A Study on Agility of School Children in India with Different Degree of Hearing Loss

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HOW TO CITE:
Banerjee, S., Biswas, R., & Ghosh, S. S. (2022). A Study on Agility of School Children in India with Different Degree of Hearing Loss. *International Journal of Special Education, 37*(1), 140-153
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DOI:
https://doi.org/10.52291/ijse.2022.37.33

ABSTRACT

Physical/motor fitness level of the hearing-impaired population have already attempted in previous studies where degree of hearing-loss of the subjects were not considered so far. Therefore, the aim of the study was to compare agility among children with different degree hearing-loss in India. Total of two-hundred-fifty-two (N=252, Boy=126 & Girls=126) hearing-impaired children (aged 13-20 years) were selected as subjects. Degree of Hearing-loss was measured by audiometric technique and divided into six different groups' viz. Profound, Severe, Moderately-Severe, Moderate, Mild and Normal with twenty one subjects in each group for each sex. Agility was measured through 4×10 meter shuttle run test. 2-way-ANOVA followed by Tukey's test was used as necessary statistics. The significance was tested at $p < .05$ level. In agility, boys were significantly better than the girls in all respect, when different hearing impaired groups were combined. Significant differences in agility among the different hearing impaired groups were observed except in few cases when both sexes were combined. No significant interaction between Sex and degree of hearing loss were observed. An increasing linear trend in agility was observed with decreasing degree of hearing Loss. Thus, an inverse relationship between agility and degree of hearing loss (dB HL) is observed.

Keywords: degree of hearing impairment, decibel hearing loss (dB HL), physical fitness, motor fitness.

INTRODUCTION

Hearing ability is one of the sensory abilities that have a crucial role over the improvement of cognitive, affective, and behavioral capacities through forms of communication during the learning process (Zittel et al., 2016). Any degree of hearing impairment restricts the sensory inputs to reach into the brain to a certain extent, particularly for the weak signals that lead to an incorrect processing of signals into the brain, and hearing impairment becomes evident to act accurately in response to an acoustical stimulus (Bilir, S. et al., 1995; Brunt & Broadhead, 1982; Jernice et al., 2011). Thus, hearing impairment is characterized by insufficiency in the perception of sounds, therefore, one become unable to realize communications (Caglar et al., 2013; Uysal et al., 2010). Hearing impairments can be acquired or even congenital in nature. Irrespective of the origin or cause, people having hearing impairments suffer not only in communicating with others but are hated and sometimes insulted too by the normal peoples. In this problem millions of people across all age groups and sex are suffering around the globe with growing prevalence in children and youth.

Worrying figures on the rising prevalence of sensorineural hearing loss worldwide have been released by the World Health Organization (WHO) time to time starting from 1985, it was initially noted that 42 million people, or 1% of the world's population, had disabling hearing loss i.e. moderate to profound HL (WHO, 1995). Since then, it grew in a geometric progression to 360 million, with 32 million children under the age of 15 (Shaikh & Sadhale, 2013; WHO, 2017). Between 2008 and 2017, this number rose from 1.2 billion (17.2%) to 1.4 billion (18.7%) (James et al., 2018). As of 2018, the WHO estimated that 466 million people worldwide (6.1% of the total population)—432 million adults and 34 million children—had "disabling" hearing loss. It was estimated that in 2030 the number will reach 630 million and in 2050 it will touch 900 million land mark (Stepanchenko et al., 2020). Additionally, it is predicted that by the year 2050, one in ten people will have hearing loss (Kushalnagar, 2019). Globally there were 9.8% of females suffering from this kind of disability in present situation (Metgud & Topkar, 2019).This data also explains why there are ever more children who are either born with a hearing impairment or develop one later in life. It is not only alarming but needs special attention to fight against this relentlessly growing health issue so as to prevent our future population from this health burden.

To ensure the normal development of the many millions of children with hearing impairment around the world, these issues relating to hearing impairment should be given enough consideration at very early stages in life. It needs to measure the hearing ability accurately to be sure whether someone has any hearing difficulty or normal hearing. Hearing ability is greater than 20 dB in both ears for healthy persons, whereas it is less than 20 dB for those who cannot hear (Kushalnagar, 2019). Based on the measurement of hearing ability, special care can be taken to those children who are hard of hearing. Depending on the degree of difficulty in hearing sound frequencies it can be categorized as normal, mild, moderate, moderately severe, severe and profound (Kushalnagar, 2019; Smith, 1998). If someone has hearing loss in one or both ears then it can be difficult to hear the speech and even louder sound frequencies. 'Hard of hearing' refers to the HL in mild to severe forms. On the other hand, people with profound hearing loss who hear little or nothing at all are also referred to as 'Deaf' (Kushalnagar, 2019). Vestibular injury, which impacts sensorineural function and psychomotor development, was the root cause of the auditory issue. When compared to children with normal hearing, previous studies have revealed that hearing impairment causes some abnormalities in the psychomotor development as well as delays in learning motor skill performance, like balance, coordination, fine and gross motor skills, power, speed, agility etc. (Gheysen & Loots, 2008; Melo et al., 2015; Rajendran & Roy, 2011; Wiegersma & Velde, 1983). Few previous studies revealed that a poor hearing ability hinders the motor development of the children (Dummer et al., 1996; Gayle & Pohlman, 1990; Weiss & Phillips, 2006).

