STUDIES IN PHYSICAL CULTURE AND TOURISM
Vol. 17, No. 2, 2010

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THE IMPACT OF HEARING LOSS DEGREE AND AGE ON UPPER LIMB COORDINATION ABILITY IN HEARING, DEAF AND HARD OF HEARING PUPILS

Key words: motor evaluation, upper limb coordination, hearing, deaf, hard of hearing, motor experience.

ABSTRACT

The study discusses the assessment of the impact of hearing loss degree and age in: i) 79 deaf, hard of hearing (HoH) and hearing; and ii) 34 deaf and HoH pupils aged 6-14 on their upper-limb coordination ability with the use of the Bruininks-Oseretsky Test. In statistical analysis the following tests were applied: three-way ANOVA with three independent variables (group, sex, age) for the deaf, HoH and hearing subjects; two-way ANOVA with two independent variables (group, age) for the deaf and HoH subjects; and the Post Hoc (Scheffe's method) for multiple comparisons between age categories. The analysis revealed statistically significant differences between deaf/HoH and hearing subjects ($F_{1,67} = 4.43$, $p = 0.039 < 0.05$) between deaf and HoH ($F_{1,67} = 5.33$, $p = 0.035 < 0.05$) and the age factor ($F_{2,67} = 12.84$, $p = 0.000 < 0.05$, and $F_{3,16} = 6.21$, $p = 0.005 < 0.05$, respectively). The obtained results can be used for adaptation of physical education programs to meet the needs of deaf and hard of hearing pupils.

INTRODUCTION

Hearing represents the most powerful line of communication among people [26]. Access to speech and linguistic abilities is the fundamental precondition for personality development, and for this reason, the fact that deaf children lack – due to hearing shortage – their speech ability from a very young age plays a determinative role in their school, social and psychological growth [27]. The result is that the personality and social characteristics of deaf persons differs from those of hearing persons.

The improvement of key motor abilities is not only training-related but it also depends on the increase of corporal mass, ability to generate strength and changes that take place with age in sensory and perceptual mechanisms [25].

Physical education and sport activities play an important role in acquiring and maintaining pupils' physical and mental health and also in adopting positive attitudes in nutritional and health matters [24, 30]. The importance of deaf and hard of hearing children's participation in sports and recreation activities for their psychophysical development has been underlined by many researchers who proposed physical education programs for the deaf and hard of hearing children similar to those for their hearing counterparts.

Zaccagnini [34] studied the characteristics of physical education classes for deaf, hard of hearing and deaf students with multiple disorders in grades K-12, in center-based schools and mainstream programs. She took into consideration the number of classes per week, length of classes, lesson duration and teachers' qualifications. Seven

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categories of course activities were studied: basic motor skills, individual and dual sports, team sports, physical fitness, gymnastic, aquatics, and dance and recreation activities. The study identified the need to develop curricula and appropriate teaching methods for teacher candidates in order to improve the deaf students' quality of school physical education. Zaccagnini believes that it is essential to create suitable structures for education and training of physical education staff to enable them to teach deaf and hard of hearing pupils.

A large number of tools have been created for the measurement of motor performance and levels of different motor abilities, which can be used in diagnosing and defining the deficiency degree in the disabled.

Comparative studies of motor performance of deaf/hard of hearing and hearing pupils

Brunt and Dearmond [5] from the Louisiana University used the Bruininiks-Oseretsky Test of Motor Proficiency in order to study and describe the motor profile of deaf and hard of hearing children. They evaluated 150 pupils attending a primary school for hearing children and a state primary school for children suffering from moderate or heavy deafness. The study involved subjects' motor evaluation and communication strategies. The authors found differences between the deaf and hearing children, but not between deaf and HoH children.

A study of 94 pupils (47 hearing and 47 deaf and hard of hearing pupils) was performed by Campell [10] using the Youth Fitness Test (American Alliance for Health, Physical Education and Reaction [AAHPER], 1976). The results of this study showed that the hearing subjects' performance was notably better than deaf and hard-of-hearing subjects', while the performance level between deaf and hard-of-hearing pupils was similar. At the same time, Winnick and Short [33] using another assessment instrument – the Project Unique Physical Fitness Test [33] evaluated 1,730 pupils (686 hearing, 152 hard-of-hearing, 892 deaf). They did not notice any differences between the deaf and hard-of-hearing children, however the hearing children scored higher in strength and stamina of the abdominal muscles. Many researchers attributed this difference to the delay in stimulus reception [19] as well as to communication problems during the tests [15].

