Use of wireless transmission system and performance of hearing impaired students from the perspective of teachers

Uso de sistema de transmissão sem fio e desempenho de estudantes com deficiência auditiva na perspectiva de professores

El uso del sistema de transmisión sin hilo y el rendimiento de los estudiantes con discapacidad auditiva en perspectiva del maestro

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Abstract

Objective: *To analyze the consistency of use of the wireless transmission or Modulated Frequency System (FM) of hearing impaired students, relating it to demographic and audiological characteristics and the teachers' perception regarding the performance of students in the classroom.* ***Method:*** *The study included 69 children and teenagers between five and 17 years, who received the FM system in 2015. The teachers of the students were invited to respond the questionnaire teacher classification and Screening instrument for targeting educational risk in secondary students (S.I.F.T.E.R.).* ***Results:*** *Were analyzed 36 (92.3%) teachers' responses compared to consistency of use of the FM system, 13 subjects (36.1%)*

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were consistent in the use of FM, there was no significant difference between the groups when compared gender, economic level, mother schooling, hearing loss, regular or special school, type of school and child education. From the teachers' responses analysis it was concluded that: only 42% of the teachers know the student's hearing loss characteristics. There was no significant difference between the consistency of use and school performance when considering the three categories of the scale used (approved, limit and failure), as the responses of teachers in SIFTER scale. ***Conclusion:*** *Actions in the health and education area are necessary in order to have success in using the FM system at school, and it is essential the participation of the school, of health services and of parents for the adherence to treatment.*

Keywords: *Hearing Loss; Hearing Aids; Self-Help Devices; Faculty.*

Resumo

Objetivo: *analisar a consistência de uso de sistema de transmissão sem fio ou de Frequência Modulada (FM) de alunos com deficiência auditiva relacionando-a a características demográficas e audiológicas e à percepção dos professores em relação ao desempenho dos alunos em sala de aula.* ***Método:*** *Participaram do estudo 69 crianças e adolescentes entre cinco e 17 anos que receberam o sistema FM em um serviço de saúde auditiva no ano de 2015 e seus professores foram convidados a responder a um questionário de classificação do professor e o Instrumento de Identificação do Risco Educacional em Estudantes do Ensino Fundamental e Médio (SIFTER).* ***Resultados:*** *Foram analisadas 36 (92%) respostas dos professores em comparação aos dados de consistência de uso do FM, 13 sujeitos (37%) fizeram uso consistente, sendo que não houve diferença significativa entre os grupos quando comparados gênero, classe econômica, escolaridade da mãe, perda auditiva, escola regular/especial, tipo de escola e escolaridade da criança. A partir da análise das respostas dos professores, foi possível concluir que: 42% dos professores sabem as características da perda de audição do estudante. Não houve diferença significativa entre consistência de uso e desempenho escolar quando consideradas as três categorias da escala utilizada (aprovado, limite e fracasso), conforme as respostas dos professores na escala SIFTER.* ***Conclusão:*** *São necessárias ações na área da saúde e educação para que se tenha sucesso no uso do Sistema FM na escola, sendo que é essencial a participação da escola, do serviço de saúde e dos pais para a adesão ao tratamento.*

Palavras-chave: *Perda auditiva; Auxiliares de audição; Equipamentos de autoajuda; Docentes.*

Resumen

Objetivo: analizar el uso de la consistencia del sistema de transmisión sin hilo o modulación de frecuencia (FM) de estudiantes con deficiencia relativa a las características y percepciones de los maestros demográficos y audiológicos en relación con el rendimiento de los estudiantes en el aula de audición. Método: El estudio incluyó a 69 niños y adolescentes de entre cinco y 17 años, que recibieron el sistema de FM en un servicio de salud auditiva en el año 2015 y se les pidió a sus profesores para responder a un cuestionario maestro de clasificación y la herramienta de Identificación de Riesgos educación primaria y en estudiantes secundarios (Tamiz). Resultados: Un total de 36 (92%) respuestas de los maestros en comparación con el uso de FM de la consistencia de los datos, 13 sujetos (37%) fueron el uso constante, y no hubo diferencias significativas entre los grupos en comparación género, clase económica, la educación madre, la pérdida, la escuela normal / especial, el tipo de educación escolar y el niño de la audición. Del análisis de las respuestas de los profesores, se concluyó que el 42% de los profesores conocen las características de pérdida auditiva del estudiante. No hubo diferencia significativa entre el uso de la consistencia y el rendimiento escolar cuando se consideran las tres categorías de la escala utilizada (límite aprobado y el fracaso), ya que las respuestas de los maestros en la escala TAMIZ. Conclusión: Se lleva a cabo acciones en el área de la salud y la educación con el fin de tener éxito en el uso del sistema FM en la escuela, y es esencial para la participación escolar, el servicio de salud y los padres la adherencia al tratamiento.

