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The Effect of Physical Fitness Exercises on Dynamic Balance and Static Balance in Hearing Impaired Girls Aged 13 to 15 Years with Hypofunction of the Vestibular System in Mashhad

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***Abstract*— the purpose of this research was the effect of physical fitness exercises on dynamic balance and static balance in hearing impaired girls aged 13 to 15 years with vestibular system dysfunction in Mashhad. The research method was semi-experimental with a pre-test and post-test design with a control group. The statistical population of this research included all hearing-impaired girls with bilateral vestibular problems aged 13 to 15 in Mashhad. The statistical sample was selected in a targeted manner and randomly selected in two experimental and control groups (12 people in each group). The experimental group participated in a physical fitness program for 8 weeks, 3 sessions per week and 60 minutes per session. The control group only did daily and normal activities. Balance tests were taken from the participants before and after the training period. The statistical method of independent t-test was used using spss21 software to compare between two groups. The results showed that physical fitness exercises increased both static balance and dynamic balance in 13 to 15-year-old hearing-impaired girls with vestibular dysfunction (P<0.05). This indicates that hearing impaired children can improve their balance by participating in a physical fitness training program that includes 8 weeks and 3 sessions per week for 60 minutes.**

***Keywords*— Physical fitness exercises, dynamic balance, static balance, hearing impaired girls**

Introduction

Hearing is one of the most important factors in communicating with others, and any disorder in this system will cause the separation of the deaf and hard of hearing person from the society, and as a result, the lack of progress and development of his personality and other aspects of his development (1). Balance is a complex motor skill that describes the dynamics of body posture to prevent falls. The activities performed in the work environment and daily tasks such as walking and going up and down the stairs, all require balance and proper posture control. Also, balance is one of the important aspects of physical fitness that athletes benefit from to improve their sports performances; So that there are few sports in which balance does not play a role (2). It has been previously shown that infants and children with congenital hearing loss usually have vestibular deficits in both ears and impaired postural control (3). Several sources have considered the use of information from the vestibular system to be decisive for maintaining balance and posture, and have mentioned the information of vision and physical sense as useful in maintaining balance (4). Damage to the structure of the vestibular system, the cause of balance deficiency, is known to disrupt normal motor development. This injury is also considered the main cause of motor impairment (5).

The sensory systems that include the vestibular part of the inner ear, the sense of sight and bodily sensation play an important role in maintaining body stability and balance. Damage to parts of the cochlear-vestibular nerve not only causes sensorineural hearing loss, but may also be associated with balance problems due to damage to the vestibular branch of this nerve and this is the reason why about 40% of deaf people have difficulty maintaining balance (6). Deaf people have different movement and social behaviors, of course, some of them are quite obvious. These characteristics are mostly seen in maintaining body balance, coordination, strength and endurance (7). In fact, these different characteristics can be classified in the field of physical fitness indicators that deaf people are less prepared in these indicators compared to their normal counterparts.

Hearing impairment as a result of damage to the balance system of the body may affect the function of the higher centers of the brain (8). According to many researchers, reducing the endurance of these muscles causes their premature fatigue, damage to pain-sensitive tissues, and finally, spine injuries (9). People with hearing impairment have problems with balance, and balance is one of the essential prerequisites for daily activities (10). Maintaining or reaching a state of balance while a person is ready to move or is moving or ready to stand is a complex ability (11). Due to its effect on the growth of the vestibular system, exercise can be considered as a strong therapeutic intervention for people with functional disorders in the vestibular system, and sports activities are recommended for these people (12). Rine (2000) supports the idea that children with sensorineural hearing loss with vestibular dysfunction also have a disorder in neural organization (13). In the study of Livingstone and Mcphillips (2011) on children with profound hearing loss, due to the high probability of movement defects in these children, the priority of effective intervention programs was emphasized (14). There are very few studies that have investigated the effect of an intervention program on improving balance in hearing-impaired children with balance disorders. The research that was conducted for the first time in order to improve the balance of these children, included exercises that focused more on single-leg movements, were performed in a limited period of time, and did not produce significant improvement between the experimental and control groups (15). But a more comprehensive exercise program that included balance exercises and body awareness showed improvement in balance skills performance (16).

The purpose of this research was the effect of physical fitness exercises on dynamic balance and static balance in hearing impaired girls aged 13 to 15 years with vestibular system dysfunction in Mashhad.

Materials and methods

The research method was semi-experimental with a pre-test and post-test design with a control group. The statistical population of this research included all hearing-impaired girls with bilateral vestibular problems aged 13 to 15 in Mashhad. The statistical sample was selected in a targeted manner and randomly selected in two experimental and control groups (12 people in each group). The experimental group participated in a physical fitness program for 8 weeks, 3 sessions per week and 60 minutes per session. The control

group only did daily and normal activities. The basis of the exercises in this protocol are specific exercises for stabilizing the spine, retraining the proprioceptive sense of the lumbar-pelvic region, tucking in the abdomen with the contraction of the multifidus muscle, and then using the dynamic stability obtained in different positions (open arch, palmar and squat) by keeping the aforementioned stabilizing maneuver and adding dynamic components to it. 24 hours before and 48 hours after the training period, static and dynamic balance tests were taken from the subjects. Static balance was measured using balance error evaluation test and dynamic balance was measured using Y balance test.
Descriptive statistics and inferential statistics were used to analyze the data. In the descriptive statistics section, mean and standard deviation descriptive indices were used, and in the inferential statistics section, independent t-test was used using spss21 software.

