

# *Postural Evaluation of Vertebral Column in Children and Teenagers with Hearing Loss*

## *Avaliação Postural da Coluna Vertebral em Crianças e Adolescentes com Deficiência Auditiva*

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### SUMMARY

- Introduction:** Posture is determined by the performance of the visual, somatosensory and vestibular systems. Children with hearing loss can present problems in their posture or postural control, enabling postural deviations and alterations to appear in their vertebral column, possibly provoked by a hypoactivity of the vestibular system as a result of deafness.
- Objective:** To evaluate the posture of the vertebral column in children and teenagers with hearing loss at school age, taking into consideration the sample gender and age.
- Method:** A descriptive and prospective study was performed at both Duque de Caxias School and Rotary Rehabilitation and Special Education Center in Caruaru – Pernambuco. 44 students aged between 7-17 years old, out of whom 22 were female and 22 were male, with hearing loss were evaluated. The study was developed by way of a postural evaluation, using a symmetrograph, marking specific anatomical points with stickers placed over polystyrene balls and fixed with double-sided adhesive tape.
- Results:** The results showed that all of the individuals evaluated in this study presented some kind of postural alteration in their vertebral column. Scoliosis was the most observed alteration among the students (84.1%), followed by thoracic hyperkyphosis (68.2%).
- Conclusion:** It has been concluded that children and teenagers with hearing loss are exposed to postural alteration in their vertebral column. Such a condition can be associated with a number of factors comprising unfavorable ergonomics of the school environment, bad postural habits and impairment of the vestibular system by virtue of the hearing loss.
- Keywords:** evaluation, vertebral column, hearing loss, posture, deafness.

### RESUMO

- Introdução:** A postura é determinada pela atuação dos sistemas, visual, somatosensorial e vestibular. As crianças com deficiência auditiva podem apresentar problemas na postura ou no controle postural, favorecendo o surgimento de desvios e alterações posturais na coluna vertebral, provocados possivelmente pela hipoatividade do sistema vestibular, em decorrência da surdez.
- Objetivo:** Avaliar a postura da coluna vertebral em crianças e adolescentes com deficiência auditiva em idade escolar, considerando o gênero e a idade da amostra.
- Método:** Foi realizado um estudo descritivo, prospectivo, na Escola Duque de Caxias e no Centro de Reabilitação & Educação Especial Rotary, localizadas no município de Caruaru-PE. Foram avaliados 44 escolares com deficiência auditiva com faixa etária entre 7-17 anos, sendo 22 do gênero feminino e 22 do gênero masculino. O estudo foi desenvolvido por meio de uma avaliação postural, com o uso de um simetógrafo, marcação de pontos anatômicos específicos com adesivos dispostos sobre esferas de isopor e afixados com fita adesiva dupla face.
- Resultados:** Os resultados apontaram que todos os sujeitos avaliados neste estudo apresentaram algum tipo de alteração postural na coluna vertebral. A escoliose foi a alteração mais observada entre os estudantes (84,1%), seguida da hipercurvatura torácica (68,2%).
- Conclusão:** Concluiu-se que crianças e adolescentes com deficiência auditiva estão sujeitos a desenvolver alterações posturais na coluna vertebral. Tal condição pode estar associada a um somatório de fatores que envolvem a ergonomia desfavorável do ambiente escolar, maus hábitos posturais e o acometimento do aparelho vestibular em virtude da perda auditiva.
- Palavras-chave:** avaliação, coluna vertebral, perda auditiva, postura, surdez.

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## INTRODUCTION

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The first years of a child's life are characterized by a wide range of modifications in his/her growth and development (1). The period between birth and the end of the first year of life is deemed to be one of the most significant for a child's neuropsychomotor development (2).

A great event in children's development is the evolution of postural control, since latents increase their possibilities of exploration and interaction with the environment to an extent that they start to stabilize their head around the 3<sup>rd</sup> month of life (3). Next, an improvement in the postural control is noticed, since between the 6<sup>th</sup> and 7<sup>th</sup> months many latents are already capable of sitting for a short period with a support of their arms (4). After two months, between the 8<sup>th</sup> and 9<sup>th</sup> months, the latents start to be able to sit down without a support; and, eventually, between the 12<sup>th</sup> and the 15<sup>th</sup> month, they develop an independent postural control (5).