Palabras clave: *Pérdida Auditiva; Audífonos; Dispositivos de Autoayuda; Docentes.*

Introduction

The Ordinance 1.274/GM/MS from the Ministry of Health[1] – which includes the Personal Frequency Modulation System (FM) in the table of procedures, drugs, ortheses, prostheses and special materials (OPM) of the Unified Health System (SUS) – was published in 2013 with the main purpose to provide assistive technology for hearing impaired individuals with ages between five and 17 years, users of hearing aids or cochlear implant (CI), particularly those with speech recognition abilities, seeking greater access to information within the classroom setting.

This type of technology captures the interlocutor's voice through a microphone connected to a transmitter, and sends the signal (radio waves) to a receptor connected to the user's hearing aid or CI, wirelessly. In the last few years, other wireless transmission technologies are being made available, such as the Adaptive System (AS).These devices, although using a different technology, have the same functions and advantages of the FM system. The difference between these technologies is the type of signal transmission, which offers better quality in the access to the information conveyed in speech, regardless the background noise, and is easier to use.

The FM and adaptive systems have the objective to minimize problems related to distance, noise, and reverberation, factors that hinder the learning of hearing impaired children within the school setting. This environment usually has a considerable number of students in the same class and rooms with little or none acoustic treatment, which makes it unfavorable for speech perception and school achievement[2-5].However, the effectiveness of these devices only occurs in joint actions that involve adhesion, therapeutic intervention, and use of the resources in a partnership process that include health and education professionals and family.

The Law of Guidelines and Bases of National Education from 1996[6] establishes service priority and accessibility for people with disabilities. Since then, the inclusion of hearing impaired children in regular education is still one of the objectives of the current education policy. The whole school environment must be adapted so it occurs, including the preparation of school employees (from administration to teachers), the use of assistive technology, and specialized educational service (SES)[7].

The Screening Instrument for Targeting Educational Risk (SIFTER)[8] is one of the instruments that evaluate the academic performance of hearing impaired children. Some studies that have applied this questionnaire to compare the academic performances of hearing impaired and normal hearing children[9,10] have shown its good reliability. This instrument allows to evaluate the student's educational risks and, hence, to elaborate strategies for better academic achievement.

To adequately conduct the inclusion process, regular schools must favor the accessibility for impaired children. In the case of hearing impaired children that communicate orally, the access to speech sound perception and to the pedagogical content must be guaranteed[11].

Thus, technology may be a strong ally in the efforts to insert and include hearing impaired children in basic education. The availability of new equipment generates several demands for their users; in the case of the FM system or wireless transmission, for children, parents, and teachers. Speech-language pathologists may collaborate with programs by applying evaluation instruments and providing necessary orientation, since auxiliary communication devices, such as the FM system, are assistive technology.Adherence to its use depends on numerous factors that may be determinant to the benefits of its use, depending on how the adaptation process was carried out.Success in the use of the FM system greatly depends on the essential role of teachers and how they incorporate it in their daily routine[5].

In hearing health services, partnership with parents and school has been a daily challenge, particularly regarding adhesion to the rehabilitation process and the interaction with the community and the school.To obtain success in the treatment, both parents and school must be involved in the process[12].

With the implementation of the FM system on the child's routine, the adhesion of the family and the teachers who will use the system for the student's benefit is indispensable. Even the hearing health service or Specialized Rehabilitation Center (SRC) must be adequate to offer quick necessary help for problem solutionand for adaptation of the FM system. The ordinance that regulates the FM system is recent, and many services are just starting

to provide the device. It is fundamental to know the possibilities of use of this technology by teachers within the educational system and to provide adequate conditions for the articulation between health and education so the use of the device is fully implemented.

According to Madell[13], there are several factors involved in the adequate use of hearing aids, cochlear implants (CI) and FM systems. In the initial stages of the child's life, the use of electronic devices boils down to audibility in more protected and silent environments. As the child grows up, she is also exposed to noisier environments, leading to the need for an FM system. The author states that parents and teachers tend to substitute the use of equipment for positioning strategies within the classroom, since the child frequently seems to be well, and do not demonstrate lack of access to all speech sounds.For these reasons, health professionals must be aware; they have the responsibility to demonstrate to the family and the teachers the benefits obtained with the FM system and the negative effects of distance and noise in the classroom, as well as to apply speech-in-noise tests with the aim to show to the child, the family, and the school the audibility losses and, hence, the need to use the FM system.

In general, teachers receive little or no orientation about the special needs of their oral hearing-impaired children. Such information should be mandatory, since these students require a series of education adjustments to be able to have similar conditions to their normal-hearing peers[14,15].

In the last few years, the population of profound hearing-impaired has been having more and more access to cochlear implants, which significantly increases the percentage of children with electronic devices within regular classrooms using the Brazilian Portuguese verbal-oral language. Academic performance is directly related to accessing the teacher's speech, explanations during the classes, and understanding the content.These questions have awakened our interest in evaluating the public health grant process for FM systems, from the initial stages of its implantation, with the aim to improve it since the first steps. This study is inserted in this theme. The perception of the teacher against the challenge of using a new technology seemed an important aspect to be discussed[16,17].

Thus, the aim of this study was to analyze the consistency of use of the Frequency Modulation System (FM) by hearing impaired students, relating it to demographic and audiological characteristics and to the teachers' perceptionregarding students' performance in the classroom.

