Original Research Article

Evaluation of balance related tasks in hearing impaired children

Tejas Borkar[1*], Pradeep Borkar[2]

[1,2]Assistant Professor, Late Shree Fakirbhai Pansare, College of Physiotherapy, Pune, Maharashtra, INDIA.
Email: tejasborkar57@gmail.com

Abstract

Aim: to find out most affected tasks related to balance in hearing impaired children. **Objectives:** To identify and compare the balance related tasks in hearing impaired children. To find out the most affected balance related tasks in hearing impaired children. To find the effect of gender and Age on balance in hearing impaired children. **Procedure:** 100 Subjects fulfilling the inclusive criteria were selected. Informed Consent was taken from respective principals to conduct the study. Subjects were assessed by pediatric balance scale (pbs). Mean and standard deviation was calculated. To find out the balance related tasks in hearing impaired children ANOVA test was done. For multiple comparison Tukey's test was applied. **Result:** The most affected component of balance in hearing impaired children is component standing with one foot in front. The balance is minimum at the age of 7 years and maximum at age of 12 years. And there is no relation between balance and gender in hearing impaired children. **Conclusion:** The most affected component of balance in hearing impaired children is standing with one foot in front. Other components which are affected are standing on one foot, standing with eyes closed, turning 360 degrees and turning to look behind. The balance changes according to the age in hearing impaired children. The balance is minimum at the age of 7 years and maximum at age of 12 years. There is no relation exists between balance and gender in hearing impaired children.

Key Words: Hearing impaired Children's, Balance, Pediatric Balance scale.

*Address for Correspondence:**
Dr. Tejas Borkar, Assistant Professor, Late Shree Fakirbhai Pansare, College of Physiotherapy, Pune, Maharashtra, INDIA.
Email: tejasborkar57@gmail.com

Received Date: 28/03/2018 Revised Date: 10/05/2018 Accepted Date: 22/06/2018
DOI: https://doi.org/10.26611/202733

Access this article online	
Quick Response Code:	Website: www.medpulse.in
	Accessed Date: 27 July 2018

INTRODUCTION

Balance is a complex process involving the reception and integration of sensory inputs and also the planning and execution of movement to achieve goal requiring upright posture. It is the ability to control the center of gravity (COG) over the base of support in a given sensory environment. The center of gravity is an imaginary point in space, and it is located just forward of the spine at approximately the S2 level. With the movement of the body and its segments, the location of COG in space constantly changes. The base of support is the body surface that experiences pressure as a result of body weight and gravity. The size of base of support will affect the difficulty level of balancing task. A broad base of support makes the task easier whereas narrow base makes it more challenging.[1] The term balance and equilibrium are often used synonymously. Balance can be considered to be the process whereby body's equilibrium is controlled for a given purpose. Normally every movement, posture must be adjusted to maintain balance (i.e.) the ability to maintain body equilibrium.[1] The task of maintaining COG over base of support is always accomplished within an environmental context, which is detected by the sensory systems. The unstable surface, unstable visual conditions or rapid head movements may alter postural cues. Balance is also affected by an individual's intentions to achieve certain goals and the purposeful tasks undertaken.[1,2] The three primary peripheral sensory inputs contributing to postural control are the bilateral receptors of the somstosensory, visual and vestibular systems. The central Vision allows environmental orientation, contributing to perception of verticality and object motion as well as identification of hazards and opportunities in environment. The peripheral vision detects the motion of the self in relation to the environment including head movements and the postural sway. Hence vision is critical for feed forward or anticipatory, postural control in changing environment.[1] The mechanisms involved in static balance were best summarized by Bannister. He noted that normal standing required:

1. Sufficient power in the muscles of the lower limbs and trunk to maintain the body erect.
2. Normal postural sensibility to convey information concerning position.
3. Normal impulses from the vestibular labyrinth concerning position.
4. A central coordinating mechanism, the chief part of which is the vermis of the cerebellum.
5. The activity of higher centers concerned in the willed maintenance of posture.

These five areas all play a vital role in maintenance of static balance. Little is known, however, about the functioning and relationship of these mechanisms in hearing impaired children. About half of all hearing impaired children have vestibular impairment.8-10 In as much as the vestibular apparatus triggers the vestibular reflex mechanisms that attempt to stabilize the eyes, head, and body in space, impairment of this mechanism will also affect postural sensibility. Thus, many hearing impaired children have a known impairment of at least two, if not more, of the mechanisms Bannister considers necessary for normal static balance.[3] Thus, Balance control is very necessary to accomplish common activities of daily living such as sitting, standing and walking. Balance impairments negatively affect function, leading to disability. These impairments often restrict activity levels, especially in children, as they are very active and involved in playful activities.[1] Static balance as required for normal standing is the ability to maintain the body equilibrium in some fixed posture. Postural control in children of 7 to 12 years of age, were essentially like those of adult. There were no significant differences in onset latency, variability, or temporal coordination between muscles within leg synergy between this age group and adults. It has been suggested that discontinuous changes seen in the development of many skills, including postural control, may be the result of critical dimension in the body of growing child.[4] There is high incidence of vestibular dysfunction associated hearing dysfunction in children with hearing impairments and poor balance proficiency.[5] Children who are hearing impaired from birth or early childhood are known to have some degree of balance impairment. This impaired balance may affect the acquisition of other motor skills or interfere with visual-perceptual-motor development and sensory integration**.** [3]

