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Original Article

Physical Medicine and Rehabilitation Section

Comparison of Minimum Muscular Fitness of Congenital Hearing Loss and Normal Children using Kraus-Weber Test: A Cross-sectional Study

JOHN BRITTO[1], SENTHIL KUMAR[2], RAJESH K SASIDHARAN[3]

ABSTRACT

Introduction: Muscular Fitness (MF) is a potent indicator and reliable marker of children's and adolescents' general health and well-being. Further, MF is a significant predictor of bio-psychosocial well-being among children.

Aim: To compare Hearing Impaired (HI) and normal hearing childrens' minimum MF utilising the Kraus-Weber (K-W) test.

Materials and Methods: This was a cross-sectional study conducted at Holy Cross School for the Hearing Impaired and Sacred Heart High School at Vellore, Tamil Nadu, India. The duration of the study was from 10th July 2018 to 20th December 2018. A total of 167 children of both genders aged 12 to 16 years, from a boarding school in Southern India with congenital hearing loss (n=82) and normal hearing (n=85) children were included in this study. The demographic information of the participants, anthropometric measures, and six subtests of the K-W tests for minimum MF were evaluated. Jeffreys's Amazing Statistics Program (JASP) version 0.16.1 was used for all statistical analyses. Descriptive statistics and Chi-square test compared K-W test item success and failure rates. Mann-Whitney test evaluated physical differences. The level of significance was fixed at 0.05.

Results: The current research found that children with HI had a significantly lower minimum level of MF than children with normal hearing on K-W Test-3 (Abdominal minus psoas), K-W Test-5 (Lower back muscles), and K-W Test-6 (Back and Hamstrings) (p-value <0.001).

Conclusion: The outcomes of this study revealed that HI children had lower minimal MF as measured by the K-W test than normal-hearing children. It highlighted the need for enhanced physical activity as well as education about the importance of maintaining minimum physical fitness.

Keywords: Education, Health, Physical activity, Well-being

INTRODUCTION

Physical fitness is a potent indicator and a good marker of health status and well-being among children and adolescents [1]. The main component of physical fitness is MF. MF includes muscle strength (the ability of the muscle to generate force), muscular endurance (the ability to contract for a long-time) and flexibility (the ability of the muscle to move freely through a full range of motion) [1]. Recently, it has been found that the MF levels of school-aged children are deteriorating [2,3]. Low muscle fitness is regarded as a powerful indication of a poor metabolic profile during childhood and adolescence, and it is associated with numerous non communicable illnesses [4,5].

Hearing-impaired children fitness levels in terms of strength, grip strength, and balance were reported to be lower than those of their hearing peers [6]. Further, HI children had a higher body fat percentage than their hearing counterparts [7]. HI children were found to be less physically active than their hearing peers [8]. A lack of physical activity was connected with poor physical fitness in HI children [9]. In addition, a lack of motivation may have an impact on physical activity and fitness among HI children [10].

Kraus H and Hirschland RP, developed the K-W test on the basis of substantial clinical experience, which had a significant impact on the notion and requirement of minimal MF in children in the United States and Europe [11,12]. This is a straightforward test that requires little effort, time, or expense to assess children's muscle strength at the most fundamental level [13,14]. The K-W test consists of six items: five muscular strength items that examine the back, waist, abdominal, and psoas strength, and one flexibility item that assesses spinal joints and hamstring muscles. The subjects perform one trial on each item, and their ability to pass or fail was considered in the evaluation.

Initial research on the minimal MF level of Indian school children revealed an inadequate minimal MF level [14]. MF may improve cognitive functioning and math performance in children [15,16]. Further, early life MF is associated with great cardiovascular health [17] and is a signal of a healthy metabolic profile in the future [4,5].

To the best of authors knowledge, there has been no prior research exploring minimum MF of HI children. Thus, current research examined minimum MF between HI and normal hearing children using the K-W test.

MATERIALS AND METHODS

The present study was a cross-sectional study conducted at Holy Cross School for the Hearing Impaired and Sacred Heart High School at Vellore, Tamil Nadu, India. The duration of the study was from 10th July 2018 to 20th December 2018. The Institutional Ethical Committee of Swami Vivekananda Yoga Anusandhana Samsthana (SVYASA) Yoga University approved all enrollment and research protocols (RES/IEC-SVYASA/82/2015).

Inclusion criteria: Only the participants who could communicate thorough sign language with or without oral speech were included in the study.

Exclusion criteria: The participants with disability other than HI, history of neural, visual disorders and mental illness (notably intellectual disability or autism spectrum disorder, as well as the use of psychopharmacologic medications) were excluded from the study.