Gheysen, Loots and Van Waelvelde [20] studied the motor development of 36 mainstreamed deaf children (20 with cochlear implants) at the age of 4-12 years without developmental problems and compared it with the motor development of 43 hearing children. The results confirmed that deaf children displayed motor delays as compared with their hearing peers.

Studies have indicated that in most cases deaf people fall short in physical fitness as compared to hearing people. Researchers analyzing the results of ten studies [21] found out that the fitness levels of deaf and hard-of-hearing were comparable. Specifically, in six out of ten studies, statistically significant differences were found between deaf and hearing persons; in three out of ten no significant differences were found, while in one study differences were noted between deaf and hard-of-hearing subjects.

Literature on motor performance in upper-limb coordination ability

Manipulative movements, e.g., throwing, catching, striking, bouncing and kicking, used in a variety of sports such as volleyball, basketball, baseball necessitate a high level of development of upper limbs coordination. In their research Butterfield and Ersing [7] studied the impact of age, sex, hearing loss degree and static and dynamic balance on the ball reception ability in deaf pupils. Butterfield [6] also evaluated their ability to throw tennis balls. The sample consisted of 131 pupils (75 boys and 56 girls, aged from 5 to 9.5 years). The subjects were divided into two groups: 124 subjects with the hearing loss degree > 60 dB in the better ear; and the remaining ones with the hearing loss degree between 30 and 55 dB. The study employed two tests: the Short Form (BOT) Test and OSU-SIGMA Scale (Ohio State University Scale of Intra Gross Motor Assessment). The results showed a statistically significant impact of age and static and dynamic balance on reception ability results, while the subjects' sex and hearing loss degree revealed no relationship with the development of upper limb coordination ability. The improvement was attributed to age and better balance ability. The same study made an assessment of tennis ball throwing ability. The results showed that most children performed as expected for their age and no retardation was reported in this capacity, as compared with internationally weighed results concerning hearing people's performance. A significant improvement was revealed with age in a comparison of the motor performance of 6-7 year-olds with 9-10 year-olds, while no statistically significant differences in performance between boys and girls was noted – a fact otherwise confirmed by other studies.

Butterfield and Loovis [8] carried out a modified study of throwing ability development among hearing pupils in an average size school in south-eastern Maine, USA. They examined the impact of age, sex, balance (static and dynamic) and participation in sport on development of ball throwing ability. The sample consisting of 719 pupils (381 boys, 338 girls) aged 4 to 14 years was divided into nine age groups. The researchers also asked children about their participation in various school activities. The subjects' throwing ability was assessed with the OSU-SIGMA test by two researchers who previously conducted a pilot study designed to predict the research results. The static and dynamic balance ability was evaluated with the Short Form BOT Test [4]. The results showed that the throwing ability improved with age. Statistically significant differences were found between boys and girls in all age categories, in particular, between the 3rd and the 8th age groups. This is different from with the results of previous investigations related to specific populations (deaf pupils and pupils with learning disabilities), which did not reveal statistically significant differences between boys and girls. Butterfield and Loovis referred to East and Hensley [18] who attributed these differences to the socio-economic level and family and school culture. Greendorfer and Lewko [22] pointed to the influence exerted by parents on their children, and especially fathers who urged boys, more than girls, to take part in sports. Anthrop and Allison [1] calls this phenomenon "Victorian influence", according to which, girls are urged not to participate in sports, based on the rationale that they are dangerous activities. Butterfield and Loovis [8] showed that the ball throwing performance was significantly in boys than in girls in all age categories. These differences were even greater between the two sexes when the boys had participated in different T-ball, baseball and softball school teams.

Ellis, Lieberman, Fittipauldi-Wert and Dummer [16] in their study of physical fitness scores of 151 deaf pupils (97 boys and 54 girls) with the weighed results of the Health Fitness Zone (HFZ) found that the physical fitness of deaf pupils was above the minimum acceptable limits with an average performance of 4.91 in 6 tests. They also identified that one of factors that reduced the performance of deaf as well as hearing subjects was the increased body weight.