Methods

This is a descriptive cross-sectional study. It was submitted to the Research Ethics Committee of the PontifíciaUniversidadeCatólica de São Paulo and PlataformaBrasil, and it was approved under number 1.110.125 (CAEE – 45415514.1.0000.5482). The research was conducted at the Child Hearing Center (Centro de Audição na Criança – CeAC)at the Derdic Outpatient Clinic, which is a service accredited by the Brazilian Unified Health System(SUS) as Specialized Rehabilitation Center II – hearing and intellectual.

Subjects

Participants were 69 students and their respective teachers. Subjects were selected among hearing aid users registered at the CeAC/Derdic – PUC-SP within the age range from five to 17 years, who were eligible to receive the FM system, according to the Ordinance 1.274 GM/MS/2013 – MS[1]. They were called to attend an appointment at the institution, to start the delivery process of the device.

Subjects records were analyzed to obtain information regarding: gender, age, age at diagnosis, age at first hearing aid adaptation, hearing age, audiometric thresholds from 500 Hz to 4 kHz for both ears, Speech Intelligibility Index (SII) for the better ear (considered as the one that better represents the child's speech perception performance), region of residence, periodicity of speech-language therapy, history of the consistency of use of hearing aids, level of education of the child and the parents or caregivers.

When the FM systems were delivered to the users, a brief interview was carried out with the parents, with the aim to verify issues related to the school and the use of hearing aids. At this opportunity, the following procedures were also conducted: application of the socioeconomic status questionnaire for families[18]; hearing aids verification and datalogging; adaptation and functioning test of the FM system; orientation about the benefits

of the device, its handling, care, battery duration, positioning of microphone and transmitter during the use; delivery of a user manual to the parents; delivery of an envelope with a presentation letter, the free and informed consent, the Brazilian SIFTER (Screening Instrument for Targeting Educational Riskfor elementary and secondary students)(7),the questionnaire for teacher characterization (Appendix), and instructions for good use of the FM system, to be delivered to the responsible teacher.

Seven to ten days after delivery, a return appointment was scheduled for the user and the family, to monitor the adaptation process, resolve possible doubts, and measure the number of hours of use (datalogging) of the device. Based on this information, the mean hours/day was calculated for each subject, categorizing them into: consistent use (≥1.5h/day), and inconsistent use (<1.5h/day).

Two variables were used in the analysis of the adaptation process and use of the FM system in school: the number of hours of use and the classification of the student, according to the teacher.

The teacher was asked to answer the questionnaire for teacher characterization and the Brazilian SIFTER, which was validated and developed to evaluate five areas of academic performance of hearing impaired students: academics, attention, communication, class participation, and school behavior[8].Three questions are asked and rated for each area and, at the end, the score is calculated based on the sum obtained by area, and the student's performance is classified as: pass, marginal, or fail.

The SIFTER questionnaire was applied before the FM was used or, at most, on the first days of use. The objective of using this scale was to identify how the child was perceived by the teacher before the FM system was used, and not to measure its benefit.

Six months after the first data collection, only 15 from the 69 teachers sent their responses through correspondence or personally through the children's parents when they returned to the institution for the scheduled appointment. To make feasible the participation of a higher number of teachers, the documents were sent online to the schools that informed their electronic contacts (n=38). It was not possible to contact eight schools, two subjects returned the FM system, five did not use it at school, and one had the device under maintenance. At the end, 39 teachers answered the questionnaires; however, it was only possible to obtain data regarding the consistency of use of the FM system (measured through the records on the FM transmitter) from 36 children. Thus, the final analyzed sample comprised 36 students and their correspondent 36 teachers.

The analyses considered data regarding: degree of hearing loss, Speech Intelligibility Index (SII), questionnaire for teacher characterization, SIFTER, mean hours of use of the device, classification in consistent or inconsistent use.

Analyses

Absolute and mean frequencies, measures of central tendency (mean and median) and dispersion (standard deviation, minimum and maximum values) were calculated in the descriptive analysis of the data.

A descriptive level of 5% was assumed for statistical significance. Data were tabulated into Excel and analyzed using the software Statistical Package for the Social Sciences (SPSS) version 22.0 for Windows.

For comparison of the qualitative variables, the Chi-square (X^2) association test was used. When a variable presented a cell with value lower or equal to 5, the Fisher's Exact test was used instead. Univariate binary logistic regression models were used to verify the odds ratio (OR) and their respective 95% confidence intervals ($CI_{95\%}$) in the analysis of independent variables associated with the outcome "inconsistent FM use". To cutoff ≥1.5 hour/day was used to determine consistent FM use, and <1.5 hour/day was considered inconsistent FM use.

The non-parametric Mann-Whitney test was used to verify the difference between the groups consistent and inconsistent use of the FM system, according to the quantitative variables, and the non-parametric Spearman test (r) was used to identify the correlation between mean time of use and the independent quantitative variables (r=0.10 until 0.39 – weak correlation; r=0.40 until 0.69 – moderate correlation; r=0.70 until 1 – strong correlation).