Results

The results of the independent t-test to compare the balance changes of the two groups are reported in Table 1. The results showed that static balance increased significantly in the experimental group compared to the control group (P=0.001). Also, dynamic balance increased significantly in the experimental group compared to the control group (P=0.001).

Table1. The results of independent t-test to compare the balance changes of two groups

Variables	Groups	Before intervention	After intervention	t	df	p
Static balance	experimental	12.16 ± 1.94	16.83 ± 1.46	4.23	22	0.001 *
	control	13.50 ± 1.31	14.41 ± 2.57			
Dynamic balance	experimental	14.50 ± 2.90	22.33 ± 1.87	7.77	22	0.001 *
	control	13.25 ± 1.28	14.16 ± 0.93			

* Significant at the level of P≤0.05

Discussion

Based on the findings of the present study, physical fitness exercises increased both static and dynamic balance of 13 to 15-year-old hearing-impaired girls with vestibular system dysfunction. To control stability, both sense, which means collecting sensory information to understand the position and movement of the body in space, and movement, which means generating forces to control it, are needed and there must be a complex cooperation between the nervous system. The present findings are consistent with the research results of Matsuda et al. (2008) (17). However, the present findings were in conflict with the findings of Piegaro et al. (2014). Among the reasons for the difference in the results, we can mention the difference in the type of training program and subjects. In any case, the improvement of balance in this research was very evident. Perhaps the reason for this is the addition of strength training, especially strength training related to muscles that play a significant role in balance strategies. The most important muscles that are tonically activated while standing and their postural tone is very important in maintaining balance are: soleus and biceps muscles, tibialis anterior muscle, gluteus medius muscle, hamstring muscle, erector spinae muscles in the chest area and lumbar and abdominal muscles (18). Some studies also state that all body muscles are tonically active in a very small range to maintain vertical balance and body balance while standing (19). In this study, the emphasis of exercise on lower body muscles was mentioned. Therefore, using strength exercises along with balance exercises gives a special advantage to that exercise combination and doubles the effectiveness of the exercise. In addition, in the exercises, the strengthening of movement strategies of balance (movement strategy of the wrist, pelvis and taking steps) and the sensory mechanisms involved in the control of balance (sense of vision, sense of body and vestibular system) have been discussed. This can be one of the reasons for the significant improvement in balance in the present study. Such a sense of vision creates information about the position of the head and its movement in relation to the environment and other objects, and in fact creates a

standard for verticality, because many things that are around us, such as doors and windows, etc., are vertical. This information is an important source for balance control (18). The vestibular system complements the visual system in recognizing internal movements and relative movements. The delay of muscle responses to stimuli and visual impulses caused by the disturbance of balance is usually high and reaches about 200 milliseconds, which is much more than the delay of responses to the sensory system of the body which is about 80 to 100 milliseconds. For this reason, the researchers believe that the central nervous system first responds to the body inputs as a result of the motion of the surface.

The results of the present research were consistent with the results of Kaka and Zarrinkoub (2013) research (12). Also, the results of this research were consistent with the results of Majlesi et al. (2014) who investigated the effect of professional training interventions on static balance and walking of deaf children (21). They concluded that the walking quality of the subjects did not change after 12 training sessions, but the balance performance in the intervention group had a significant increase. The reason for the effectiveness of exercise programs on balance and height control can probably be attributed to the improvement of sensory organization and increased coordination, because exercise programs are balanced by increasing the organization of other senses that affect balance, such as the sense of body and vision, leading to improvement (22). On the other hand, the results of this research are not consistent with the findings of Piegaro et al.'s (2004) research (2). These researchers investigated the effect of 4 weeks of central stability and balance training on dynamic and static balance and did not observe a positive effect on balance performance as a result of these balance exercises (2). The reasons for this inconsistency include the different nature of the exercise program, the different balance evaluation tests, the number of sample sizes of children participating in the study, and the possible difference in the severity of children's deafness. According to the results of the present study, it seems that training in different sensory conditions with eyes open and closed and by manipulating different environmental components and tasks improves sensory integration and adaptation to different environmental conditions. Also, in hearing-impaired children, it makes better use of other senses involved in balance (vision and body sense) and subsequently improves balance performance in static and dynamic conditions.

Conclusion

As in many researches, the effectiveness of various exercises on the balance of hearing impaired people has been proven, in this study, the static balance and dynamic balance of the subjects improved significantly, and this indicates that hearing impaired children by participating in Physical fitness training program includes 8 weeks and 3 sessions per week for 60 minutes, they can improve their balance.

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