Anatomy of Ear: The inner ear contains the sensory organs for hearing and balance. The cochlea is the hearing part of the inner ear. The vestibular system is the sensory apparatus of the inner ear that helps the body maintain its postural equilibrium. The vestibular system provides information about position and motion of the head, to the Central Nervous system.[2] The vestibular system consists of three semicircular canals, a utricle, and a saccule. The semicircular canals, the utricle and the saccule are the balance part of the inner ear Each of the semicircular canals lies anatomically in a different plane, each plane at a right angle to each other. There are three semicircular canals; horizontal, anterior and posterior. Thus, each deals with different movement: up and down, side to side, and tilting from one side to the other. All contain sensory hair cells that are activated by movement of inner ear fluid known as endolymph. Endolymph moves freely within semicircular canal to the direction of angular head rotation.[1,2] The vestibular system is critical for balance because it uniquely identifies self motion as different from motion of the environment.[1]

Physiology of Hearing: The inner ear contains the sensory organs for hearing and balance. The cochlea is the hearing part of the inner ear. The cochlea is a bony structure shaped like a snail and filled with fluid (endolymph and perilymph). The Organ of Corti is the sensory receptor inside the cochlea which holds the hair cells, the nerve receptors for hearing. The mechanical energy from movement of the middle ear bones pushes in a membrane in the cochlea. This force moves the cochlea's fluids that, in turn, stimulate tiny hair cells. Individual hair cells respond to specific sound frequencies so that, depending on the frequency of the sound, only certain hair cells are stimulated. Signals from these hair cells are translated into nerve impulses. The nerve impulses are transmitted to the brain by the cochlear portion of the acoustic nerve.[7] The acoustic nerve carries impulses from the cochlea to a relay station in the Mid-brain, Cochlear nucleus and on to other brain pathways that end in the auditory cortex of the brain. At the cochlear nucleus, nerve fibers from each ear divide into two pathways. One pathway ascends straight to the auditory cortex on one side (hemisphere) of the brain. The other pathway crosses over and ascends to the auditory cortex in the opposite hemisphere of the brain. As a result, each hemisphere of the brain receives information from both ears.

Hearing Impairment: A hearing impairment or deafness is a full or partial decrease in the ability to detect or understand sounds. It is caused by a wide range of biological and environmental factors, Hearing impairment can be of various degrees, such as mild, moderate, severe, profound, or total. The degree of impairment is typically categorized by the loss of hearing sensitivity i.e. how loud are sounds for particular individual to hear. The degree of impairment can refer either to the loss of hearing sensitivity for individual pitches of sounds for each ear separately, or to an overall loss of hearing sensitivity for both ears.[8] Hearing impairment, including deafness, means a significant impairment in hearing, Hearing impairment may be present at birth or acquired later in life. A hearing impairment or deafness is a full or partial decrease in the ability to detect or understand sounds.[9] Conductive hearing loss occurs when sound is not conducted properly through the outer ear, middle ear, or both. Any disease process which interferes with the conduction of sound to reach cochlea causes conductive hearing loss. Sensorineural hearing loss is due to insensitivity of the inner ear, the cochlea, or to impairment of function in the auditory nervous system. Sensorineural hearing loss results from the lesions of cochlea, eighth nerve or central auditory pathways. It may be congenital or acquired.[8] Rao *et al*. 2002 Rural south India, have screened First year school children population for Sensorineural, mixed; Unilateral or bilateral hearing loss cases, and found out 32 per 1000 cases of permanent childhood impairment children. The major etiological classification system suggested by Davidson *et al.* has been used in most recent studies. The categories are:[9]

- Genetic
- Prenatal
- Peri-natal
- Post-natal causes such as infections, ototoxic agents or trauma.
- Cranio-facial anomalies
- Nerve damage; Injuries to the eardrum including Foreign objects, Explosions,Car wrecks, fights, and sports injuries. [9]

The vestibular end organs and the cochlea are closely related in anatomy and development, strong potential exists for a related vestibular deficit when the hearing mechanism is impaired. It is well documented that the incidence of both vestibular and motor deficits is high in children with hearing impairments. Impaired balance may affect the acquisition of other motor skills or interfere with visual-perceptual-motor development and sensory integration.[5] Children with hearing impairments tend to display inferior balance and gross motor skills compared with children with normal hearing. In contrast, children with hearing impairments often perform similarly to children without hearing impairments on fine motor coordination and visual-perceptual tasks, which are vital to manual communication methods. Arnvig[10] found that 82% of 89 children with severe postnatal hearing loss (eg, resulting from meningitis, measles, or encephalitis) and 34% of 129 children with inherited hearing loss had abnormal responses to vestibular tests.[5] Most of the cases with severe hearing loss or deafness acquired in prenatal or perinatal period. Similarly children with acquired hearing loss or deafness after birth have impaired vestibular function. Vestibular function is frequently abolished in children with meningitis. Also nystagmus can be found in hearing impaired children with various etiologies.[11] The vestibular apparatus and cochlea are closely related both anatomically and physiologically. A noxious influence prenatally, perinatally may cause damage to one or both the systems. The children with sensorineural hearing loss resulting from various etiologies without other handicapping conditions have hypoactive vestibular response. Boyd found deficient balance and locomotor coordination in 90 hearing impaired boys using an adaptation of the Oseretsky Scale. Lindsey and O'Neal compared the performance of 31, 8-year-old hearing impaired children with that of 77, 8-year-olds with normal hearing on a battery of 16 static and dynamic balance tests. The hearing impaired children failed significantly more balance tests than did the hearing group.[13] Elimination of visual input in static balance tasks increased the difficulty of the tasks for both the hearing impaired and hearing groups, with the hearing impaired group more seriously impaired. Children with loss of vestibular sensitivity appear to be functionally capable in their interactions with the environment except in certain balance activities.[5] There is high incidence of vestibular disturbances in children with acquired hearing-loss due to inner-ear infections that affect hair cells in the vestibular labyrinth as well as in the nearby cochlea. Vestibular function and balance skills of hearing impaired children are of interest to physical or occupational therapists working with this group because the characteristics of these functions may differ from those of children with unimpaired hearing.[17] Congenitally hearing impaired infants and children commonly suffer vestibular failure in both ears, and impairments of postural control, locomotion, and gait. These children eventually catch up with their normal peers in terms of development and growth as a result of central vestibular compensation.[14] The high incidence of vestibular dysfunction and problems with static balance in hearing impaired children without other handicaps is important information for therapists evaluating and treating hearing impaired children.[11]