Results

Inferential analysis of the students' consistency of use of the FM system at school

Most of the 36 subjects analyzed were female (58%), enrolled in regular schools (92%), with bilateral hearing loss (86%); 13 subjects (36.1%) consistently used the FM system, and their mean age was 9.4 years (SD=2.7), with a median of 9.5 years (ranging from 5 to 14 years).

Table 1 shows the analysis for all 36 subjects, classified according to the consistency of use of the FM system, for the variables: gender, socioeconomic status, maternal level of education, hearing loss, regular or special school, type of school, and child's level of education. No significant statistical associationwas found between these variables and the consistent use of the FM system.

Figure 1 presents the distribution of quantitative variables, according to the groups. No significant differences were found between the consistent and inconsistent groups for the variables age and Speech Intelligibility Index (SII) for the better ear. The same occurred for the Spearman (r) correlation analysis between the mean hours/day of FM use at school *versus* these same variables, that is, no significant correlation was found between the independent variables and the mean hours of use of the FM system per day.

Based on the analysis of the questionnaires sent back from schools (n=36), it was observed predominance of teachers trained in Pedagogy, with or without habilitation (n=21, 58%), and with other trainings (n=15, 42%), such as Mathematics, Languages and Literature, History, Psychopedagogy, Arts, Art Therapy, and post-graduationin School Management. The mean age of the subjects' teachers was 41 years, and their mean time teaching within the school setting was 17.4 years. Only five of them (14%) hadteaching assistants, and the mean number of students per classroom was 26. No significant differences were observed between the consistent and inconsistent groups regarding the variables: teachers' time in the profession, number of students per classroom, and visited schools (Table 2).

As for the teachers' knowledge regarding the students' hearing loss, 42% (n=15) knew the characteristics of the hearing loss, 31% (n=11) had no knowledge about it, and 28% (n=10) reported to know the information, but the responses obtained indicated divergence from this statement.

Analysis of the Screening Instrument for Targeting Educational Risk in Elementary and Secondary Students (Brazilian SIFTER)

The Screening Instrument for Targeting Educational Risk in Elementary and Secondary Students (SIFTER) was used in this study to identify the students' characteristics before using the FM system, which allowed to analyze possible demands for using this technology.

Tendencies were analyzed using the SIFTER areas (academics, attention, and communication). The answers provided for the three questions in each content area were rated and summed, and the final scores were categorized as pass, marginal or fail. Table 3 shows that the category variables were not significantly associated with the outcome consistent FM use, when all three categories (pass, marginal, fail) were simultaneously compared.

It was expected that the consistent use of the device would lead to better academic performance. However, an opposite tendency was observed, and the subjects with better performance did not seem to need the consistent use of the FM system. At the same time, all students categorized as fail did not have a consistent use of the device.

Table 1. Analysis of the association between consistency of use of the FM system and the variables gender, socioeconomic status, maternal level of education, hearing loss, regular/special school, type of school, and child's level of education (n=36).

Variables	Use of the FM system		p (X^2)	OR*	$CI_{95\%}$	P
	Consistent	Inconsistent				
	n (%)	n (%)				
Gender						
Male	6 (40.0)	9 (60.0)	0.681	1.0		
Female	7 (33.3)	14 (66.7)		1.33	0.3 – 5.3	0.682
Socioeconomic status						
B1/B2	4 (26.7)	11 (73.3)	0.319	1.0		
C/D/E	9 (42.9)	12 (57.1)		0.48	0.1 – 2.0	0.322
Maternal level of education						
Incomplete Elementary or Middle School	0 (0.0)	6 (100.0)	0.193	--	--	--
Complete Elementary or Middle/Incomplete High School	3 (42.9)	4 (57.1)		0.67	0.1 – 5.1	0.697
Complete High School/ Incomplete Higher education	7 (50.0)	7 (50.0)		0.50	0.1 – 2.8	0.434
Complete Highereducation	3 (33.3)	6 (66.7)		1.0		
Hearing loss§						
Bilateral	11 (35.5)	20 (64.5)	1.000	1.0		
Unilateral	2 (40.0)	3 (60.0)		0.82	0.1 – 5.7	0.845
Regular school§						
No	1 (33.3)	2 (66.7)	1.000	1.0		
Yes	12 (36.4)	21 (63.6)		0.87	0.1– 10.7	0.917
Type of school						
Municipal	3 (20.0)	12 (80.0)	0.230	1.0		
State	5 (45.5)	6 (54.5)		0.30	0.0 – 1.7	0.174
Private	5 (50.0)	5 (50.0)		0.25	0.0 – 1.5	0.125
Child level of education						
Kindergarten	1 (50.0)	1 (50.0)	0.777	1.0		
Elementary	7 (31.8)	15 (68.2)		2.14	0.1– 39.5	0.608
Middle/High	5 (41.7)	7 (58.3)		1.40	0.1– 28.1	0.826
Total	13 (36,1)	23 (63,9)				

*the consistent group was used as reference category; §Fisher's Exact test; -- cells with null values.