Various studies have shown that hearing impairment leads an individual to avoid physical activity (Bouffard et al., 1996). Many studies have also shown that hearing impairments minimize balance & coordination ability and reduced physical ability (Al-Rahamneh et al., 2013; Livingstone & McPhillips, 2011). Most studies on individuals with hearing impairment have focused on the components of balance & stability that are due to the functional problem in the vestibular mechanism of the inner ear (Rajendran & Roy, 2011). According to the smoothness of the vestibular function of the inner ear hearing impairment can also vary to a different degree (Ghosh et al., 2022). Hearing loss can be classified according to the severity or degree of the disease. American Speech-language Hearing Association (ASHA) has categorized hearing loss into seven types according to the degree of hearing loss, viz. Hearing losses greater than 91 dB Profound, between (71-90) dB Severe, (56-70) dB Moderately Severe, (41-55) dB Moderate, (26-40) dB are considered Mild, (16-25) dB are considered Slight and (-10-15) dB considered as Normal (Baiduc et al., 2013; Banerjee & Ghosh, 2021; Clark, 1981; Pittman & Stelmachowicz, 2003; Alshuaib et al., 2015). It is already an established fact that the degree of a hearing loss proportionately affects balance and coordination (Metgud & Topkar, 2019). In few previous studies it was observed that vestibular injury impacts on sensorineural function and psychomotor development (Ghosh et al., 2022) and when compared to children with normal hearing, previous studies have revealed that hearing impairment causes some abnormalities in the psychomotor development as well as delays in learning motor skill performance, like balance, coordination, fine and gross motor skills, power, speed, agility etc. (Gheysen & Loots, 2008; Melo et al., 2015.; Rajendran, 2011; Wiegersma & Velde, 1983). Few previous studies revealed that a poor hearing ability hinders the gross motor development of the children (Gayle, & Pohlman, 1990; Dummer et al., 1990; Weiss & Phillips, 2006).

Different studies on the physical & motor fitness level of the hearing impaired population have already been attempted (Caglar et al., 2013; Engel-Yeger & Weissman, 2009; Hartman et al., 2011; Livingstone & McPhillips, 2011; Martin et al., 2012; Shaikh & Sadhale, 2013; Veiskarami & Roozbahani, 2020) where the degree of impairments of the subjects were not taken into consideration so far. Thus in the present study apart from balance and coordination, the specific motor fitness parameter i.e. agility was considered. Agility can be defined as rapid change of velocity or direction of the whole-body or individual limbs quickly and accurately in response to a stimulus (Altug et al., 1987; Barrow et al., 1989; Johnson & Nelson, 1986; Bloomfield et al., 1994; Clarke, 1976; Horička et al., 2014). Thus, agility has not only to build with speed component but also composed of balance, coordination, and the ability to react in a changing environment (Baechle & Earle, 2008). In the present study degree of HL was measured by audiometric technique and the agility of the subjects were also measured by standard motor fitness test and it was compared both for male and female subjects. Therefore in the present investigation, the researchers find out the impact of hearing loss on the agility.

It was believed that the research works already conducted in this field to determine the effects of different degree of hearing loss on agility was insufficient to draw an exact conclusion in this area of expertise. Therefore, the researchers felt that a scientific study should be designed to learn more about this surprisingly under-researched population of hearing impaired people. Accordingly, the current study was designed to look into the relationship between hearing loss severity and agility in Indian children with various degree of hearing loss. The researchers also believed that the findings will be valuable to future academics, educators, and movement and sports scientists for further research. Keeping this in mind while creating a physical activity programme for those kids with special needs will also be beneficial to the trainers and the adapted physical educationist. Additionally, it will assist present and upcoming researchers in the field of adapted physical activity in formulating plans for more in-depth studies on a unique population with varied degrees of hearing loss.

METHODS

Purpose: The purpose of the present study was to investigate the agility among the different degrees of hearing-impaired children in India. To achieve the purpose, the present study was planned to initiate research work in the following way

Selection of Sample: For the purpose of the present study the researchers used a purposive sampling technique. To investigate the variation of agility with degree of hearing loss the researchers were bound to select those subjects with varying degree of deafness (hearing loss) as required for this study. In this respect; researchers followed the classification of degree of hearing loss guidelines for different categories by *American Speech-language Hearing Association* (ASHA) that showed over a continuum of (0%-100%) hearing loss (dB HL) into six different categories viz. normal, mild, moderate, moderately severe, severe and profound (Ghosh et al., 2022) which is discussed earlier in the introduction part. For the present study the above six dB HL categories of subjects were purposively selected on the basis of audiometric assessment (details given in procedure of measurement of degree of hearing loss) which has been discussed in group division part.