Maintaining standing-up position involves some constant and coherent body adjustments with the intention to keeping the body segments properly aligned and guided. In the situation of proper postural alignment, the musculoskeletal structures are balanced, and, therefore, lesions or deformities are less likely to occur (6). This task requires an intrinsic relation with sensorial information and motor action (7).

The main sources of sensorial information for the postural control to satisfactorily work are the visual, somatosensory and vestibular systems (8). This labyrinth of information on each sensorial system occurs on a selective basis, thus increasing the relevance of a more useful system and reducing the relevance of that or those systems, which are less useful to maintain and regulate posture (9, 10).

According to HORAK & MACPHERSON (11), the postural control system identifies the sensorial information coming from the three sensorial channels and produces effective motor responses so that the desired position is reached or maintained. If one of the sensorial channels does not provide the proper sensorial information, the working dynamics of the postural system can be altered. In this case, the postural control system does not seem to have a coherent and stable relation between sensorial information and motor action and, therefore, the motor development can be impacted, just like in children with hearing loss.

The vestibular system is an organ with double function, in which the cochlea is responsible for hearing

and the vestibule is responsible for regulating the postural control and equilibrium (12). The ability of hearing, however, is actually a secondary characteristic, being the primary responsibility of the hearing organ to maintain and regulate the postural control and equilibrium (13). As a result of the anatomic proximity to the structures responsible for the hearing and vestibular functions, it is normal to find associated alterations in both systems, therefore, it is reasonable to assume that many deaf children have vestibular problems simultaneously with their hearing loss (14). Moreover, studies show that hypoactivity of the vestibular system is a frequent finding in otoneurological evaluations on children with hearing loss, creating vestibular disorders in these children (15, 16, 17).

Accordingly, it is assumed that children with hearing loss can develop postural strategies to overcome or compensate their equilibrium difficulties, by selecting a certain posture for purposes of attaining a higher corporal stability, and they can therefore develop postural alterations in their vertebral column. At a long length, these improper postural standards culminate in the acceleration of the degeneration process of the musculoskeletal system, causing pain and affections to occur in the vertebral column at adulthood (18).

As stated, the purpose of this study was to evaluate the posture of the vertebral column on children and teenagers with hearing loss, taking into consideration their gender and age and identify the painful symptomatology in their group.

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## METHOD

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This descriptive study was performed in the period between February and July 2009. 44 volunteers participated in this study were grouped under a sample for convenience, comprising children and teenagers with hearing loss, selected from both Duque de Caxias School and Rotary Rehabilitation and Special Education Center, state schools located in the city of Caruaru – Pernambuco.

The volunteers were divided into two groups, namely: HDF group (Hearing-Disabled Female) and HDM group (Hearing-Disabled Male). Each group was composed of 22 school children and teenagers aged between 7 and 17, with 2 representatives of each age per group.

The exclusion criteria of the study for both groups were: to present any other related deficit (physical, mental, visual and/or cerebral palsy) or present inconsistency bigger than 2 cm in lower members, attained by the real measure and apparent measure test previously performed by the evaluators.

The inclusion criteria in the study for both groups were: to be regularly registered in one of the schools cooperating with the research, be in the age range intended for the study and show the term of free and clarified will (TCLE) duly signed by a parent or responsible for the child or teenager.

For purposes of data acquisition, volunteers were submitted to a postural evaluation of the vertebral column individually performed by physiotherapists, by using a symmetrograph and mark of specific anatomic points, being photographed next, according to criteria proposed by KENDALL, McCREARY & PROVANCE (6), POLITANO (19) and KISNER & COLBI (20). Such criteria allow postural alterations and deviations in the vertebral column to be evaluated and identified, such as scoliosis, thoracic hyperkyphosis, hyperlordosis in the cervical column and lumbar column.

For purposes of postural evaluation, the student was put in the orthostatic position, barefooted, in front of Cerci® symmetrograph at a 20-cm distance from the wall, wearing bath clothes (short for boys and a short and a top for girls), having specific anatomic points marked with Pimaco colored adhesives, placed over 1-cm diameter polystyrene balls and fixed with Cremer double-sided adhesive tape.