Wiegersma and Vander Velde [32] showed that hearing children achieved significantly higher results in their coordination ability in general and in optic-kinetic control. They also confirmed that the performance speed of the deaf subjects' movements was sensibly lower than of the hearing ones and suggested further research.

Studies comparing motor performance levels in deaf and hard of hearing subjects

Winnick and Short [33] using the Project Unique Physical Fitness Test Winnick & Short Test (1985) evaluated and compared the motor performance of 152 hard-of-hearing children with 892 deaf children and found no differences between the two groups. Goodman and Hooper [21], who analysed the results of 10 studies, found out that in three of them the levels of deaf and hard-of-hearing physical fitness were comparable.

Zwierzchowska, Gawlik and Grabara [36] evaluated 190 deaf pupils (105 boys and 95 girls) aged 10-15 years to determine their physical fitness level and, more precisely, coordination ability. For performance assessment they applied the Eurofit (1989) Test battery, in which the first six tests were used for assessment of energetic activities and the other six for assessment of coordination ability. The results showed no differences between boys and girls, but a significant impact of deafness on the coordination test scores in all age categories.

The same researchers four years later [37] examined the following correlations: the degree of hearing damage, the cause that provoked it and the degree of hearing loss v. the degree kinetic abilities using the Eurofit test battery. The sample included deaf children aged 6-18 years, 6.8% of whom had a hearing loss (hl) of 40-60 dB, 37.4% of 60-80 dB, and 65.8% of less than 90 dB. The correlation analysis confirmed the impact of the hearing loss degree and the cause of hearing loss on coordination ability, and of the type of hearing damage on coordination ability.

The aim of the present study was to examine the impact of the hearing loss degree on the coordination ability of upper limbs in deaf and hard-of-hearing pupils, and to compare it with the performance level of hearing pupils of the same age. The results will allow us to formulate proposals for enhancement of school physical education programs aimed at the improvement of upper limbs coordination ability and integration of deaf children in sport.

METHODS

Sample

Two comparative studies of motor performance assessment were carried out with deaf, hard-of-hearing and hearing children. Firstly, the motor performance level was assessed between deaf/HoH and hearing pupils with the sample of 40 deaf and HoH subjects (23 boys, 17 girls) aged 6-12 years (mean = 114.1 months, SD = 22), 39 hearing subjects (22 boys and 17 girls) aged 6-12 (mean = 114.4 months, SD = 19.68) attending the National Deaf Institute, Special Primary School of Panorama and 10th Hard-of-Hearing Primary School of Thessaloniki (Tab. 1). The sample of hearing subjects was created with layered sampling, equivalently distributed for age, sex and hearing loss degree. The factorial experimental design was represented as 2X3X3 with three independent variables, group with two levels: deaf and HoH; sex with two levels: boys and girls; and age with three age categories: 7-8, 9-10 and 11-12 years.

Table 1. Mean performance values and sample populations: comparison of deaf/hard of hearing and hearing subjects

		Hearing		Deaf/HOH	
sex	Age yr	MVmo.	N	MVmo.	N
Boys	7-8	84.6	5	97.7	6
	9-10	106.8	6	103.4	6
	11-12	133.1	11	134.3	11
	total	114.9	22	116.1	23
Girls	7-8	93.8	6	99.2	6
	9-10	113.7	6	111.2	6
	11-12	133.2	5	130	5
	total	113.8	17	112.3	17
Total		114.4	39	114.1	40

The second part of the study examined the motor performance of deaf and HoH pupils aged 6-14 years. The sample consisted of 17 deaf pupils with the hearing loss (HL) of > 70 dB (mean = 126.3, SD = 25.64) and 17 hard of hearing pupils with HL < 70 dB (mean = 127.7, SD = 23.69). The groups were created taking into consideration subjects' age and hearing loss degree (Tab. 2). The factorial experimental design was represented as 2X4 with two independent variables: group with two levels: deaf and HoH; and age with four age categories: 7-8, 9-10, 11-12 and 13-14 years.