Procedure: Formal permission of the principal of the deaf schools was taken for assessment of children. Children who fulfill the inclusion criteria were taken up for the study purpose. The purpose of the study and procedure was explained to the parents and teachers.

Explanation and consent form was be given to the parents of the children. A teacher was selected who can explain the children with the help of sign language. The teacher was explained about paediatric balance scale. Then with the help of the teacher's explanation of each component was given. Along with that explanations, multiple trials were given to them. The instructions regarding each task were also given. If the child was unable to complete the task based on their ability to understand the directions, second practice trial was given. Each item was scored utilizing 0 to 4 scales as per paediatric balance scale.. According to the protocol for scoring, the child's performance was scored based upon the lowest criteria, which describes the child's best performance. If on the first trial a child received maximal score of 4, additional trials were not administered. Several items required the child to maintain a given position for a specific time demonstration by investigator was given to individual child. Child was given a practice trial on each item. If child was unable to complete task on basis to understand the directions or the. Progressively more points were deduced if the time or distance requirements were not met. The child was asked to perform the activity, three trials were given and the lowest one was considered for scoring. The activities performed were:

MATERIALS AND METHODOLOGY

Study design: Descriptive analysis- exploratory type. **Study setting**: **1)** Chinchwad deaf and dumb School, Nigdi, pune. **2)** Suhrud deaf and dumb School, Shivajinagar, Pune **3)** Ayodya charitable trust's residential school for deaf children. **Sample size**: 100. **Target population** hearing impaired children aged 7 to 12 years. **Sample population:** hearing impaired children who satisfy inclusion criteria. **Sampling Method:** Purposive sampling. **Inclusion Criteria:** Children with congenital and acquired deafness, 7-12 years of age group, Children of both Genders.

Exclusion Criteria

- Children with musculoskeletal and any other neurological disorders affecting balance
- Children with visual impairments.
- Children with cochlear implants

Materials Used

- Bench with adjustable height
- Adjustable Chair with back support and arm rest
- Stopwatch
- Masking tape
- Step stool of 6" height
- Chalkboard eraser
- Ruler or yardstick
- A Small level
- Paper, pen.

OUTCOME MEASURE

PEDIATRIC BALANCE SCALE (PBS)

- Sitting to standing
- Standing to sitting
- TransfersStanding unsupported
- Sitting unsupported
- Standing with eyes closed
- Standing with feet together
- Standing with one foot in front
- Standing on one foot
- Turning 360 degrees
- Turning to look behind
- Retrieving object from floor
- Placing alternate foot on stool
- Reaching forward with outstretched arm

After administration of Paediatric balance scale, scores for all 14 components of scale and total score were noted in separate data recording sheet for each child. Data was collected and tabulated for Statistical analysis.

RESULT

Table 1: Distribution of mean scores and standard deviation of PBS components

Component	1	6	8	9
Mean Score	3.93	3.49	3.36	3.47
SD	0.2932	0.6435	0.7852	0.7311

When the components of paediatric balance scale are analyzed by ANOVA, it showed significant difference and the p value was less than 0.0001 ($p<0.0001$)

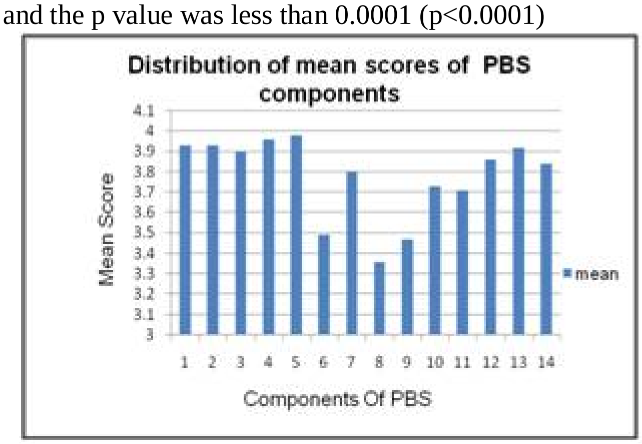

Figure 1: Distribution of mean scores of PBS components

Table 2: Comparison of component 1 with components 6,8, 9 of pbs

Component	1	6	8	9
Mean Score	3.93	3.49	3.36	3.47
SD	0.2932	0.6435	0.7852	0.7311

When the component 1 was compared with component 6, 8 and 9 there was a significant difference and $p<0.05$