The marked anatomic points were: glabellum, tragus, menton, acromion, stern manubrium, C7 spinal process, T3 spinal process, lower scapula angle, lateral epicondyle of humerus, anterior-superior iliac spine, postero-superior iliac spine, bigger trochanter of femur, articular line of knee, medium point of patella, point over the medium line of leg, tuberositates of tibia, lateral malleolus, calcaneus tendon, point over calcaneus, point between head and 2nd and 3rd metatarsus.

It was observed the painful symptomatology in the muscles of the evaluated students' vertebral column, by using criteria proposed by PALMER (21). The procedures consisted of digital palpation of the transverse processes of the evaluated student' vertebral column in the cranium-caudal direction. Evaluators instructed the volunteers to raise one arm when digital palpation would cause pain and this way the painful symptomatology has been reported in the evaluated students' vertebral column by this study.

Orientations prior to examination, postural evaluation and evaluation of pain were previously explained by the researchers to volunteers by way of the Brazilian Language of Signs (BLS), since one of the researchers is a BLS interpreter.

The data was organized and described with the help of Packstage Statistical Science (SPSS) Software, version

11.5, and the results were expressed in frequency percentage. This study was evaluated and approved by the ethical committee in research at Caruarens Association of University Degree – ASCES, in accordance with the final protocol N° n° 068/08 CEP/ASCES, as per the National Council of Health's resolution N° 196/96.

## RESULTS

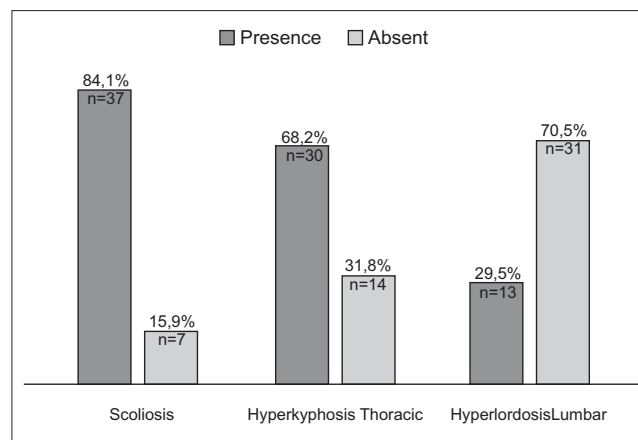
This study evaluated the column vertebral posture of 44 students with hearing loss aged between 12±3.2 and identified an elevated index of postural alterations in the evaluated students, considering the results presented.

The results achieved in the present researched revealed that all the volunteers showed at least one kind of postural alteration in their vertebral column.

Scoliosis was the most observed postural alteration between the evaluated children and teenagers and it is present in 84.1% of the students, being mostly noticeable in the group age between 7-14 male children (Figure 1 and Table 1).

Thoracic hyperkyphosis appears to be the second most occurring postural alteration among students with hearing loss (68.2%), it is also more prominent in 7-14 year-old male (Graphic 1 and Table 1).

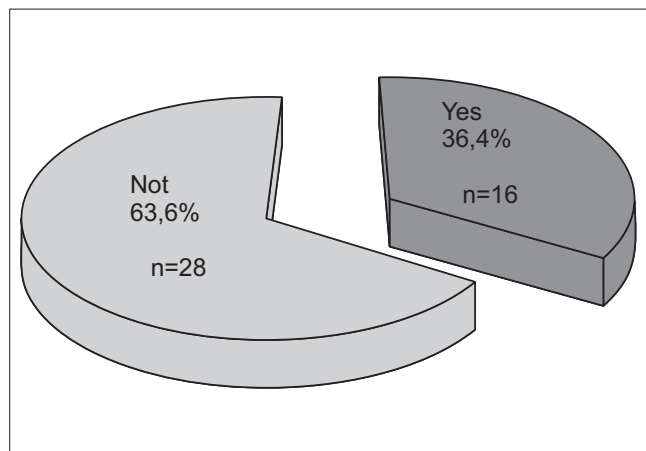
Conversely, lumbar hyperlordosis was the least observed alteration in the sample, more frequently in 7-10-year-old female (Table 1 and Graphic 1).



