in hearing; 2018: Thieme Medical Publishers.

[9] Zafar A, Ijaz T. Assessment of Psychosocial Problems of Individuals with Hearing Impairment: A Case Study. Pakistan Journal of Social Sciences (PJSS). 2017;37(2):354-67.

[10] Melo RdS, Marinho SEdS, Freire MEA, Souza RA, Damasceno HAM, Raposo MCF. Static and dynamic balance of children and adolescents with sensorineural hearing loss. Einstein (São Paulo). 2017;15:262-8.

[11] Brachman A, Kamieniarz A, Michalska J, Pawłowski M, Słomka KJ, Juras G. Balance training programs in athletes–A systematic review. Journal of human kinetics. 2017;58:45.

[12] Zakeri F, Taghian F. Comparing the Effect of 8 Weeks of Total Body Resistance Exercise and Core Stability Training on Selected Common Abnormalities and Postural Control in Deaf Adolescents. Journal of Rehabilitation Sciences

& Research. 2020;7(2):87-95.

[13] Bozkurt S, Erkut O, Akkoç O. Relationships between Static and Dynamic Balance and Anticipation Time, Reaction Time in School Children at the Age of 10-12 Years. Universal Journal of Educational Research. 2017;5(6):927-31.

[14] Chang Y-C, Hsu C-T, Ho W-H, Kuo Y-T. The effect of static balance enhance by table tennis training intervening on deaf children. International Journal of Medical and Health Sciences. 2016;10(6):356-9.

[15] Santos CF, Belinha J, Gentil F, Parente M, Areias B, Jorge RN. Biomechanical study of the vestibular system of the inner ear using a numerical method. Procedia IUTAM. 2017;24:30-7.

[16] Lopez C. The vestibular system: balancing more than just the body. Current opinion in neurology. 2016;29(1):74-83.

[17] Giboin L-S, Gruber M, Kramer A. Task-specificity of balance training. Human movement science. 2015;44:22-31.

[18] Maïano C, Hue O, Morin AJ, Lepage G, Tracey D, Moullec G. Exercise interventions to improve balance for young people with intellectual disabilities: a systematic review and meta-analysis. Developmental Medicine & Child Neurology. 2019;61(4):406-18.

[19] Thierry B, Blanchard M, Leboulanger N, Parodi M, Wiener-Vacher SR, Garabedian E-N, et al. Cochlear implantation and vestibular function in children. International journal of pediatric otorhinolaryngology. 2015;79(2):101-4.

[20] Mazaheryazdi M, Moossavi A, Sarrafzadah J, Talebian S, Jalaie S. Study of the effects of hearing on static and dynamic postural function in children using cochlear implants. International journal of pediatric otorhinolaryngology. 2017;100:18-22.

[21] Vitkovic J, Le C, Lee S-L, Clark RA. The contribution of hearing and hearing loss to balance control. Audiology and neurotology. 2016;21(4):195-202.

[22] Ebrahimi A-A, Movallali G, Jamshidi A-A, Haghgoo HA, Rahgozar M. Balance performance of deaf children with and without cochlear implants. Acta Medica Iranica. 2016:737-42.

[23] Fernandes R, Hariprasad S, Kumar VK. Physical therapy management for balance deficits in children with hearing impairments: a systematic review. Journal of paediatrics and child health. 2015;51(8):753-8.

[24] O'Sullivan SB, Schmitz TJ, Fulk G. Physical rehabilitation: FA Davis; 2019.

[25] Lima R. Balance assessment in deaf children and teenagers prior to and post capoeira practice through the Berg Balance Scale. The international tinnitus journal. 2017;21(2):77-82.

[26] Melo RS, Lemos A, Paiva GS, Ithamar L, Lima MC, Eickmann SH, et al. Vestibular rehabilitation exercises programs to improve the postural control, balance and gait of children with sensorineural hearing loss: A systematic review. International journal of pediatric otorhinolaryngology. 2019;127:109650.

[27] Sibley KM, Beauchamp MK, Van Ooteghem K, Paterson M, Wittmeier KD. Components of standing postural control evaluated in pediatric balance measures: A scoping review. Archives of physical medicine and rehabilitation. 2017;98(10):2066-78. e4.

[28] Vernadakis N, Papastergiou M, Giannousi M, Panagiotis A. The effect of an exergame-based intervention on balance ability on deaf adolescents. Sport Science. 2018;11:36-41.

[29] Walowska J, Bolach B, Bolach E. The influence of Pilates exercises on body balance in the standing position of hearing impaired people. Disability and rehabilitation. 2018;40(25):3061-9.