Participants: At the start of the research work total of three hundred eighty-four subjects were recruited but the researchers were able to collect complete data from two hundred eighty-four subjects because some of the subjects were not present in the venue at the date of data collection. Due to equating the no. of subjects in each subgroup for the sake of statistical software, finally; the researchers considered two hundred fifty-two subjects for the present study by eliminating the subjects having borderline db HL in-between two categories. Thus, a total of two hundred fifty-two (N=252) hearing-impaired children aged between 13-20 years, were finalized as subjects for this study. Among them Boys=126, mean age 17.43±2.84, height 160.09±6.80, weight 49.74±6.04 & Girls=126, mean age 16.97±2.05, height 151.61±5.73, weight 45.39±5.96 were purposively selected from two separate districts of West Bengal i.e. Burdwan and Kolkata situated in the eastern part of India. The subjects were selected from seven schools of which four schools were especially for the deaf & dumb (hearing impaired) students. The audiometric technique was used to detect their exact degree of hearing loss by a group of qualified experts.

Group division: In the total subjects, one hundred and twenty-six were Boys (NB=126), and one hundred and twenty-six were Girls (NG=126). Depending on the degree of hearing loss these subjects were divided into six groups for each sex with equal (21 in each category) number of subjects; viz. (1) Profound Group hearing disability 91 up to 100 dB, (2) Severe Group hearing disability 71 up to 90 dB, (3) Moderately Severe Group 56 up to 70 dB, (4) Moderate Group 41 up to 55 dB and (5) Mild Group 25 up to 40 dB (6) Normal group 0 up to 20 dB (Banerjee & Ghosh, 2021; Clark, 1981; Rajendran & Roy, 2011).

Variable Studied: Among various physical and motor fitness components, agility was considered as the only variable for the present study.

Equipments & Tools Used: To measure agility, the equipment and materials used was stopwatch, 50m measuring tape, duster, cone, flag and 20m long and 5m wide marked ground. 4x10 m shuttle run test was used to measure agility. To measure the degree of hearing loss Audiometers were used. In these testing devices a pure tone signals was generated by adjusting both frequency and intensity, independently. The machine was operated by an experienced Audiologist who recorded the lowest sound responded by the subject at each frequency.

Procedure of Measurement

Agility: There were several tests that are widely and commonly used to measure agility like Illinois agility test, Agility T-test, The 505 agility test, 4×10 m. shuttle run test etc. After execution of different agility test on few hearing impaired subjects (particularly on severe & profound groups) the researchers felt that the complexity of movement pattern for executing the first three tests for the hearing disabled population seemed really difficult in the field settings, though, few researchers used 'Agility T-test' and even other tests also to measure the agility of the hearing impaired population (Ibrahim et al., 2017; Metgud & Topkar, 2019; Tetik et al., 2017), but these were not considered in the present study. However, the last one i.e. 4×10 m. shuttle run test, as little easier to conduct could be applicable for the target population as it was also used by few previous researchers for the same population (Abdullah et al., 2014, 2016; Al-Rahamneh et al., 2013; Hartman et al., 2007) therefore, selected as a test to measure agility for the present study. The procedure for conducting the selected agility test (4×10 m. shuttle run test) has been discussed below.

Two parallel lines, one is starting line and finishing line and the other is the block placement lines which were marked on the floor 10 m apart. The two wooden blocks were placed behind the block line. The subjects were directed to start from behind the starting line. On the signal (flag) the timekeeper started watch and the subject runs towards the blocks, picked up one block, run back to the starting line, place the block behind the starting line, run back and picked up the second block to be carried and back across the starting line. As soon as second block was placed on the ground the timekeeper stopped the watch and recorded the time. The time was recorded to the nearest of 1/10 second as score. The 4 × 10 m shuttle run test has shown in fig: 1.

Degree of hearing loss (dB HL): It was measured through audiometer. Audiometry is a very popular painless, noninvasive hearing test that is basically used to measure the degree of hearing loss of an individual quantitatively by measuring his/her hearing sensitivity. This test actually measures a person's ability to hear different

Fig. 1. Measurement of Agility by 4×10m shuttle run test

sounds, pitches, or frequencies (Choi et al., 2019; Fausti et al., 2005; Hederstierna et al., 2007; May, 2000). The test was conducted in a sound proof room by using sounds of single frequency, tested at various intensity levels to determine the lowest loudness level that a subject was capable to hear in each frequency. The pure tone (single frequency), was presented into the ear canal by using standard headphones. The testing was performed across several frequencies for the human hearing range. The subject was instructed to give a response on hearing a tone, by lifting hand or finger. In each frequency the lowest loudness level heard by the subject (Threshold level) was recorded. It was performed with different frequencies starting from 125 Hz and increasing onwards by half-octaves like 250 Hz, 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz and 8000 Hz. This test was performed separately for the right and left ears. The intensity for the tone was measured in decibels or dB with the range from 0 to 120 dB. To find out the severity and category of hearing loss pure tone average was computed by using the thresholds (softest sound heard) at the 500 Hz, 1000 Hz and 2000 Hz for each ear. On the basis of pure tone average the severity of hearing loss is categorized as follows: a) Normal hearing (0 to 20 dB) - 0 dB is not the absence of sound, b) Mild hearing loss (21 to 40 dB) - difficulty in following speech especially in noisy situations, c) Moderate hearing loss (41 to 55 dB) - Difficulty in following speech and other quiet sounds, d) Moderately severe hearing loss (56 to 70 dB) - Unable to hear speech even in quiet surroundings, e) Severe hearing loss (71 to 90 dB) - Only very loud sounds like traffic noises can be heard, f) Profound hearing loss (Above 91 dB) - Unable to hear sounds unless extraordinarily loud (Shown in table 1). In the present study the category of dB HL of an individual was considered by the ear with maximum hearing loss. Measurement of degree of hearing loss by the Audiologist has shown in fig. 2.