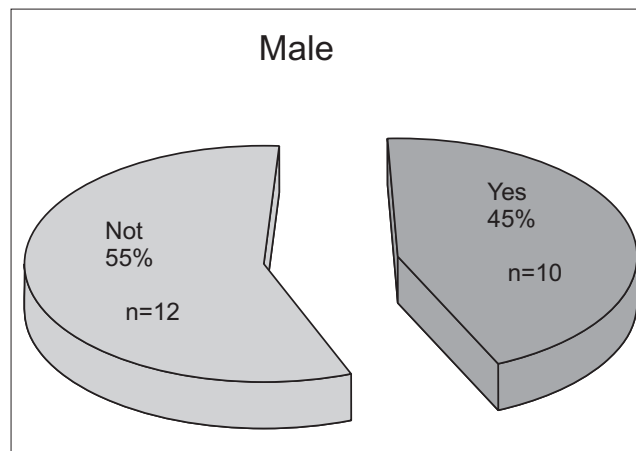
**Graphic 1.** Distribution (%) of the kinds of postural alterations in the vertebral column in the sample children and teenagers with hearing loss (n=44).

**Table 1.** Occurrence of the kinds of postural alterations in the vertebral column in children and teenagers with hearing loss according to their gender and age.

Age (age),0	N	Male N=22						Female N=22]						
		Scoliosis		Hyperkyphosis Thoracic		Hyperlordosis Lumbar		Scoliosis		Hyperkyphosis Thoracic		Hyperlordosis Lumbar		
		n	%	n	%	n	%	n	%	n	%	n	%	
7-10	08	08	100	06	75	02	25	08	06	75	04	50	05	62,5
11-14	08	08	100	06	75	02	25	08	06	75	08	100	01	12,5
15-17	06	03	50	04	66,7	01	16,7	06	06	100	02	33,3	02	33,3



**Graphic 2.** Occurrence of painful symptomatology in the vertebral column of the sample children and teenager with hearing loss (n = 44).



**Graphic 3.** Occurrence of painful symptomatology in the vertebral column of the sample male children and teenagers with hearing loss (n = 22).

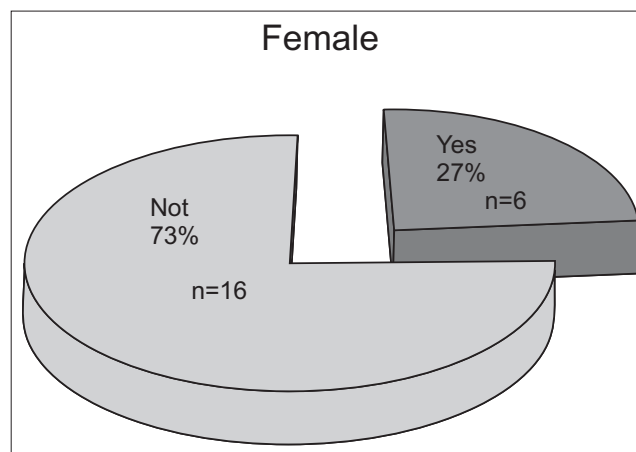
In the pain investigation, results showed that 36.4% of the evaluated students showed a painful symptomatology in their vertebral column (Graphic 2).

With respect to pain distribution between the genders, male students complained more about pains in their vertebral column (45%) more than female students (27%) (Graphics 3 and 4).

## DISCUSSION

This study evaluated the posture of 44 students with hearing loss and identified an elevated index of postural alteration in the evaluated students.

As to the occurrence of postural alterations on the whole, all of the children with hearing loss showed postural alterations, what confirms VASCONCELOS *et al's* study (22), in which they evaluated the vertebral column posture of 32 students with hearing loss aged between 7-21 and reported that 90.62% of the evaluated samples showed postural alterations in their vertebral column.



**Graphic 4.** Occurrence of painful symptomatology in the vertebral column of the sample female children and teenager with hearing loss (n=22).