Sample size: A convenience sample comprising of 167 children of either gender was recruited for this study.

The study enrolled 82 HI children with moderate to profound congenital hearing loss from a residential school (Holy Cross School) in Tamil Nadu, India. The degree of hearing loss classified as moderate (41-55 dB HL), and profound (91 and above dB HL) [18]. Personal files of participants were used to determine the condition. The normal hearing (n=85) children, were participated from school (Sacred Heart High School) located within the three kilometers from the recruitment site for deaf children. A prior informed consent was obtained from the parents as well as the head of the institution, and assent was obtained from the children after providing a comprehensive explanation regarding the purpose of the research.

Procedure

The study was conducted in a spacious room between the hours of 9 and 11 am and 4 and 5 pm. Groups of five or six children were asked to participate in the assessments. Each participant's height, weight, demographic information (age and gender) as well as the results of the K-W test, were recorded independently after a demonstration of the six subtests.

Assessments: A standard weighing machine (GVC Large Surface Iron Analogue Weighing Scale) was used to measure body weight and a stadiometer (LABART Wall Mounted) was used to measure height. To calculate Body Mass Index (BMI) using the weight in kg and height in cm, the formula is: BMI=weight (Kg)/height (cm)^2 [19].

Kraus-Weber (K-W) Test [11]: The MF of the participants were assessed using the K-W test. Six tests evaluated six distinct muscle groups in the human body. The first test, conducted in a supine posture with the hands behind the neck and the feet held by the examiner, measured the strength of the abdominal and hip muscles of the individual. In test two, individuals had to remain in the same position as in test one, except that their knees had to be bent. On command, the subjects had to roll up into a sitting position, excluding the psoas muscle. The third test evaluated the lower abdominal muscular strength by having individuals lie flat on their backs with their hands behind their necks as they lifted their legs straight 10 inches off the floor and stayed in that position for 10 seconds. In test four, subjects had to lie prone with a cushion under their belly and be asked to lift their heads, shoulders, and chest off the floor and hold them for 10 seconds while the strength of their upper back muscles were tested. In test five, participants were placed in the same position as in test-4, and the subject was directed to lie on his back over the pillow with their hands in front of him and head resting on them, as in Test-4. It was time for the subject to lift their legs up without bending the knees for 10 seconds. The examiner held the chest down. This put the lower back muscles to the test. After that, they were tested for their ability to extend their hamstring muscles and their back flexibility. Subjects were instructed to stand upright with their hands at their sides and their feet together. On instruction, individuals progressively bent down to touch the floor. The knees had to remain straight, and the leaning down position had to be held for 10 seconds. When attempting to touch the ground, there was no bouncing permitted.

The K-W test was scored based on a pass or fail system for each of the six tests. Children were considered to have passed the test if they passed all six tests. If a child failed one or more tests, they were considered to have failed the overall test. A child who passed all six exercises was considered to have achieved a minimum level of physical fitness.

STATISTICAL ANALYSIS

Statistical software Jeffreys's Amazing Statistics Program (JASP) (https://jasp-stats.org/) was used for all statistical analyses. Descriptive statistics were employed to compare the frequency and percentage of HI and normal children. Since, the anthropometric parameters were not normally distributed, Mann-Whitney U test was conducted to determine the significance between the two groups. Additionally, the results of the K-W test were analysed using a Chi-square test. Level of significance was set at p-value <0.05.

RESULTS

Participants' age ranged from 12 to 16 years, with HI group having a mean age of 14.54±1.09 years and normal group having a mean age of 14.48±0.89 years.

[Table/Fig-1] shows that the demographic (gender) and anthropometric variables (age, weight, and BMI) did not have significant differences between the two groups. The groups were only different in terms of height (p-value <0.001).

Demographics	Variables	Hearing impaired (n=82)	Normal hearing (n=85)	p-value
Gender* n (%)	Boys	43 (52.44%)	36 (42.35%)	0.191
	Girls	39 (47.56%)	49 (57.65%)	
Anthropometric parameters	Age (years)†	14.54±1.09	14.48±0.89	0.714
	Weight (kg)†	45.84±11.80	42.80±10.58	0.101
	Height (cms)†	155.14±10.49	149.75±9.88	<0.001
	BMI (kg/m^2)†	18.83±3.38	18.90±3.43	0.950

[Table/Fig-1]: Demographic data of study population.
*Chi-square test, †Mann-Whitney test, p-value <0.05 considered significant

The main findings from the K-W test showed that the HI group had the highest failure percentage in Test-5 measuring lower back muscles at 98.78% and the lowest failure percentage in Test-6 measuring flexibility in abdominal, back, and hamstring muscles at 45.12%. The normal hearing group had the highest failure percentage in Test-4 measuring upper back muscles at 77.65% and the lowest failure percentage in Test-6 at 21.18% [Table/Fig-2]. There was a statistically significant association between groups on K-W Test-3 (Abdominal Minus Psoas), K-W Test-5 (Lower back muscles), and K-W Test-6 (Back and Hamstrings) (p-value <0.001). The results of the K-W test for HI boys group showed that the highest failure percentage was found in Test-5 at 97.67% and the lowest failure percentage was found in Test-6 at 41.86% [Table/Fig-3].