Statistical Analysis: Before the statistical analysis of data, the Kolmogorov-Smirnov test of normality was performed and the test confirmed that the data were normally distributed. Though there were several other powerful tests also for verifying the normality (Shapiro–Wilk test, Jarque–Bera test, D'Agostino's K-squared test etc.) of the collected data, Kolmogorov-Smirnov test of normality was adopted as it is also very powerful and popular for testing normality of data. All data were expressed as means ± standard deviation (SD). For data interpretation, as these were normally distributed, the parametric statistics i.e. Two Way Analysis of Variance (2-Way ANOVA) was performed, followed by Tukey's LSD test as a post hoc test for finding the exact location of the differences separately in a row, column and interaction. The level of significance was set at $p < 0.05$. Data were analyzed by an excel spreadsheet of Microsoft office software in Windows version-10. The Kolmogorov-Smirnov test of normality was performed by social science statistics software and the rest of the statistical calculations were performed by Vassar stats a statistical computation software package. All software packages were freely available in online.

Fig. 2. Measurement of degree of hearing loss by Audiometer

RESULTS

In the following section the results of the study were presented in the tables with proper explanation. Table 1 shows the descriptive statistics (age in year, heights in cm, weight in kg) of the subjects for different sub-group (two sex category i.e. boys & girls, six hearing loss category) with respective degree in decibel hearing loss (dB HL). It also shows no of subjects in both sex category (boys =126, girls = 126) and in each hearing loss category (21 in each) with the total no. of subjects (N=252).

In table 2 the mean value and the standard deviation of agility (s) for all hearing impaired groups both for boys and girls have been presented and it has been depicted graphically in fig. 3 & fig. 4 as well. From the

Table 2. **Mean and Standard Deviation (SD) of agility (s) of Six Different Hearing Loss Groups both for Boys' and Girls'**

Sl. No.	Name of the Group	dB HL	No. of Subjects in different Group		Girls			Boys		
					Age (years)	Height (cm.)	Weight (kg.)	Age (years)	Height (cm.)	Weight (kg.)
			Boys	Girls	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
1.	**Normal**	0 - 20	21	21	16.92±2.45	151.23 ±5.81	45.42±7.41	17.12±2.42	156.54±5.88	51.48±6.74
2.	**Mild**	21 - 40	21	21	16.77±2.50	154.62±5.89	49.52±6.15	18.15±0.93	156.81±4.84	54.11±6.93
3.	**Moderate**	41 - 55	21	21	18.86±5.25	155.43±6.81	47.57±6.00	18.24±2.99	164.90±6.79	50.71±4.60
4.	**Md. Severe**	56 - 70	21	21	15.51±3.61	151.04±4.45	46.19±6.82	17.29±3.02	160.81±7.59	50.86±4.73
5.	**Severe**	71 - 90	21	21	17.02±2.86	154.14±3.85	49.05±3.02	17.91±3.77	160.14±6.77	48.57±7.24
6.	**Profound**	91+	21	21	16.71±4.67	150.19±7.59	44.62±6.38	18.19±4.11	160.81±8.91	51.71±5.98
No. of Subjects in each Sex			126	126						
Total No. of Subjects			(N = 252)							

Table 2. **Mean and Standard Deviation (SD) of agility (s) of Six Different Hearing Loss Groups both for Boys' and Girls'**

Name of The Group	Name of the group having different degree of hearing loss					
	Pofound	Severe	Md Severe	Moderate	Mild	Normal
	Mean ± SD	Mean ± SD	Mean ± SD	Mean± SD	Mean ± SD	Mean ± SD
Boys	13.90 ± 0.99	12.64 ± 1.34	12.24 ± 1.31	12.07 ± 0.95	11.62 ± 0.83	11.14 ± 0.68
Girls	14.11 ± 0.86	13.16 ± 1.36	12.64 ± 1.34	12.28 ± 1.86	12.10 ± 0.91	11.64 ± 1.06

table it was evident that the mean values of agility (s) i.e. time taken in 4×10m shuttle run by the different girls groups were greater than the respective boys groups in different categories for degree of hearing loss. In this case lesser the time taken to cross 4×10 m shuttle run better is the agility. Thus lesser the mean value of the boys indicated that better the agility they have than the girls, likewise, the time taken by the profound groups were higher and the time decreases when considered the groups from profound towards the normal group. In this case also the agility of a particular group is better than the groups placed immediate left side of it in the table. But in both the two cases (difference in sexes or differences in different HL groups) whether the differences of