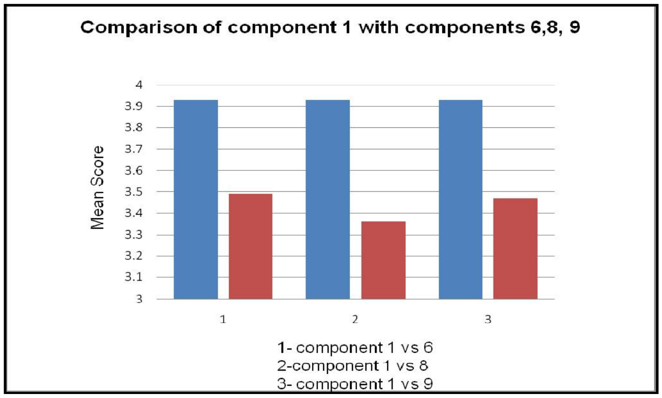

Figure 2: Comparison of component 1 with components 6,8, 9 of PBS

Table 3: Comparison of component 2 with components 6,8, 9 of PBS

Component	2	6	8	9
Mean	3.93	3.49	3.36	3.47
SD	0.2932	0.6435	0.7852	0.7311

When the component 2 was compared with component 6, 8 and 9 there was a significant difference and $p<0.05$

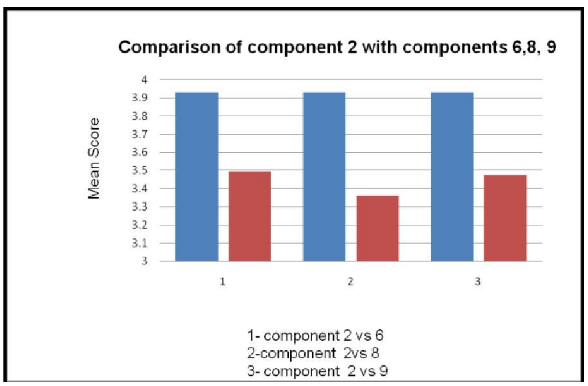

Figure 3: Comparison of component 2 with components 6,8, 9 of PBS

Table 4: Comparison of component 3 with components 6,8, 9 of PBS

Component	2	6	8	9
Mean Score	3.9	3.49	3.36	3.47
SD	0.3015	0.6435	0.7852	0.7311

When the component 3 was compared with component 6, 8 and 9 there was a significant difference and $p<0.05$

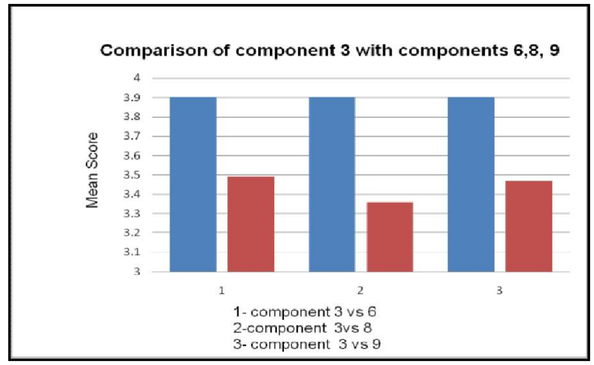

Figure 4: Comparison of component 3 with components 6,8, 9 of pbs

Table 5: Comparison of component 4 with components 6,8, 9,10,and 11 of PBS

Component	4	6	8	9	10	11
Mean	3.96	3.49	3.36	3.47	3.73	3.71
SD	0.1969	0.6435	0.7852	0.7311	0.566	0.5559

When the component 4 was compared with component 6, 8, 9, 10 and 11 there was a significant difference and $p<0.05$

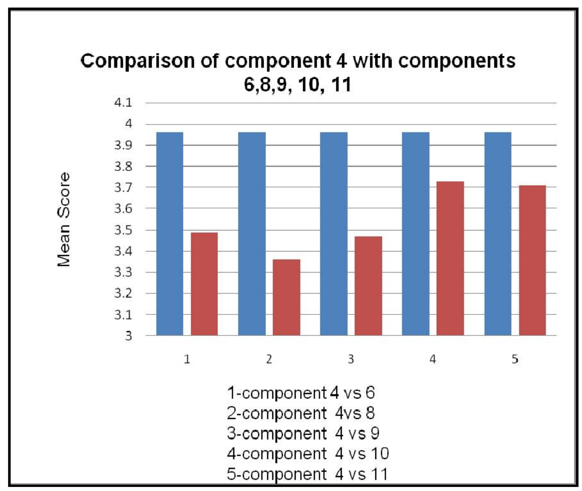

Figure 5: Comparison of component 4 with components 6,8, 9,10, and 11 of PBS

Table 6: Comparison of component 5 with components 6,8,9,10,and 11 of PBS

Component	5	6	8	9	10	11
Mean Score	3.98	3.49	3.36	3.47	3.73	3.71
SD	0.1407	0.6435	0.7852	0.7311	0.566	0.5559

When the component 5 was compared with component 6, 8, 9, 10 and 11 there was a significant difference and $p<0.05$

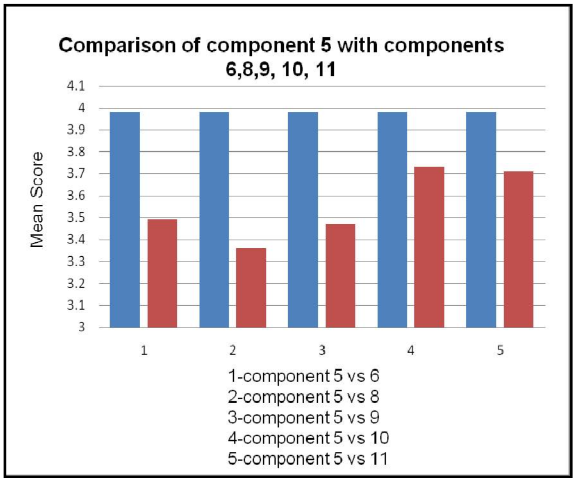

Figure 6: Comparison of component 5 with components 6,8, 9,10,and 11 of PBS

Table 7: Comparison of component 7 with components 6,8, 9 of PBS

Component	7	6	8	9
Mean Score	3.8	3.49	3.36	3.47
SD	0.4714	0.6435	0.7852	0.7311

When the component 7 was compared with component 6, 8 and 9 there was a significant difference and $p<0.05$