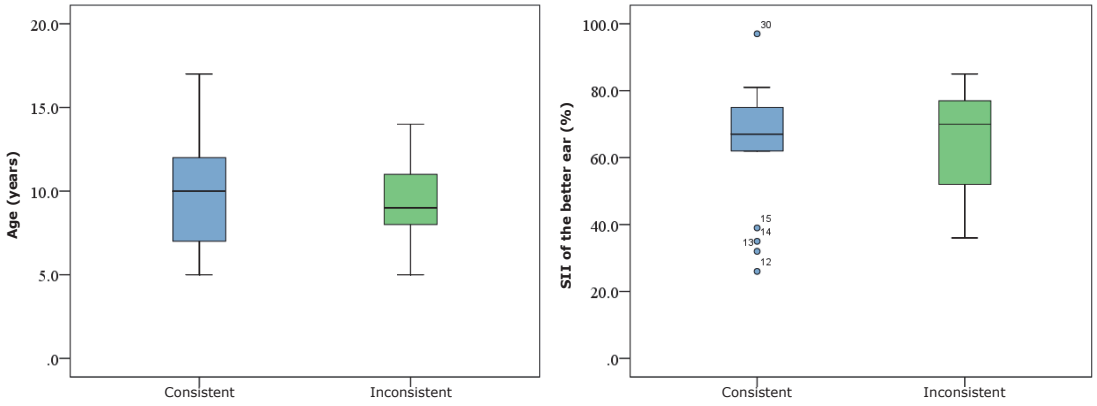


Figure 1. Box-plot distribution of the consistency of use of the FM system according to age, SII* of the better ear (n=36).

Table 2. Analysis of the association between consistency of use of the FM system and time of professional experience of the teacher, number of students per classroom, and visited school (n=36).

Variables	Use of the FM system		p (X^2)	OR*	$CI_{95\%}$	P
	Consistent	Inconsistent				
	n (%)	n (%)				
Teachers' time of professional experience§						
≤ 10	1 (16.7)	5 (83.3)	0.640	1.0		
> 10	11 (37.9)	18 (62.1)		0.33	0.0 – 3.2	0.336
Number of students per classroom§						
≤ 25	6 (50.0)	6 (50.0)	0.281	1.0		
> 25	7 (29.2)	17 (70.8)		2.43	0.6– 10.2	0.225
Visited school§						
No	8 (33.3)	16 (66.7)	0.720	1.0		
Yes	5 (41.7)	7 (58.3)		0.70	0.2 – 2.9	0.624
Total	13 (36,1)	23 (63,9)				

*the consistent group was used as reference category; §Fisher's Exact test; -- cells with null values.

Table 3. Analysis of the association between consistency of use of the FM system and the students' classification on the SIFTER scale according to the teachers (n=36) – Chi-square and univariate binary logistic regression

Variables	Use of the FM system		p (X^2)	OR*	$CI_{95\%}$	P
	Consistent	Inconsistent				
	n (%)	n (%)				
Academics						
Pass	5 (35.7)	9 (64.3)	0.013	1.0		
Marginal	8 (61.5)	5 (38.5)		0.35	0.1 – 1.6	0.185
Fail	0 (0.0)	9 (100.0)		--	--	--
Attention						
Pass	4 (30.8)	9 (69.2)	0.353	1.0		
Marginal	7 (50.0)	7 (50.0)		0.44	0.1 – 2.1	0.313
Fail	2 (22.2)	7 (77.8)		1.56	0.2 – 11.1	0.659
Communication						
Pass	8 (42.1)	11 (57.9)	0.079	1.0		
Marginal	5 (50.0)	5 (50.0)		0.73	0.1 – 3.4	0.685
Fail	0 (0.0)	7 (100.0)		--	--	--
Total	13 (36.1)	23 (63.9)				

*the consistent group was used as reference category

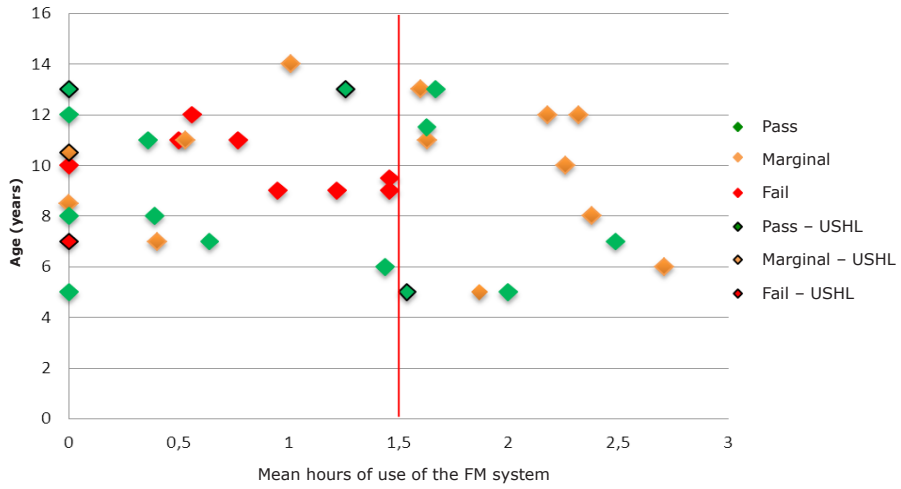
Tendencies for the relationship between the development areas for the academic performance of hearing impaired students and the mean number of hours using the FM system and the SII of the better ear

The relationship between the mean number of daily hours of use of the FM system at school, the students' age, and the SII of the better ear (n=32, for subjects S26, S32, S52, and S56 did not have SII data) may explicit the functioning tendencies of this study group and tendencies for the analysis of students with higher demands of use of wireless transmission technology.The cutoffs for the classification of consistent and inconsistent use of the FM system were, respectively, ≥1.5 hour/day and <1.5 hour/day.