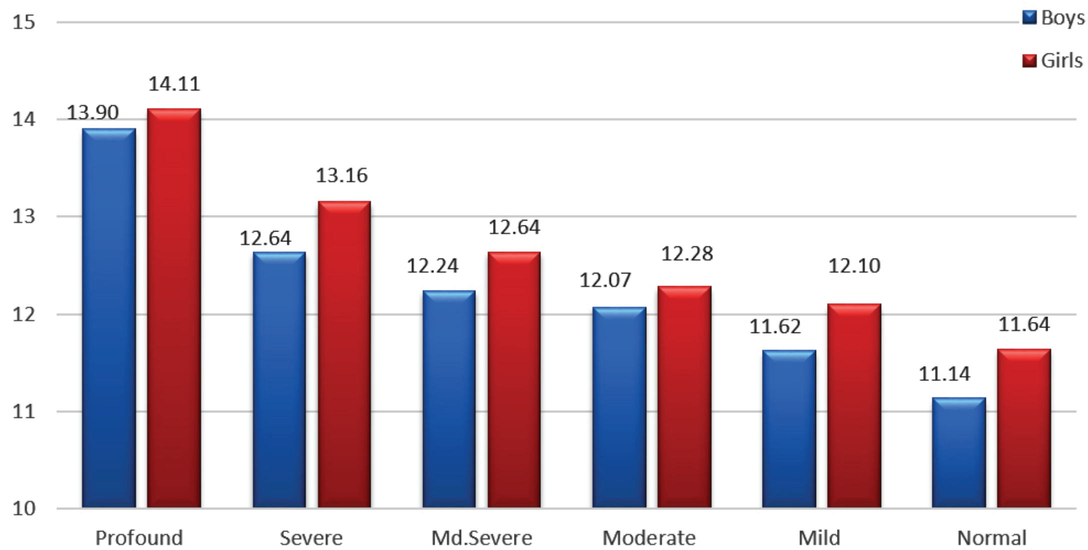

Fig. 3. Comparisons for the Mean Value of Agility(s) among Boys and Gigls

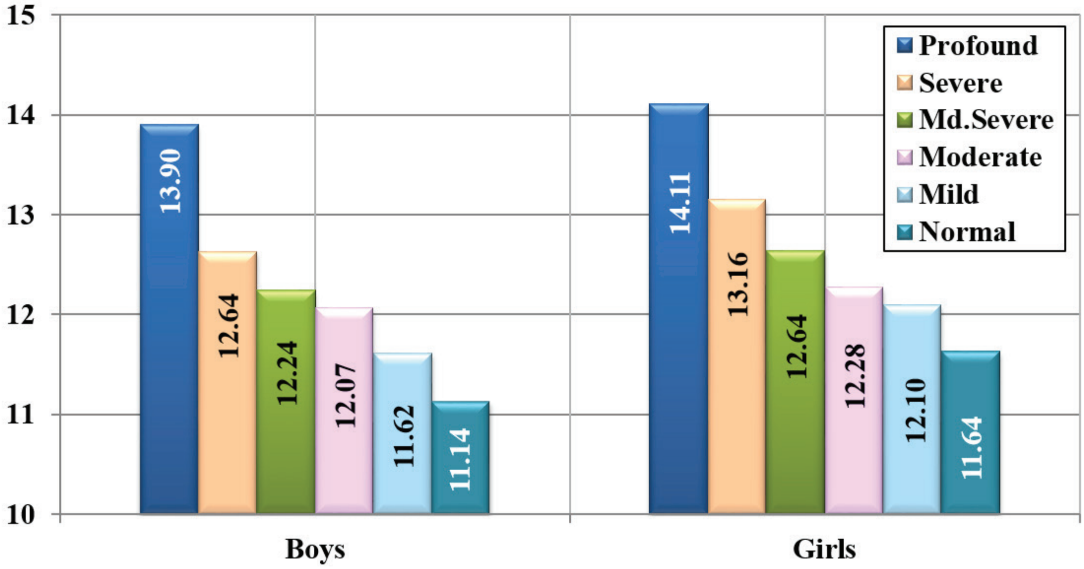

Fig. 4. Comparisons for the Mean Value of Agility (s) among different Hearing Impaired Groups

time taken to cross 4×10 m distance by the subjects of different groups is statistically significant or not at all, it need to be confirmed through appropriate inferential statistics that's why 2-way ANOVA followed by Tukey's LSD test for pair-wise comparison (both for rows & columns) were performed and presented in the next tables (tables 3 to 5).

In the bar diagrams i.e. in fig. 3 & fig. 4 the Mean value of agility(s) of the Subjects of Different Degree of Hearing loss groups has been presented both for Boys & Girls.

In table 3 the 2-way ANOVA for agility(s) has been presented. It is seen that the computed F-value for Row (F=6.89, $p<0.05$) and Column (F=25.74, $p<0.05$) were statistically significant but F-value for Interaction (Sex × Degree of Hearing Loss) was found statistically insignificant (F=0.16, $p>0.05$). Therefore, between both Sexes i.e. between the boys and girls (Row) there is a significant difference in agility (s). Again, it was also confirmed that the boys were significantly superior in agility (s) than the girls. Likewise, it was observed that in agility (s) the subject belongs to different Degree of Hearing Loss (Column) i.e. among Profound, Severe, Md. Severe, Moderate, Mild and Normal groups there was significant difference also. It was also found that agility increases with decreasing degree of hearing loss. To find out the exact location of differences among the groups both for rows as well as columns, pair-wise comparison analysis were done separately by using Tukey's LSD test and presented in table 4 and table 5 respectively.