Items	Group	K-W Test		χ^2 value (p-value)
		Success n (%)	Failure n (%)	
K-W Test-1 (Abdominals Plus Psoas)	Normal	40 (47.06)	45 (52.94)	0.0496 (0.823)
	Hearing impaired	40 (48.78)	42 (51.22)	
K-W Test-2 (Abdominal Minus Psoas)	Normal	20 (23.53)	65 (76.47)	0.0170 (0.896)
	Hearing impaired	20 (24.39)	62 (75.61)	
K-W Test-3 (Psoas and Lower Abdominals)	Normal	59 (69.41)	26 (30.59)	39.8838 (<0.001)
	Hearing impaired	17 (20.73)	65 (79.27)	
K-W Test-4 (Upper Back muscles)	Normal	19 (22.35)	66 (77.65)	1.6449 (0.199)
	Hearing impaired	12 (14.63)	70 (85.37)	
K-W Test-5 (Lower back muscles)	Normal	36 (42.35)	49 (57.65)	40.9444 (<0.001)
	Hearing impaired	1 (1.22)	81 (98.78)	
K-W Test-6 (Back and Hamstrings)	Normal	67 (78.82)	18 (21.18)	10.8347 (<0.001)
	Hearing impaired	45 (54.88)	37 (45.12)	

[Table/Fig-2]: Performance on individual items of Kraus-Weber (K-W) test for both groups.
Normal (n=85); Hearing Impaired (HI) (n=82); p-value <0.05 considered significant

Comparison	Group		K-W test		p-value
			Success n (%)	Failure n (%)	
K-W Test-1 (Abdominals Plus Psoas)	Boys	HI	24 (55.81)	19 (44.19)	0.787
		Normal	19 (52.78)	17 (47.22)	
	Girls	HI	16 (41.03)	23 (58.97)	0.862
		Normal	21 (42.86)	28 (57.14)	

K-W Test-2 (Abdominal Minus Psoas)	Boys	HI	11 (25.58)	32 (74.42)	0.623
		Normal	11 (30.56)	25 (69.44)	
	Girls	HI	9 (23.08)	30 (76.92)	0.586
		Normal	9 (18.37)	40 (81.63)	
K-W Test-3 (Psoas and lower abdominals)	Boys	HI	6 (13.95)	37 (86.05)	<0.001
		Normal	22 (61.11)	14 (38.89)	
	Girls	HI	11 (28.21)	28 (71.79)	<0.001
		Normal	37 (75.51)	12 (24.49)	
K-W Test-4 (Upper Back muscles)	Boys	HI	5 (11.63)	38 (88.37)	0.205
		Normal	8 (22.22)	28 (77.78)	
	Girls	HI	7 (17.95)	32 (82.05)	0.603
		Normal	11 (22.45)	38 (77.55)	
K-W Test-5 (Lower back muscles)	Boys	HI	1 (2.33)	42 (97.67)	<0.001
		Normal	14 (38.89)	22 (61.11)	
	Girls	HI	0	39 (100)	<0.001
		Normal	22 (44.90)	27 (55.10)	
K-W Test-6 (Back and Hamstrings)	Boys	HI	25 (58.14)	18 (41.86)	0.064
		Normal	28 (77.78)	8 (22.22)	
	Girls	HI	20 (51.28)	19 (48.72)	0.005
		Normal	39 (79.59)	10 (20.41)	

[Table/Fig-3]: Analysis of success and failure rates with respect to gender.
p-value <0.05 considered significant

For HI girls' group, the highest failure percentage was found in Test-5 at 100% and the lowest failure percentage was found in Test-6 at 48.72%. The K-W test for normal boys group showed that the highest failure percentage was found in Test-4 measuring upper back muscles at 77.78% and the lowest failure percentage was found in Test-6 at 22.22%. For normal girls' group, the highest failure percentage was found in Test-2 measuring abdominal muscle without psoas at 81.63% (40 of 49) and the lowest failure percentage was found in Test-6 at 20.41% [Table/Fig-3]. There was a statistically significant association between groups (HI vs Normal) on K-W Test-3 (Psoas and Lower Abdominals), p-value <0.001 and K-W Test-5 (Lower Back Muscles), p-value <0.001, among boys and girls. Further, the K-W Test-6 (Back and Hamstrings) in girls revealed a statistically significant association between groups, p-value=0.005, whereas there was no statistically significant association in boys.