Table 2. Mean performance values and sample populations: comparison of deaf and hard of hearing subjects

	Deaf		Hard-of-Hearing	
Age	MV mo.	N	MV mo.	N
7-8 yr	84	4	87	4
9-10 yr	105	4	112	4
11-12 yr	137	5	136	5
13-14 yr	151	4	151	4
Total	126.3	17	127.7	17

Tools

For determination of motor development levels the Long Form of BOT (Bruininks-Oseretsky Test of Motor Proficiency) [4] was used, which is considered to be a highly reliable and most technically valid instrument. It is used for assessment of individuals with developmental disorders and different physical characteristics in a wide age range (4.5 – 14.5 years) [13]. It is a fairly common tool and it differs allowing us not only to discern the differences between individuals with mild, moderate and severe delays, but also to provide different norms for comparison of different populations [2].

The Long-Form test evaluates the gross and fine motor abilities in eight areas: running and speed agility, balance, bilateral coordination, strength, upper limbs coordination, response speed, visual motor control, upper limb speed and dexterity. For determination of upper limb coordination the following tests were used: bouncing a ball and catching it with two hands (5 trials), bouncing a ball and catching it with the preferred hand (5 trials), catching a tossed ball with both hands (5 trials), catching a tossed ball with the preferred hand (5 trials), throwing a ball at a target with the preferred hand (5 trials), touching a swinging ball with the preferred hand (5 trials), touching the nose with the index finger with the eyes closed (90 seconds), touching the fingertips with the thumb with the eyes closed, pivoting the thumb and the index finger (90 seconds).

In order to ensure the reliability and validity of results the following the study was conducted according to the following guidelines:

– recording of scores strictly followed the manual instructions [4];
– all students' assessments were carried out by the same person with a ten-year PE experience in a school for deaf children;
– the assessor had been previously trained in the use of the BOT test;
– during assessment, the philosophy of each school was respected, using appropriate communication forms for each population, i.e. total communication system (signs, lips reading, finger spelling) for the pupils from the school for deaf children, and oral speech and lips reading for the pupils from the school for hard-of-hearing children [28].

Statistical analysis

Mean values (MV) and standard deviations (SD) in upper-limb coordination for both comparisons were calculated. A three-way ANOVA was used in the comparison between deaf/HoH pupils and their hearing counterparts, with three independent groups of variables: deaf/HoH and hearing pupils, sex (boys and girls), and age (7-8, 9-10 and 11-12 years).

A two-way ANOVA was used for the comparison of performance between the deaf and HoH subjects with two independent variables: group (deaf and HoH) and age (7-8, 9-10, 11-12 and 13-14 years).

RESULTS

Results of comparison of deaf/HoH and hearing subjects' motor performance.

The results of upper limb coordination ability tests in both groups reveal an improvement of this capacity in the deaf and hearing subjects with age (Tab. 3).

The results of the variance analysis and the post hoc test for multiple comparisons (Tab. 4) revealed no statistically significant correlations between the group, gender and age factors in upper limbs coordination ($F_{2,67}$ = 1.12, p = 0.333). No statistically significant correlations were found between the factors of gender and age ($F_{2,67}$ = 0.21, p = 0.809), group and age ($F_{2,67}$ = 99, p = 0.377) and group and gender ($F_{1,67}$ = 0.06, p = 0.805). It was also found that the gender had no impact on upper limbs coordination ($F_{1,67}$ = 1.01, p = 0.319); however, such an impact was noted between the factors of group ($F_{1,67}$ = 4.43, p = 0.039 < 0.05) and age ($F_{2,67}$ = 12.84, p = 0.000 < 0.05).

Table 3. Mean values and standard deviations for upper-limp coordination ability test results

Group		Hearing		Deaf/HoH	
sex	Age	MV	SD	MV	SD
Boys	7-8	13.00	2.45	13.50	3.67
	9-10	15.00	2.28	13.57	3.15
	11-12	18.09	1.70	15.36	2.98
Girls	7-8	12.33	3.50	11.60	3.36
	9-10	15.67	0.82	12.20	4.21
	11-12	16.60	2.70	16.17	2.32
Total	7-8	12.64	2.94	12.64	3.50
	9-10	15.33	1.67	13.00	3.52
	11-12	17.63	2.09	15.65	2.71
	total	15.51	3.02	14.03	3.41

Table 4. Statistical analysis

	Freedom degrees	Average squares	F	P
Group	1	35.09	4.43	0.039*
Sex	1	8.01	1.01	0.319
Age	2	101.86	12.84	0.000*
Group*sex	1	0.49	0.06	0.805
Group*age	2	7.85	0.99	0.377
Age*sex	2	1.69	0.21	0.809
Group*age*sex	2	8.88	1.12	0.333

It was also established that 11-12 year-old pupils displayed better upper limbs coordination than pupils aged 7-8 and 9-10 years (DMV = 3.97, p < 0.05; DMV = 2.44, p < 0.05). Among the 7-8 and 8-9 year olds a statistically significant better performance was not observed (DMV = 1.53, p = 0.191).