Row Analysis: Tukey's LSD test for both Sexes (all hearing impaired groups are combined):

In table 4 the mean value of agility (s) for both boys (12.27s) and girls (12.25s) group have been presented when all six different-degree of hearing-impaired groups were combined. The value of critical difference (CD

Table 3. **M2-Way ANOVA (Sex in Row & Degree of HL in Column) for Agility (s)**

Source of Variation	Sum of squares (SS)	Df	Mean squares (MS)	F-value	P value	Table Value of F	At
Sex *(Row)*	9.38	1	9.38	6.89*	0.00922	3.88	$F_{0.05}(1, 240)$
Hearing Loss Group *(Column)*	175.23	5	35.05	25.74*	0.00001	2.25	$F_{0.05}(5, 240)$
Interactions *(Row× Column)*	1.08	5	0.22	0.16	0.9768	2.25	$F_{0.05}(5, 240)$
Error *(Residual)*	326.74	240	1.36				
Total	512.43	251					

Table 4. **Mean Value of Agility (S) Mean diff and Critical diff for Boys & Girls**
(When all hearing impaired groups are combined)

.Mean Scores of Rows		Mean Difference	CD at 0.05 level
Boys	Girls		
12.27	12.65	0.39	0.29

=0.29) were computed by employing Tukey's LSD test for (df=240, k=6, n=21 and p<0.05). The value of combined mean difference is (0.39s) between Boys and Girls group. It was observed that the mean difference were greater than the critical value, therefore, statistically significant. Thus it may be concluded that the agility (s) of differently able hearing boys is better than the pair girls when all six hearing loss groups are combined.

Column Analysis: Tukey's LSD test for different groups with varying degree of hearing loss (When both Sexes i.e. Boys & Girls are combined):

In table 5 the mean values of agility (s) for six different hearing-impaired groups i.e. Profound, Severe, Md. Severe, Moderate, Mild and Normal groups have been presented as 14.01s, 12.90s 12.44s, 12.18s, 11.86s and 11.39s respectively when both sexes i.e. (boys & girls) were combined.The value of critical difference (CD = 0.50) were computed by employing Tukey's LSD test for (df =240, k=2, n=21 and p<0.05). It was observed from the table- 5 that the mean difference of profound group differed significantly with all other five groups (Severe, Md. Severe, Moderate, Mild, and Normal). Again, it was also observed that the mean differences of severe group differed significantly with all other groups except with its immediate next group i.e. with Md. Severe group. It was further observed that the mean difference of Md. Severe group differed significantly with three other groups (Profound, Mild, and Normal) but no significant difference observed with its immediate right and left groups (Severe & Moderate group). It was further observed that the mean difference of Moderate group differed significantly with three groups (Profound, Severe and Normal) but no significant differences were observed with its immediate right & left groups (Md. Severe & Mild). The Mild group differed significantly with three groups (Profound, Severe and Md. Severe) but not differed significantly with its immediate right & left groups (Moderate & Mild). It was further observed that that the Normal group differed

Table 5. **Mean Values of agility (s), Mean diff and CD value for Different Hearing Impaired Groups**
(When both Sexes i.e. Boys & Girls are combined)

Mean Scores of Column						Mean Difference	CD at 0.05 level
Profound	Severe	Md. Severe	Moderate	Mild	Normal		
14.01	12.90					**1.11 ***	0.50
14.01		12.44				**1.57 ***	0.50
14.01			12.18			**1.83 ***	0.50
14.01				11.86		**2.15 ***	0.50
14.01					11.39	**2.62 ***	0.50
	12.90	12.44				0.46	0.50
	12.90		12.18			**0.72 ***	0.50
	12.90			11.86		**1.04 ***	0.50
	12.90				11.39	**1.51 ***	0.50
		12.44	12.18			0.26	0.50
		12.44		11.86		**0.58 ***	0.50
		12.44			11.39	**1.05 ***	0.50
			12.18	11.86		0.32	0.50
			12.18		11.39	**0.79 ***	0.50
				11.86	11.39	0.47	0.50

significantly with four groups (Profound, Severe, Md. Severe and Moderate) except with Mild group.

In general, it may be concluded from the findings of the column analysis, that there are significant differences between most of the pair of groups with varying degree of hearing impairments when both sexes are combined. But in some cases for a particular group with its immediate left and/or right groups/group no significant difference observed. No matter whether the pair of groups was significant or not, the agility of the group placed in the right side was better than its left groups. The mean values of agility (s) for different hearing impaired groups have been presented in fig. 5 when both sexes are combined. From the figure it was seen that the mean value of time (s) taken to cover 4×10m shuttle run distance increases with increasing hearing loss when both sex are combined, therefore, an increasing tendency of agility was observed with increasing degree of hearing ability from profound group towards the normal group. In other words, it was observed with increasing hearing loss, agility decreases. Though this tendency of agility were not too linear, some damping were there, but in general, agility decreases with increasing degree of hearing loss.