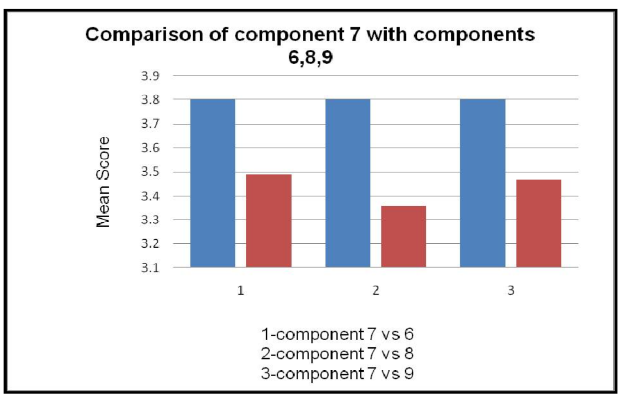

Figure 7: Comparison of component 7 with components 6,8, 9 of PBS

Table 8: Comparison of component 10 with components 6,8, 9 of PBS

Component	10	6	8	9
Mean Score	3.73	3.49	3.36	3.47
SD	0.566	0.6435	0.7852	0.7311

When the component 10 was compared with component 6, 8 and 9 there was a significant difference and $p<0.05$

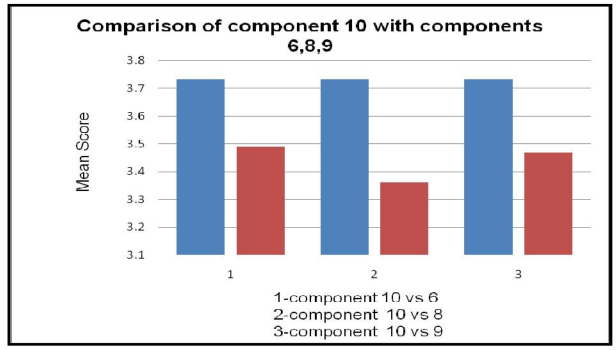

Figure 8: Comparison of component 10 with components 6,8, 9 of PBS

Table 9: Comparison of component 11 with components 8, 9 of PBS

Component	11	8	9
Mean Score	3.71	3.36	3.47
SD	0.5559	0.7852	0.7311

When the component 11 was compared with component 8 and 9 there was a significant difference and $p<0.05$

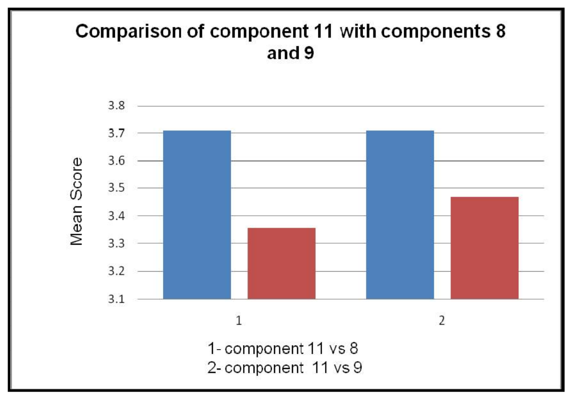

Figure 9: Comparison of component 11 with components 8, 9 of PBS

Table 10: Comparison of component 12 with components 6,8, 9 of PBS

Component	12	6	8	9
Mean Score	3.86	3.49	3.36	3.47
SD	0.4025	0.6435	0.7852	0.7311

When the component 12 was compared with component 6, 8 and 9 there was a significant difference and $p<0.05$.

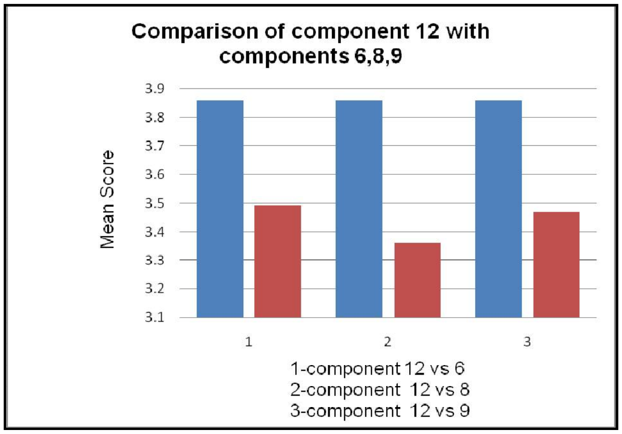

Figure 10: Comparison of component 12 with components 6,8,9 of PBS

Table 11: Comparison of component 13 with components 6,8, 9 of PBS

Component	13	6	8	9
Mean Score	3.92	3.49	3.36	3.47
SD	0.3075	0.6435	0.7852	0.7311

When the component 13 was compared with component 6, 8 and 9 there was a significant difference and $p<0.05$

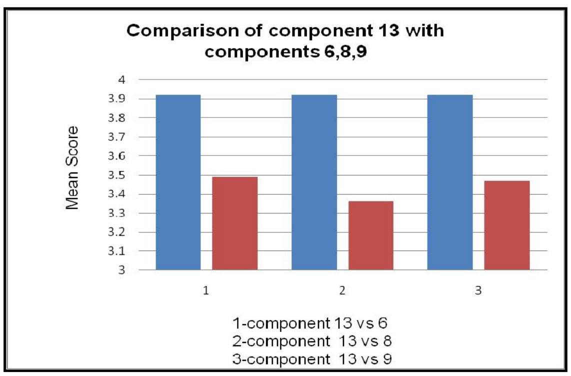

Figure 11: Comparison of component 13 with components 6,8,9 of PBS

Table 12: Comparison of component 14 with components 6,8,9 of PBS

Component	14	6	8	9
Mean Score	3.84	3.49	3.36	3.47
SD	0.3949	0.6435	0.7852	0.7311

When the component 14 was compared with component 6, 8 and 9 there was a significant difference and $p<0.05$