SIFTER – Student's evaluation by the teacher in the Academics area

In the Academics area, the aspects involving the following abilities are scored in comparison with classroom peers and with the teachers' own expectations: reading, summarizing and drawing conclusions (logic reasoning).

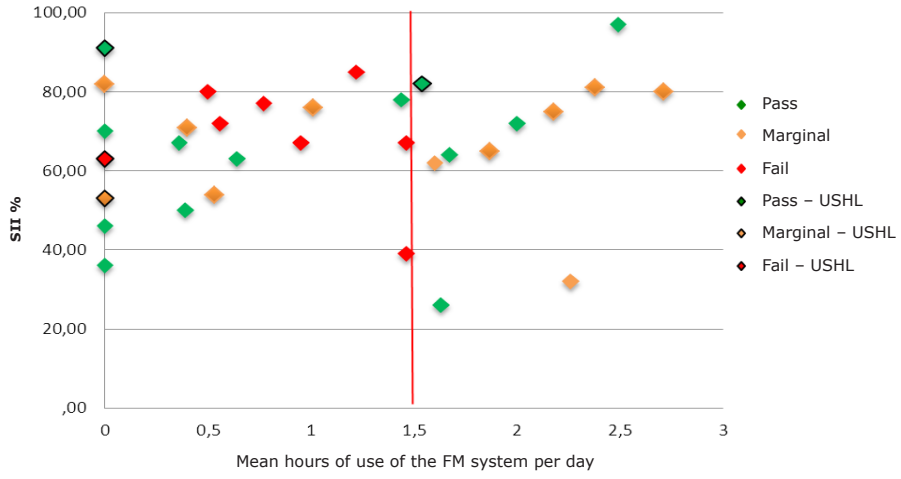
Figure 2 shows a tendency for subjects who failed in the Academics area (n=9) to use the FM system inconsistently (<1.5 hour/day).



Note: USHL – unilateral sensorineural hearing loss

Figure 2. Correlation between mean hours of use of the FM system*versus* age *versus* Academics area of the SIFTER (n=36).

Both students who did not use the FM system (zero hours of use) and failed from the teachers' perspectives were enrolled in public elementary schools. One was a ten-year-old child (S32) with mild bilateral hearing loss, and the other was a seven-year-old (S12) with severe unilateral hearing loss. Figure 3 shows that the SII of the latter suggests good audibility on the normal-hearing ear (63% on the ear with hearing loss), which may explain why the child did not use the device, since she hears without the hearing aid and the FM system.The other subject did not have SII data, but the mild bilateral hearing loss probably justifies the apparent lack of need to use the FM system.



Note: USHL – unilateral sensorineural hearing loss

Figure 3. Correlation between mean hours of use of the FM system per day *versus* SII of the better ear *versus* Academics area of the SIFTER (n=32).

The same figure also shows that eight subjects failed and inconsistently used the device, varying from 0.53 to 1.46 hours/day. One of them presented a mild hearing loss (S57, with SII of 85%). Four had moderate hearing loss (S1, S7, S9, S15) and the other two, severe hearing loss (S35/SII of 67%, and S53/SII of 39%). It may be that the four subjects with moderate loss did not feel the need to use the FM system, since they had better audibility in silence with the use of hearing aids (SII from 67 to 80%), and therefore used the FM device inconsistently.

It may be observed that the two subjects that are very close to the cutofffor consistent use (≥1.5 hour/day) are elementary school students, with only one teacher in the classroom, which favors the use of the device. One of these subjects has severe hearing loss (S53/SII of 39%) and the other, moderate hearing loss (S1/SII of 67%), with better audibility.

SIFTER – Student's evaluation by the teacher in the Attention area

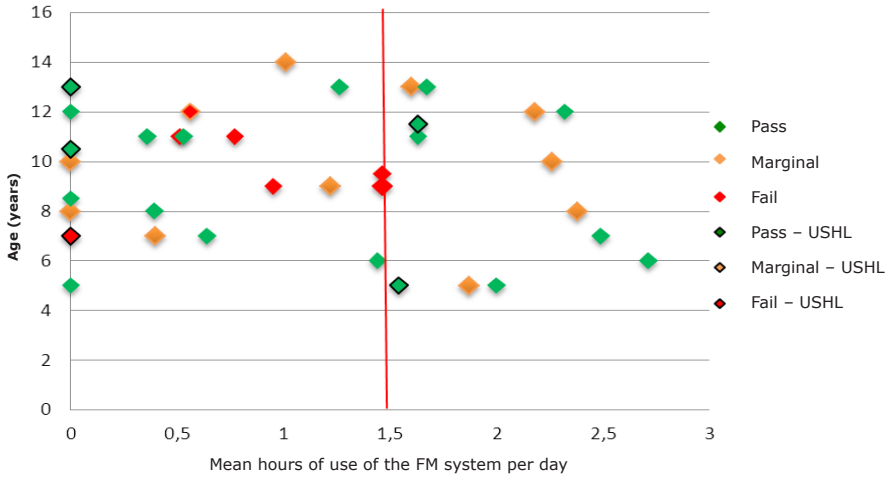
In the Attention area, the tendency includes: being called to answer a question and to understand the essence of the question;how much the student avoids being distracted by noise, images, personal objects or activities unrelated to teaching within the classroom and attention to details (avoiding errors for distraction), in comparison to their classroom peers and to the teachers' expectations.