Results comparison of deaf and hard of hearing subjects

The scores in the coordination ability of the upper limbs are shown in Table 5. It can be seen that the mean values and typical divergences improved with age in both groups.

There was no significant correlation between the group and age factors ($F_{3,16}$ = 2.03, p = 0.151 > 0.05). Group and age were found to have a main impact on the upper limbs coordination ($F_{1,67}$ = 5.33, p = 0.035 < 0.05; and $F_{3,16}$ = 6.21, p = 0.005 < 0.05, respectively).

Table 5. Mean values and standard deviations for upper-limp coordination ability test results

	Deaf		Hard-of-Hearing	
Age	MV	SD	MV	SD
7-8 yr	15.00	1.41	9.00	1.41
9-10 yr	15.00	0.00	11.50	6.36
11-12 yr	16.00	1.41	16.80	2.49
13-14 yr	18.67	1.53	17.33	2.89
Total	16.33	1.875	14.75	4.39

Table 6. Statistical analysis

	Freedom degrees	Average squares	F	P
Group	1	32.83	5.33	0.035*
Age	3	38.27	6.21	0.005*
Group *Age	3	12.49	2.03	0.151

The 4th age category (13-14 year-olds), performed statistically better than the group of 7-8 year-olds (DMV = 6, p < 0.05). No statistically significant differences in performance were noted between the age groups of 7-8 and 9-10, 7-8 and 11-12, 9-10 and 11-12, 9-10 and 13-14, 11-12 and 13-14 year-olds (DMV = 1.25, p = 0.916; DMV = 4.4, p = 0.062; DMV = 3.15, p = 0.244; DMV = 4.75, p = 0.066; DMV = 1.6, p = 0.675, respectively).

DISCUSSION

Comparison of deaf/HoH and hearing subjects' performance.

Numerous studies have shown that in most cases deaf people fall short in physical fitness as compared to hearing people. This was supported by Brunt and Dearmond [5], who used the same evaluation instrument (BOT), and other researchers [10, 33, 20].

Most study results as well as the findings of the present research correspond with those of Goodman and Hooper (1992), who in their review of ten research studies found out that the physical fitness level of the deaf, hard-of-hearing and hearing pupils is comparable: statistically significant differences were found between the deaf and the hearing in six out of ten studies; in three out of ten no significant differences were found, and in only one out of ten differences were noted between the deaf and hard-of-hearing pupils. Many researchers attributed this difference to the delay in stimulus reception due to hearing deficiency [19] as well as to communication problems between the assessor and the assessed during the test performance [15].

In the present study the initial assumption regarding the correlation between performance of the tests and coordination of the upper limbs has been confirmed: group and age were factors which had a significant impact on the test results; while the results for gender are contradictory. It appears that there is a high correlation between upper limbs coordination ability and the degree of hearing loss, since statistically significant differences in performance were noted between the deaf/hard-of-hearing and hearing subjects, and between the deaf and hard of hearing subjects. The same opinion is expressed by Wiegersma and Vander Velde, [32] who demonstrated that hearing subjects outclassed the deaf substantially in coordination ability and visual-motor control and suggested further research in the area. The present study results were found to correspond with the results of Dummer, Haubensticker and Stewart [14], who using the Ulrich Test (1985) assessed 211 deaf/hard of hearing pupils and compared their output against the output of a national hearing sample. They noted that the deaf/hard of hearing pupils displayed a significant delay as compared with the hearing subjects, amounting from 1 to 3 years from the average performance of each age category upper limbs coordination tests (handling a tennis ball). The results seem to agree with those of Butterfield and Ersing [7] and Butterfield [6], who found a significant impact of age, static and dynamic balance on motor performance (ball reception ability), but not of gender and hearing loss degree. After studying the impact of age, gender, static and dynamic balance and participation in sports on ball throwing ability, Butterfield and Loovis [8] found out statistically significant differences between the two sexes. In their effort to justify this difference, Butterfield and Loovis [8] accepted the theory of Greendorfer and Lewko [22] related to the acquisition of increased motion experience by boys as compared with girls, which stipulates that fathers motivate boys more to participate in sports. Anthrop and Allison [1] called this phenomenon "Victorian influence" and explained girls' lack of participation in sports as sports were considered dangerous activities. This opinion does not fall in line with the findings of the present research and, at the same time, it contradicts results of earlier studies of specific or non-specific populations (deaf, persons with learning difficulties, etc) which sustain that there are statistically significant differences in various abilities between boys and girls. Butterfield [6] formulates a different opinion regarding pitching test scores that deafness is not responsible for the retarded development of this dexterity. It is also later supported by Butterfield et al. [9] who found out that at the age of 5-7 years, the pitching ability was developed at a satisfactory level and that sometimes, deaf subjects performed better than hearing subjects, when the dexterity was assessed on the basis of number of successful hits rather than correct technique execution.