When analyzing the types of postural alterations observed among the students of this study, scoliosis was the most observed kind of alteration (84.1%), and it was more prominent in 7-14-year-old male. Confirming these results, VASCONCELOS *et al* (22) observed that 37.5% of the students showed scoliosis and the age group between 7-12 was the one with the highest indexes of this pathological deviation; in this study, however, females showed a bigger occurrence of this postural alteration.

The results achieved with regard to scoliosis in this study were superior to studies where they evaluated the posture of hearing students that utilized the same methodology of this study. FORNAZARI (23), who studied the prevalence of scoliosis in 655 students without hearing loss, at the same age group of this study, found scoliosis in 26% of the evaluated samples; the author believes that the postural alterations may be associated with factors related to school environment. BIASOTTO & GODOY GOMES (24), on the other hand, who analyzed the posture of 66 students without hearing loss aged between 12-16, both genders, reported that 65.1% of the evaluated students showed scoliosis.

Contrary to these results, the study performed by SANTOS *et al* (25), who also evaluated the posture of students without a hearing loss aged between 6-12, both genders, showed that scoliosis was found in 15.7% of the evaluated students. The authors concluded that scoliosis can be associated with the prevailing factor whether the student is right-handed or left-handed, what could cause a more accentuated muscular hypertrophy and an elevation in the shoulder on the dominating side, or by the frequent use of school backpacks, in an operational way in case supporting it in only one shoulder. ESTEVES (26) reports that scoliosis is the most often kind of postural deviation in students of both genders, what corroborates with the results of this study.

Thoracic hyperkyphosis was the second most predominant alteration in this study (68.2%), and it was more largely noticed in 7-14-year-old male. Confirming this data, VASCONCELOS *et al* (22)'s study, which also evaluated the posture of students with hearing loss, shows that thoracic hyperkyphosis was the most frequent alteration (75%), and the distribution between the genders is the same (50%), with its occurrence being more frequent in 7-12-year-old students, what agrees with the results of this study.

The prevalence of thoracic hyperkyphosis observed in this study was higher than that of studies that evaluated the posture of children without hearing loss; BIASOTTO & GODOY GOMES (24) evaluated the posture of students of both genders aged between 12-16 and report that 49.9%

of the samples of their study showed thoracic hyperkyphosis. Contrary to BIASOTTO & GODOY GOMES (24)'s study, SANTOS *et al* (25)'s study, which also evaluated the posture of students without hearing loss aged between 6-12, of both genders, found thoracic hyperkyphosis in 9.1% of their samples. MORO (27), who evaluated in his study the sitting posture of 200 students without hearing loss in the public schools of Florianopolis/SC, identified that, concerning the postural standards adopted in the classroom, children used to sit most of the time with their stem flexed and they put their hands on the cheek during the activities in the school desk, what could allow for the hyperkyphotic posture of the thoracic column among the students.

Lumbar hyperlordosis was the least observed postural alteration in the students evaluated in this research (29.1%), with a higher occurrence between female and a higher frequency between 7-10-year-old children. Corroborating with this data, VASCONCELOS *et al* (22) report that lumbar hyperlordosis was the second most predominant alteration between the students with hearing loss evaluated in their study, it was observed in 50% of the samples, equally distributed between the genders (50%), being most frequent in the age group between 7-12.

Likewise, BIASOTTO & GODOY GOMES (24) reported that lumbar hyperlordosis was also the least predominant alteration between the students without hearing loss in their study, with an occurrence of 42.4%. SANTOS *et al* (25) report that the incidence of lumbar hyperlordosis in their study evaluating students without hearing loss was 26.3%, with the highest indexes being in the age group between 9 and 13. According to DETSCH & CANDOTTI (28), until the nine years of age, lumbar hyperlordosis is considered normal in the infantile motor development, since there is not a postural stability yet, what could create a search for the corporal equilibrium by abdominal protrusion and anterior pelvic inclination.