It was again evidenced that subjects who failed also used the FM system inconsistently (<1.5 hour/day), but not for all participants with this classification. Two children who consistently used the FM system (2.26 and 2.18 hours/day) were evaluated as fail. S50 had a low SII (32%), which may explain his lack of attention and concentration.In the Academics area, this same subject was categorized as marginal, that is, his lack of attention may be related to not having full access to the message conveyed by the teacher, which causes him to get distracted and to lose interest on the content, thus hindering his learning. Subject S69, on the other hand, who had a SII of 75%, was categorized as fail in the Attention area, and marginal in the Academics area.

SIFTER – Student's evaluation by the teacher in the Communication area

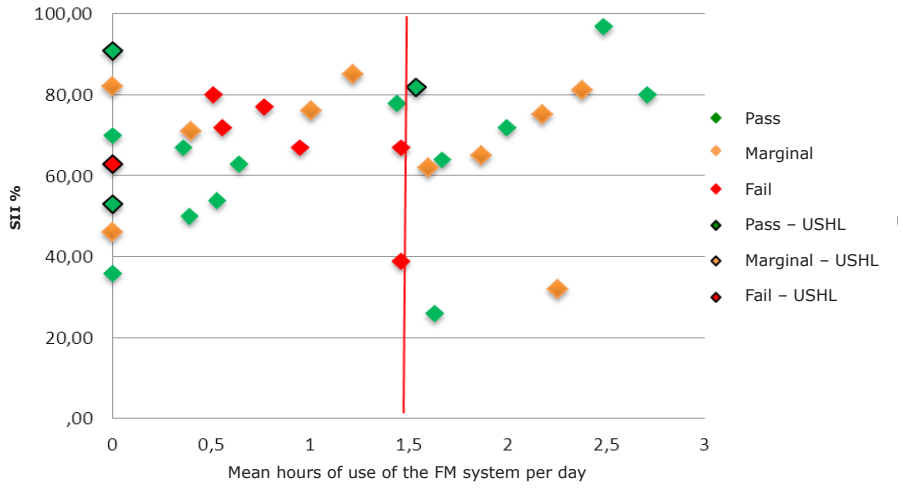
The Communication area involves communicating with the teacher, the student's ability with vocabulary issues (written words or signs), and the ability to assimilate the teacher's instructions (presented either orally or verbally), in comparison to their classroom peers and to the teacher's expectations.

Figures 4 and 5 show a certain tendency of subjects who failed according to the teachers to have usedthe FM system inconsistently (<1.5 hour/day).



Note: USHL – unilateral sensorineural hearing loss

Figure 4. Correlation between mean hours of use of the FM system *versus* age *versus* Communication area of the SIFTER (n=36).



Note: USHL – unilateral sensorineural hearing loss

Figure 5. Correlation between hours of use of the FM system per day *versus* SII of the better ear *versus* Communication area of the SIFTER (n=32).

All subjects evaluated as fail who had inconsistently used the FM presented SII above 60%, except for S53, who had a severe hearing loss and SII of 39%. On the other hand, S25, who had a very low SII (26%) was categorized as pass in the Communication area while consistently using the FM system; he used hearing aids bilaterally due to a profound hearing loss, and was enrolled at a public regular school that provided the presence of an interpreter in the classroom.

Discussion

This FM system has been available for half a century and international literature have already demonstrated its effectiveness through a vast scientific production. Nevertheless, it was only in 2013 that Ordinance 1.274 was published, including the Personal Frequency Modulation (FM) System in the table of procedures, drugs, ortheses, prostheses, and special materials (OPM) of the Brazilian Unified Health System (SUS), which made the device accessible to the population with hearing impairment.This equipment is granted by Derdic/CeAC, according to the criteria described in the ordinance.

Since the ordinance is recent, few studies have been published in Brazil which have evaluated the processes involved, from grant to adaptation of the device for children and adolescents.

We have selected a sample of 69 subjects who were granted the FM system by Derdic and have been periodically followed up at the institution. In this study, the age of the subjects varied from five to 17 years, as determined in the ordinance, since the use of the device is fundamental to the student's access to information and academic achievement. Other national studies[4,5] have evaluated subjects within the same age range, considering that the use of the device in school age is decisive for academic performance.

International studies[2,3] that have investigated the FM system have presented outcomes that show the benefits of using the device for children with ages between five and 17 years, with the aim to deepen knowledge during the school phase.