Analysis of agility (s) vs. degree of hearing loss graph *(Mean values of dynamic balance in score):*

In fig. 5, Agility (s) vs. Degree of Hearing Loss (dB HL) has been depicted for both boys and girls. In this cases trend lines have also drawn and the equations of the trend line both for the boys and girls groups have also provided in the diagram. In this case the trend lines were *Oblique* or *Slanted* lines. The general nature of both trend lines follows the equation $y=mx+c$, which is actually an equation of straight line in slope-intercept form where 'm' is the slope or gradient of the line and 'c' is a constant called the y-intercept. For girls the equation was $y=-0.4535x+14.242$, where slope $m=-0.453$ and intercept $c=14.24$. Again, for boys the equation was $y=-0.4872x+13.974$, where slope $m=-0.4872$ and intercept $c=13.974$. Thus it was seen that the slope of the trend lines both for the boys and girls are negative which indicated that the increment of agility happens with the decrees of hearing loss. In all respect lower the position of the trend line for boys indicated that the time (s) taken to run the 4×10m distance of the boys were less than the respective girls groups consequently the agility of boys were better that its pair girls groups.

Interaction Analysis:

From table 3 it was evident that the F-value (0.16) was not statistically significant [$p<0.986$, table value of F = 2.25 at df (5, 240)], therefore, the null hypothesis accepted. It indicates that there are no interactions among the row (sex) and column (dB HL) as analyzed through 2-way ANOVA statistics. Therefore, no post hoc LSD was performed for finding the exact location of interactions between the row and column.

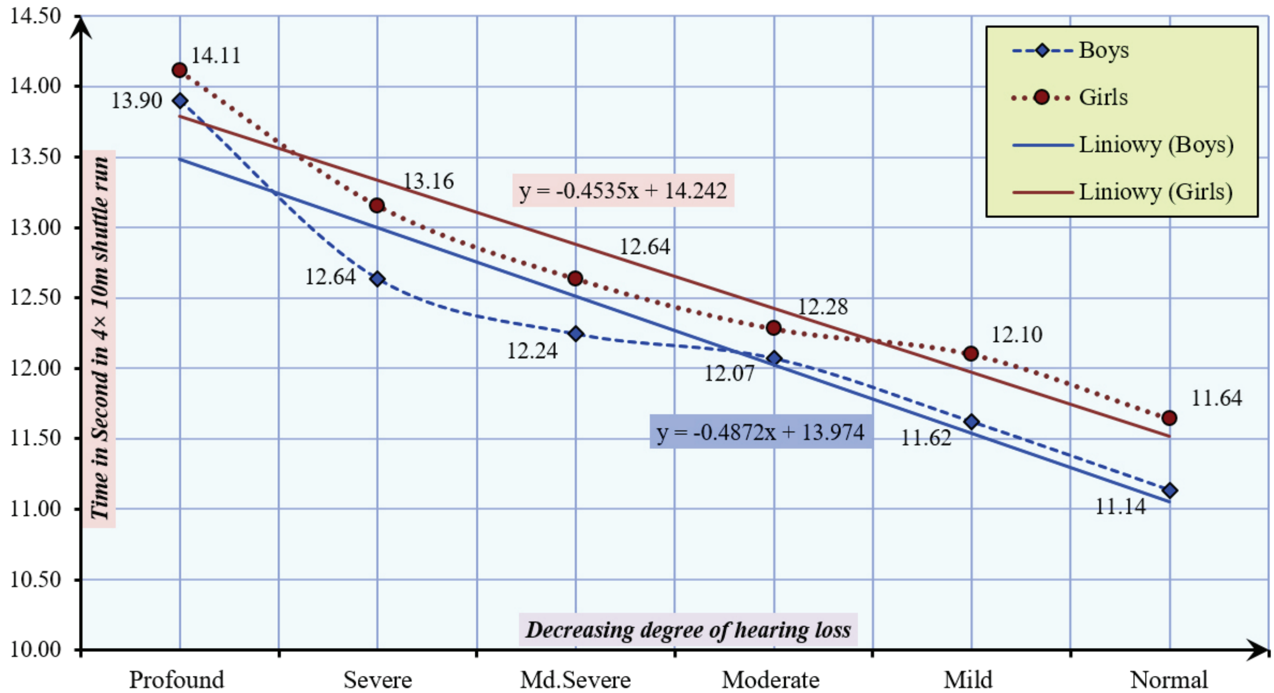

Fig. 5. Agility (S) Vs. Degree of hearing loss Graph

DISCUSSION

The findings of the present study showed that there was a significant difference in agility between both sexes when different degrees of hearing-impaired (dB HL) groups were combined. The present study also showed that the agility of the boys was found higher than the girls in all respect. Like other motor ability components and psychomotor tasks, the sex difference in hearing loss groups is supported by few literatures (Ghosh, 2014; Ghosh & Banerjee, 2015; Gromeier et al., 2017). Again, in a previous study, it was seen that there was a significant difference between visual reaction time values of students in terms of gender and hearing impairment situation, and male and hearing-impaired students had faster visual reaction time values compared to female and normal hearing students (Sözen & Arı, 2020). Further, it is already accepted that the strength and power generation ability of different muscles groups for the male shows greater value in comparison with the female. This result indicates that there is a significant difference in strength and power relative to body mass, and muscle thickness exists between males and females in strength and power (Bartolomei et al., 2021). The results of a few studies suggested that besides strength and power, agility depends on several factors like reaction, speed, acceleration, deceleration accompanied by the change of direction of movement (Veiskarami & Roozbahani, 2020); it comprises also perceptual components determined by the complex reaction to unexpected, changeable stimuli occurring during a sports game. It also demands a high degree of neuromuscular specificity. Perceptual components that underpin speed and agility must also be accounted for, which include also anticipation and decision-making (Bloomfield et al., 2007; Horička et al., 2014). In the present study, there may also be present some significant sex differences in the neuromuscular specificity and Perceptual components coupling and decision-making ability between the boys and girls that played a significant role behind the difference in agility.