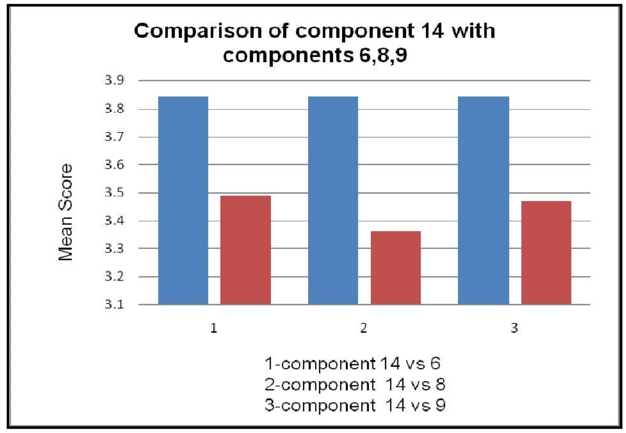

Figure 12: Comparison of component 14 with components6,8,9 of PBS

Table 13: Balance according to age in hearing impaired children

	Total no.	Mean scores
Male	64	52.4219
Female	36	53.6944

When the total mean score for age were not homogeneous hence they were analysed by Kruskal-Wallis test P= 0.0110 shows that there was significant difference.

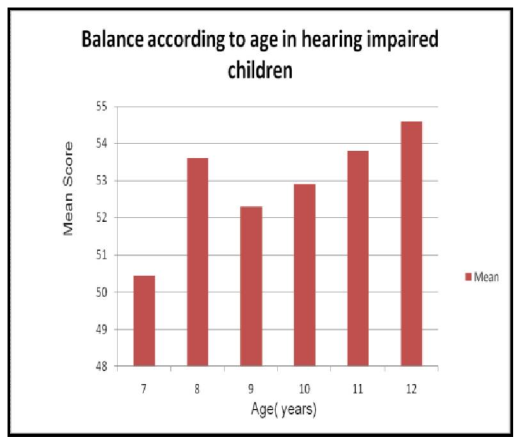

Figure 13: Balance according to age in hearing impaired children

TABLE 14

Balance according to the sex in hearing impaired children When the total mean score for sex were not homogeneous hence they were analysed by Kruskal-Wallis test P= 0.2933 shows that there was no significant difference.

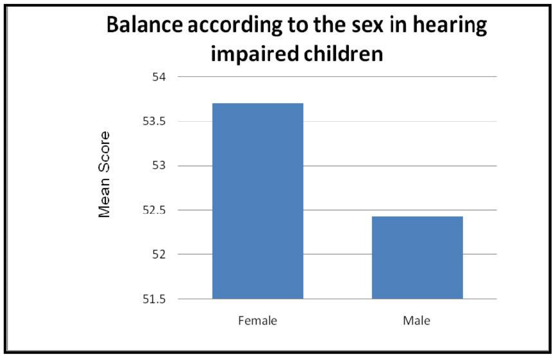

Figure 14: Balance according to the sex in hearing impaired children

RESULTS

Most affected component of balance in hearing impaired children is component 8 (standing with one foot in front). Other components which are affected are 9 (standing on one foot), 6 (standing with eyes closed), 10 (turning 360 degrees) and 11(turning to look behind). When component 1, 2, 3, 7, 10, 12, 13 and 14 were compared with the 6, 8(standing with one foot in front), 9 (standing on one foot); the p value was p< 0.05 hence showed significant difference. Thus component 6, 8 (standing with one foot in front). and 9 (standing on one foot) are more affected than components 1 (sitting to standing), 2 (standing to sitting), 3 transfer), 7 (standing with feet together), 10 (turning 360 degrees), 12 (retrieving object from floor), 13 (placing alternate foot on stool), 14 (reaching forward with outstretched arm) When component 4 and 5 was compared with 6, 8, 9, 10 and 11; the p value was p< 0.05 hence showed significant difference. Hence component 6(standing with eyes closed), 8 (standing with one foot in front)., 9 (standing on one foot), 10, 11 are more affected than component 4 (standing unsupported) and 5 (sitting unsupported) When component 11 was compared with 8 and 9 the p value was p< 0.05 hence showed significant difference. Thus component 6 (standing with eyes closed), 8 (standing with one foot in front). and 9 (standing on one foot) are more affected than 11 (turning to look behind) When total balance score was compared as per age p value was P= 0.0110, which shows that there was a significant difference. Hence results suggest that balance changes according to age. Balance is most found at 12 years and least at 7 years. When total balance score was compared as per age value was P= 0.2933 which shows that there was no significant difference. Thus result shows that there is no relation between balance and sex of the child.