Besides the factors associated with the environment and school ergonomics, another important fact that could enable postural deviations to appear in the students evaluated in this study are GUILDER & HOPKINS (29), who evaluated children with hearing loss by rotating stimulation and they found results of the diverse labyrinthic examinations, thus affirming that children with hearing loss frequently showed a hypoactivity of the vestibular system. The authors still stressed that vestibular hypoactivity is more observed in children with deep and severe hearing loss. These results confirm ALCOHOLADO (30)'s study, evaluating 7 children with hearing loss by computed vectoelectronystagmograph, observed that 6 children had a response of hypoexcitability of the vestibular system. The author still suggests that any patient with a hearing loss diagnosis, apart from age and gender, must be submitted

to vestibular examinations, even when vertigo and dizziness are not present.

For SHUMWAY-COOK & WOOLLACOTT (31), the most critical period for the postural control development is between 4 and 6 years of age. Sensorial organization in this stage consists of the ability of the central nervous system to select, supply and combine the vestibular, visual and proprioceptive stimuli, providing thus the proper postural orientation. Such an affirmation seems to justify the results of this study, where children with hearing loss showed postural alterations in their vertebral column, from childhood to adolescence, what makes us suggest that it is possible that the teenagers in this study can have adopted inadequate postural standard in their childhood and that, without any information, specific treatment and interventions, these compensating postures would remain year after year leading to a final condition with musculoskeletal maturation in adult age.

By analyzing the occurrence of the painful symptomatology in the students evaluated in this study, 36.4% complained about pains in their vertebral column during digital palpation performed by the physiotherapists. Male gender showed a higher occurrence of pain in the vertebral column (45%) than female gender, with an incidence of 27%.

In this study, the male gender showed more distribution of postural alteration in their vertebral column as a whole, what leads us to agree with RESENDE *et al* (18), who affirmed that the postural alterations can lead to the degeneration of the musculoskeletal system represented by algic diseases. VASCONCELOS *et al* (22)'s study also evaluated the painful symptomatology in the vertebral column among the students with hearing loss and they showed that the pain was found in 86.2% of the evaluated students. There was no association between pain and age, however, the authors associated pain with the postural alterations and observed that the pain was found more among the students presenting thoracic hyperkyphosis (91.7%), and this alteration was the most predominant among the students of this study, what comes to corroborate with RESENDE *et al* (18).

According to KENDALL, MCCREARY E PROVANCE (6), pain arises from the accumulation of repeated biomechanical overstrains for a long time. DETSCH & CANDOTTI (30) also reported that many corporal postures adopted in the day-to-day life interfere with the anatomic structures, increasing the stress over the vertebral column and provoking discomforts, pains or functional disabilities.

According to this data, it was observed that children and teenagers with hearing loss are subject to develop

postural alterations in their vertebral column. Besides the risk factors of the school environment, such as inadequate proportions of furniture, inadequate transportation of material and school backpack, bad postural habits in daily life, such as: watch TV, play videogame and use the computer, the students with hearing loss showed still an attack of the vestibular system together with hearing loss, provoking alterations in the activity of this sensorial system, which is one of the three systems responsible for regulating the postural control. Accordingly, children with hearing loss can present difficulties in regulating postural control, or this regulation seems to be uncoordinated. Such a fact could justify the high indexes of postural alterations in the vertebral column observed in the students with hearing loss evaluated in this study.

The satisfactory postural control is essential to the success of a great deal of the daily tasks. Knowing the neurological and biomechanical aspects of this control has direct implications for physiotherapy, justifying the importance of future researches approaching this theme. There are scarce studies in literature evaluating the posture and painful symptomatology of the vertebral column in children with hearing loss, restraining the authors to go more deeply into the discussion of this study.

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## CONCLUSIONS

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In this study, an elevated frequency of postural alterations was observed in students with hearing loss, with a lower occurrence of painful symptomatology in the samples.

This data stresses the need to develop preventive programs and therapeutic measures that are adequate to the school environment, preventing postural alterations from occurring, reestablishing the postural standard in the students who already showed postural asymmetries, providing thus an adequate postural standard to children with hearing loss.

The physiotherapist can interfere with these disorders still in childhood, by working at schools, institutions serving this population and in interdisciplinary teams, what emphasizes the relevance of this professional in the school environment.

Such interventions could be incorporated in the day-to-day life of schools and institutions serving this population, pursuing to adequate or enhance the motor and postural development, and the quality of life of children and teenagers with hearing loss.

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