The findings of the present study also showed that there was a significant difference in agility between most of the pair of groups among the different degrees of hearing-impaired (dB HL) boys & girls. It also showed that agility is lower for the groups with a higher degree of hearing loss. Thus agility increases with the decrease in the degree of hearing loss i.e. the groups having a lesser degree of hearing loss (dB HL) had better agility. It was also observed that the time taken to cross 4x10 m distance for the higher degree of hearing-impaired groups was higher than the lower degree of hearing impairments and it had decreased with decreasing degree of hearing loss. In this case, a linear nature was also observed in the trend lines (continuous lines) in fig. 5 with a negative gradient for both sexes. Therefore, agility increases linearly with decreasing degree of hearing loss (dB HL). Thus, there was a negative relationship between agility and degree of hearing loss (dB HL).

It is due to the fact that increasing degree of hearing loss reduces the balance and coordination more, as a result, the speed of movement and change of direction ability (agility) are considerably affected (Ibrahim et al., 2017; Metgud & Topkar, 2019). It is known that balance, which is defined as the ability to apply movements at a speed as high as possible, affects agility (Brown & Ferrigno, 2005; Ghosh, 2014; Young et al., 2001). In the course of performing dynamic coordination movements as 4×10m shuttle run, most of the subjects with auditory deprivation (deaf children) had uncoordinated movements of the hands and feet (Stepanchenko, et al., 2020). Maintaining balance and postural control requires sensory inputs from visual, somatosensory, and vestibular systems as well as the integration of sensory systems within the environment (Shumway-Cook & Woollacott, 2018). The responsible factors for initiation and conduction of any movements are – visual, vestibular, and somatosensory systems to send sensory inputs through the CNS to generate motor outputs seen as static and/or dynamic movements (Jernice et al., 2011). Among these three sensory systems, the proper functioning of the vestibular system is highly responsible for maintaining the balance ability whether in a static position or in dynamic movements (Dunn, 1983). Previous research suggested that hearing and vestibular dysfunctions lead towards lowering the level of spatial awareness that manifests in different movements like walking, running, orientation ability (Engel-Yeger & Weissman, 2009). Balance is maintained by three biomechanical signal systems, namely, visual, proprioceptive, and vestibular (Jernice et al., 2011). Damage to any of these systems or an abnormality in the central nervous system (CNS) can cause balance problems (Casselbrant & Mandel, 2005; Dunn, 1983). A most recent systematic review confirms that balance and motor impairments were associated with hearing impairment (Rajendran et al., 2012). Again, the progressive motor deficit was observed in children with sensorineural hearing loss (Rine et al., 2000). Previous study showed that deaf children were inferior both in general dynamic coordination and visual-motor coordination (Said, 2014). Thus, it can also be explained by the fact that the vestibular mechanism of the hearing impaired students may affect the static and dynamic balance (Banerjee & Ghosh, 2021; Ghosh, 2014; Ghosh & Banerjee, 2015) which may also be a cause of reduced agility for the increased degree of hearing impairment. This finding was inconsonance with few previous studies (Hartman et al., 2011; Martin et al., 2012; Rajendran et al., 2012; Rajendran, V. & Roy, F. G., 2011).

CONCLUSION

On the basis of the findings it can be concluded that the agility of the boys is significantly superior to their girl's counterpart when all degree of hearing loss groups is combined. The mean values of agility also showed that the boys are better than the girls belong to respective hearing impaired groups. There are significant differences in agility for most of the pair of hearing impaired groups when both sexes are combined except in few cases. It is also seen that the agility increases with decreasing degree of hearing loss for different hearing impaired groups when both sexes are combined. From the findings of the study it was also observed that the mean value of time (s) to cover 4×10 m shuttle run increases with increasing degree of hearing loss (dB HL). Thus in agility there is a linear increasing trend with negative gradient from profound towards the normal group. It indicated that there may be a linear relationship between hearing ability and agility that need further investigation and analysis. It can also be concluded that the agility increases linearly with decreasing degree of hearing loss (dB HL). Thus, there is a negative relationship between agility and degree of hearing loss (dB HL).

ACKNOWLEDGEMENT

The researchers greatly acknowledge all the subjects of the present study along with their guardians and head of the institutions for their support and cooperation throughout the course of the study without which the study could not be successfully completed. The researchers also extend their gratitude to the Departmental Research Committee (DRC) of the Department of Physical Education, University of Kalyani, Nadia, West Bengal. India for issuance of the approval and all possible support needed for the present research work.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

FUNDING

None.

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