Figure 1:

Figure 2:

Figure 3:

Figure 4:

Figure 5:

Figure 6:

Figure 7:

Figure 8:

Figure 9:

Figure 10:

Figure 1: sitting to standing
Figure 2: standing unsupported
Figure 3: Sitting unsupported
Figure 4: Standing with eyes closed
Figure 5: Standing with feet together
Figure 6: Standing with one foot in front
Figure 7: Standing on one foot
Figure 8: Turning to look behind
Figure 9: Placing alternate foot on stool
Figure 10: Reaching forward with outstretched hand

DISCUSSION

The interpretation of data suggests that, hearing impairment and balance have correlation with each other and standing with one foot in front, standing on one leg and standing with eyes closed are more affected than other tasks. The vestibular labyrinth consists of two saclike structures the saccule and utricle and three semicircular canals. Labyrinth is located deep within temporal bone and is continuous with cochlea. The semicircular canals are primarily stimulated by angular acceleration; otolith organs are stimulated by transient linear acceleration and by changes in head position. These stimuli evoke phasic and tonic vestibule-ocular and vestibulospinal reflexes, which act on the head and limbs to maintain posture. The vestibule-ocular reflexes activated in the semicircular canals provide a shift in angular position of eyes or head to compensate for movement produced by external stimuli. Activation of the reflexes in the semicircular canals influences the activity of many muscles throughout the body and contributes to sensations of body position.[11] Most affected component is standing with one foot in front. This alters both the center of gravity as well as base of support. The given base of support places a limit on the distance a body can move without falling or establishing new base of support either by reaching or stepping.[1] Thus as the child tries to keep foot ahead the base of support narrows and position of COG changes, and child is unable to balance. The standing on one leg is also affected as it again minimizes the base of support and thus the balance is reduced. The other affected task is standing with eyes closed. many studies have shown that hearing impaired children use bilateral receptors of the somstosensory, visual and vestibular systems.[5,11,24] The central Vision allows environmental orientation, contributing to perception of verticality and object motion as well as identification of hazards and opportunities in environment. The peripheral vision detects motion of self in relation to environment including head movements and postural sway. Hence vision is critical for feed forward, postural control in changing environment. [1] When eyes are closed there is no contribution from the visual system. Some studies have shown that the postural stability of profound hearing impaired children improves as a result of adaptive sensory compensation, both visual and somatosensory. Also the postural control is more highly dependent upon visual input than on somatosensory input.[25] The COG is an imaginary point in space, and is located just forward of the spine at approximately the S2 level. With movement of body and its segments, the location of COG in space constantly changes.The task of maintaining COG over base of support is always accomplished within environmental context, which is detected by sensory systems. The unstable surface, visual conditions or rapid head movements may alter postural cues.[1,2] The vestibular system itself cannot tell if head movement through space is produced by neck motion. Movements of the head are detected by semicircular canals. The position of head in relation to gravity is detected by otolith system. They respond to linear acceleration and static head tilt. As head moves, hair cells in semicircular canals send nerve impulses to brain by way of vestibular portion of acoustic nerve. Hence when child is turning his body 360 degrees or he is turning his head, child loses balance as hypoactive vestibular system is unable to detect the movement of the body or head. This results in balance loss or other vestibular symptoms such as vertigo which further may result in fall. The effect of loss of a sensory input on postural control depends on a) the availability of other senses, b) the availability of accurate orientation cues in environment, c) ability to correctly interpret and select sensory information for orientation. The person with loss of vestibular information for postural control may be stable under most of the conditions as long as alternative sensory information from vision or the somatosensory systems. The situations in which vision and somatosensory inputs are reduced leaving mainly vestibular inputs for postural control, the person may experience sudden falls.[23] According to Anne Shumway Cook, motor development in able-bodied children proceeds in orderly sequence. Stance control in children is different from adults as they are shorter and are proportioned differently as compared to adults. The Center Of Mass in children is at about T_{12} vertebral level as compared to adults. Any delay or abnormality in this development may lead to serious problems in the later life of child hence balance assessment is very crucial in physical therapy assessment of the child. Valid and reliable measures of functional balance are of critical importance to the pediatric physical therapists. This would help in finding, not only whether interventions are needed but also would show the effect of the intervention on balance. Postural control in children 7 to 12 years of age, were essentially like those of adult. There were no significant differences in onset latency, variability, or temporal coordination between muscles within leg synergy between this age group and adults. It has been suggested that discontinuous changes seen in the development of many skills, including postural control, may be the result of critical dimension in the body of growing child. The clinician must predict the ability of the child to safely and independently function in variety of environments. According to this study there was significant difference in balance of hearing impaired children. the results suggests that balance changes according to the age. Balance is most found at 12 years and least at 7 years. There was uneven distribution of subjects [7years (16), 8 years (15), 9 years (19), 10 years (23), 11 years(10), 12 years (17)] Bartlett's test for inequality of population variances was applied. As age increases from 7 years to 12 years the balance improves. This can be due to the change in spontaneous sway level in children reaches adult level by 9-12 years of age for eyes open condition and 12-15 years of age for eyes closed conditions.[4] Also as per role of cognitive systems in postural development younger children showed greater increases in postural instability than older children. Changes in the motor components may involve changes in body morphology as well as refinement of muscular response synergies including 1) A decrease in onset latencies, 2) Improvement in the timing and amplitude of muscle responses, and 3) A decrease in variability of muscle responses.[4] Although the postural control in children is similar to that of adultlike at age 7-12 years of age; the vestibular system continues to mature with full maturity attained between ages 10-14 years. The balance performance peaks between ages 9-12 years.[26] So the observed increase in balance with age can be seen maximum at age 12 years of age and minimum at age of 7 years. According to this study there is no sex difference in the balance of the hearing impaired children.[15] There was uneven distribution of subjects (64 boys, and 36 girls) Bartlett's test for inequality of population variances was applied. Some researchers have found no difference in balance abilities of hearing impaired male and female subjects. They discussed that age appropriate activities or exercise used to improve balance ability in hearing impaired children need not differ for male and female subjects because neither gender is superior. [11,13,15]

CONCLUSION

The most affected component of balance in hearing impaired children is standing with one foot in front. Other components which are affected are standing on one foot, standing with eyes closed, turning 360 degrees and turning to look behind. The balance changes according to the age in hearing impaired children. The balance is minimum at the age of 7 years and maximum at age of 12 years. There is no relation exists between balance and sex in hearing impaired children.