DISCUSSION

The study found that children with HI had lower MF levels in the K-W Test-3 (lower back muscles), K-W Test-5 (lower abdominal muscles), and K-W Test-6 (back and hamstring flexibility) when compared to children with normal hearing. The highest failure percentage was found in the lower back muscles test (K-W Test-5) for HI children, while the highest failure percentage for normal hearing children was found in the upper back muscles test (K-W Test-3). MF is a crucial aspect of overall physical fitness and a strong indicator of current and future physical [20] and mental health [21] in children and young adults. Hence, the study findings suggest that interventions to improve the MF of HI children are necessary to reduce the gap between the two groups.

Initial findings from K-W tests reported that 56.6% of American children and 8% of European children failed one or more of the tests [22]. A minimum level of physical fitness was considered to have been attained by a child who successfully completed all six exercises. The cumulative results of previous studies conducted among normal children in India had recorded failure rates of 20.8%, 48%, 28.75%, and 35.8% in the K-W test [14,23-25]. According to the current results, no HI children have passed all of the tests, whereas 2.35% of normal children have passed all of the tests.

In line with prior findings, the current investigation indicated a maximum failure rate in the upper back muscles [12,26]. This, however, contradicts prior findings that revealed a maximum failure rate on the flexibility test (15.31%) [24] as well as the abdomen, back, and hamstrings tests [14].

The drop-in minimum physical fitness may be attributed to the children's emotional stress [24]. Satapathy DU, findings compared to the urban group, the rural group had greater minimum muscle strength (96% vs. 88%), indicating a reduction in minimal physical fitness due to a lack of physical activity and sedentary behaviour, which is associated with increased mental activity [27]. The increasing use of the internet and smartphones due to developments in information technology is one reason for this behaviour [28,29]. According to Stewart DA and Kathleen Ellis M, HI children are not immune to the increased trend toward sedentary lifestyles, which has resulted in an increase in the number of overweight and obese school-aged children among HI children [30]. Further, children and children with HI reported lower levels of physical activity [31] and physical fitness [32] than their counterparts without impairments.

Children with special needs appear to benefit from having a basic level of physical fitness. HI children who participate in exercise and sports program have improved their physical fitness as well as their psychological well-being [33,34]. Further, HI children benefited from regular aerobic, ice skating, tai chi, gymnastics, and karate training [35-38]. Numerous studies have found that yoga improves psychological well-being and physical fitness in children with special needs [39-46]. Therefore, it is important to focus on MF development in children with HI to promote overall health and well-being. Additional physical activity programs such as aerobics, karate, judo, gymnastics, yoga, and others should be included, as well as education about the importance of maintaining a basic level of physical fitness is needed.

Limitation(s)

There were certain limitations to the findings. Firstly the number of subjects were limited. The inclusion of solely boarding students within the same locale in order to eliminate cultural bias was the primary reason for the small sample size. Further, the study drawback is that it was not explicitly designed to measure children's levels of physical activity, participation in sports activities, or other forms of physical exercise. Future research may focus on various aspects of physical fitness and psychomotor performance in children with HI who come from diverse cultural and psychosocial backgrounds. Further, intervention studies to improve physical fitness in children with HI could be investigated in more detail.

CONCLUSION(S)

The current study aimed to examine the minimum MF levels between HI and normal hearing children using the K-W test. The results showed that children with HI had lower levels of MF in the lower back muscles, lower abdominal muscles, and back and hamstring flexibility compared to children with normal hearing.

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PARTICULARS OF CONTRIBUTORS:
1. PhD Scholar, Division of Yoga and Physical Science, Swami Vivekananda Yoga Anusandhana Samsthana, Bengaluru, Karnataka, India.
2. PhD Scholar, Department of Psychology, Anugraha Institute of Social Sciences, Dindigul, Tamil Nadu, India.
3. Associate Professor, Division of Yoga and Physical Science, Swami Vivekananda Yoga Anusandhana Samsthana, Bengaluru, Karnataka, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Mr. John Britto,
Kallubballu Post, Anekal, Swami Vivekananda Road, Jigani,
Bengaluru-560105, Karnataka, India.
E-mail: brittocap@gmail.com

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