Savelsbergh, Netelendos and Whiting [29] found that the deaf also fell short in ball reception tests as compared with the hearing, and attributed this difference to the effect of the former's decreased ability in spatiotemporal orientation, which requires good limbs and body synchronization. These conclusions correspond with the results of the present study.

The significant influence of age appears not only in studies of motor performance of deaf pupils but also of all student populations. Many researchers attributed this improvement to the increasing maturity of the central nervous system and myoskeletal development with age [17, 35, 33, 3, 11].

The results of the present study do not agree with the results of Gruber et al. [23] who noted better performance results in six out of eight abilities: speed, bilateral coordination, strength, reaction time, visual-motor control, upper limbs speed and dexterity in 15-16-17-year-old students as compared with 14-year-old students. On the contrary, the coordination ability of the upper limbs and the equilibrium showed to stabilize at the age of 12, which they attributed to the myoskeletal development and maturation of the neural system [23].

Comparison of deaf and hard of hearing pupils' performance

Very few studies have noted differences in motor performance in deaf and hard of hearing subjects [21]. The results of present comparison of the ability of upper limbs coordination between the deaf and hard-of-hearing students correspond with the results of Zwierzchowska, Gawlik and Grabara [36] who did not find any significant differences between boys and girls, but a significant influence of hearing loss degree in all age categories. The same researchers reached the same conclusions as we did, when using the Eurofit Test battery and dividing their sample on the basis of hearing loss. They confirmed the effect of the hearing loss degree and cause of deafness (lesion) on subjects' coordination ability, while the type of hearing damage seemed to influence the equilibrium ability [37]. In our comparison of deaf and hard-of-hearing students, a significant impact of age was observed, which is concordant with the results of earlier studies. The performance level in the fourth age category (13-14 years), does not differ substantially from the performance level in the third age category (11-12), where our results agree with those of Gruber et al. [23] who demonstrated that the improvement of the specific ability is completed at the age of 12 with the maturing of the Central Neural System and myoskeletal development.

The analysis of the obtained results ascertained that hearing pupils performed generally better than their deaf/hard-of-hearing counterparts in upper limbs coordination ability tests. Statistically significant differences were noted in the performance in all three age categories.

In the last 15 years, the population of deaf students with cochlear implants has increased significantly. This resulted in a larger number of studies concerning motor performance of deaf students with cochlea implants. The sample in the present study did not include students with implants, and thus it is not possible to include these types of studies in our bibliographic review.

Specific studies point to the need to improve the deaf and hard of hearing pupils' upper limbs coordination ability. A modification of the Physical Education curriculum should be recommended to improve the mentioned ability. For this purpose it is necessary to take into consideration other factors influencing the performance such as the cause of deafness, type of hearing loss (sensori-neural), requirements for each test (simple or complex; technique execution or performance precision), previous motor experiences, opportunities for playing in their daily life, family, school, community as well as methods of communication.

Further research is required to create new services and improve the already existing ones aimed at hearing loss diagnosis, intervention and formulation and adaptation of suitable PE programs to meet deaf pupils' educational and social needs [12]. It is necessary to create suitable structures for training specialized physical education personnel able to teach deaf and hard of hearing students [34]. The educational staff should not ignore the positive contribution of quality physical education to the general physical and socio-sensitive development of hearing, deaf and hard-of-hearing students. Unfortunately many times students have to act following general school guidelines, and their needs are assessed on the basis of available resources, strict charts, and school-academic progress results [31].

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