REFRENCES

1. Darcy Umphred :Neurological Rehabilitation-5th edition,Ch-23; Lesile Allison, Kenda Fuller.732-773.
2. Susan O'sullivan Physical Rehabilitation-, 5th edition, vestibular rehabilitation; Michael C. Schubert, 1000-1029.
3. Susan K. Effugen :effect of exercise program on static balance of deaf children J Physical Therapy vol 61, no 6, June 1981; 873-877.
4. Motor control 3rd edition, Anne Shumway- Cook, Marjorie Woollacott; Lippincott Williams and Wilkins. 2000 Ch-8: Development of postural control,187-211.
5. Terry K. Crowe and Fay B. Horak : Motor Proficiency Associated with Vestibular Deficits in Children with Hearing Impairments ; J Physical Therapy Volume 68, Number 10, October 1988, 1493-1499.

6. Report by Royal college of Physicians, London ;Hearing and balance disorders Achieving excellence in diagnosis and Management, 2007
7. P. L. Dhingra Diseases of ENT 3rd Edition Elsvier 2004, Ch 3 physiology of ear, pg 19-22
8. P. L. Dhingra Diseases of ENT 3rd Edition Elsvier 2004, Ch 6 Hearing loss pg.38-52, Ch 20 The deaf child, pg 148-152
9. A. Davis, K. Davis and G. Mencher Paediatric : Epidemiology of Permanent childhood hearing impairment; Paediatric Audiological Medicine)
10. Arnvig J: vestibular function in deafness and severe hardness of hearing.Acta Otolaryngeology 4:283-288, 1955.
11. Cyntia N. Potter and Lyn Newman Silverman: Characteristics of Vestibular Function and Static Balance Skills in Deaf Children, J Physical Therapy vol 64, no 7 July 1984 1071-1075.
12. Rapin I: Hypoactive labyrinths and motor development. Clin pediatrics(Phila) 13:922-937, 1974
13. Linsey D, O'Neal J: static and dynamic balance skills of eight year old deaf and hearing children, Am Ann deaf 121:49-55, 1976
14. Kimitaka Kaga, Yukiko Shinjo, Yulian Jin and Hideki Takegoshi :Vestibular failure in children with congenital deafness International journal of Audiology; 2008, Vol. 47, No. 9, Pages 590-599.
15. Janet Collins Siegel, Maria Marchrtti, Jan Stephen Tecklin: Age relate balance changes in hearing impaired children J of physical therapy, vol 71(3); March1991,183-189
16. Ewa Raglan, Paul Radomskij, John Veness, Kaukab Rajput : 'An audio- vestibular study of 128 children presenting to a specialized paediatric audio-vestibular clinic: Should every child with hearing impairment have vestibular function assessed?'J Audiological medicine 2009, Vol. 7(3), Pages 143-147.
17. Fay B. Horak Anne Shumway-Cook Terry K. Crowe F. Owen Black:Function and motor proficiency of children with impaired hearing or with Learning disability and motor impairments: J Developmental medicine and child neurology, 1988(30):64-79.
18. Franjoine MR, Gunther JS, Taylor MJ: Pediatric balance scale: a modified version Of the berg balance scale for the school-age child with mild to moderate motor impairment. J Paediatric physical therapy 2003 Summer;15(2):114-28.
19. Rine, Rose Marie, Rubish Kimber Chrrisopher : Measurement of sensory system effectiveness and maturational changes in young children, J of Paediatric Physical Therapy,1988 vol 10(1).
20. Cumberworth VL, Patel NN The maturation of balance in children, Journal of Laryngology Otol 2007 May,121(5):449-54
21. Peter selz vestibular deficits in deaf children otolaryngology, head neck surgery vol 113,(2)
22. Beck DL, Petrak MR, Bahner CL. Advances in vestibular diagnosis and rehabilitation. Hearing Review. 2010;17(11):12-16.
23. Anne Shumway Cook. Motor Control: Theory and Practical Applications.2nd Edition Lippincott Williams and Wilkins. 2000.chapter 3: physiology of motor control pg 46-82 ; ch10: abnormal postural control, 233-256
24. Suarez H et al. Balance sensory Organization in children with profound hearing loss and cochlear implants. Int J Pediatric otorhinolaryngology, 2007Apr,71(4):629-37
25. An MH, Yi CH, Jeon HS, Park SY :Age related changes of single limb standing balance in children with and without deafness, Int J Pediatric otorhinolaryngology 2000;73(11): 1539-44
26. Dolores B. Bertoti: functional neurorehabilitation through life span, F.A. Davis 2004, Ch-3; 49-88
27. Rine, Rose Marie(2009) 'Growing evidence for balance and vestibular problems in children',Audiological Medicine, 7(3), 138 –142
28. Hale, Sheri Anne :Postural control in children and young adults, 2004
29. O'Reilly et al: Prevalence of vestibular and balance disorders in children, Otol Neurotol. 2010 Dec; 31 (9): 1441-4
30. Medeiros IR et al : Vestibular rehabilitation therapy in children, Otol neurotolol, 2005 Jul; 26(4): 699-703
31. Freja Gheysen, Gerrit Loots, HildeVan Waelvelde :motor development of deaf children with and without cochlear implants Journal of deaf studies and deaf education2008,13(2);215-223

Source of Support: None Declared
Conflict of Interest: None Declared