Adhesion to the FM system is much more complex than simply granting the device and hoping that the subject succeeds in using it without any articulation with parents, teachers, and health professionals. In this study, adhesion to the device was not yet satisfactory, considering that the adequate time of use of one and a half hour within the school period was consistent only for 37% of the participants. However, it must be emphasized that the study followed up the subjects for the initial adaptation period with the FM system, which may influence the analysis regarding the time of use and the continuity of use.

This may be related to several factors reported in this research:the little information provided to

the teacher about the use of the equipment; his little knowledge regarding the student's hearing loss; the possibility that the student is ashamed to use the device; good audibility initially preventing the student to perceive the difference with and without the FM; and, in some cases, the family's lack of understanding of the actual need and therefore not insisting on the use of the device[3,14,15].

Figure 3 shows that, among the subjects that inconsistently used the FM system (n=21), most had good audibility (over 60%) in silence, which may justify their low adhesion to the device in the initial phase of adaptation, as they reported good listening abilities using only the hearing aids or the CI. According to another study[13], the healthcare team has the responsibility to provide enough information for parents and teachers about the benefits of using the FM system, as well as to conduct more sensible tests, such as speech-in-noise recognition.

The professional training of the teachers participatingon this research was varied, including bachelor degrees in Mathematics, Languages and Literature, and History; Psychopedagogy; Arts and Art Therapy; and post-graduation in School Management. However, most teachers had degree in Pedagogy. They referred not to have teaching assistants or specialized educational service (SES) in the classroom, and their mean time in the profession was 17.4 years.Even with the great experience of the education professionals, the lack of information regarding hearing impairment was evident among them, which should be supplied by the SES[7].

Our results corroborate those of another study[14] that had the aim to verify teachers' knowledge on hearing loss through a permanent education program. The answers obtained on the questionnaires used in this study evidenced that teachers had only scarce knowledge on the topic, showing misconception of the characteristicsof children with different hearing losses; 59% of the subjects proved not to know much about the students' impairment, even though they claimed to know. Similar results were found in the previous study[14], demonstrating that teachers did not have the specific knowledge required to work with hearing impaired students before participating in the continued education program.

The SIFTER questionnaire was used, in this study, to identify the characteristics of the students before they started using the FM system, which allowed the analysis of possible demands for the use of this technology.

We obtained responses from 36 teachers in our sample related to the areas analyzed in the SIFTER instrument. From the students evaluated, 52.7% in the area of Communication, 38.8% in Academics, and 36% in Attention were categorized as pass, that is, had performances that were according to the expected development, when compared to their classroom peers and based on the teachers' expectations.

In a study conducted in Malaysia[9] that used the SIFTER as evaluation tool to analyze 20 school-aged children with CI (who received the implants with ages between 2 years and 3 months and 6 years and 3 months) enrolled in regular schools, the results showed that 11.8% of the subjects were at educational risk. The classification of the five areas evaluated by the questionnaire was: Social behavior (76.5%), Class participation (70.6%), Attention (58.8%), Academics (47.1%), and Communication (11.8%).

Our results corroborate the literature regarding the Academics area, but in the Communication area, the results were inverted. This may be related to the population studied: in this study, the sample comprised, predominantly, subjects with moderate hearing loss (Figures 1 and 2), while the previous study[9] was conducted with children with profound hearing loss who received their implants belatedly, hindering the area of Communication.

It was expected that the consistent use of the FM device would lead to better academic performance in the teacher's evaluation. Nevertheless, there was an opposite tendency, as the subjects with better performance seemed not to recognize the need to consistently use the device. At the same time, all students categorized as fail did not use the FM system consistently. It must be emphasized that the SIFTER scale was applied before the subjects used the device or, at most, after a few days of use. Thus, we did not analyze the difference that using the FM system caused on the student's performance. Further analyses for continuation of this study will consider the subjects' hearing age and thetime elapsed after adaptation of the FMsystem, as well as the comparison of evaluations conducted before and after using the device.

Conclusion

The concession of FM systems or wireless transmission systems to be used in schools is a recent practice in hearing health rehabilitation services. The family receives the device and is oriented to take it to school and provide guidelines for the teacher on how to use it. This study showed that the interaction between parents and school might be hindered by factors related to the daily routine in the school and/or in the family.

Characteristics of the respondents and consistency of use of the FM system:

- Considering the 36 responses (52%) received from teachers, no significant differences were found between the groups regarding: modality (regular or special) and type (municipal, state, or private) of school, and level of education (kindergarten, elementary and middle school, or high school).
- When the consistency of use of the FM system was analyzed, there were no significant differences between the groups regarding gender, socioeconomic status, maternal level of education, hearing loss, regular or special school, type of school, and level of education of the child.

Regarding consistency of use of the FM system and academic performance:

- No significant association was found between consistency of use and academic performance when the three categories of outcomes in the SIFTER scale (pass, marginal, fail) were considered, according to the teachers' responses.
- All students categorized as fail on the Academics and Communication areas of the SIFTER were inconsistently using the FM device.
- Most students with better academic achievement according to the SIFTER scale were inconsistently using the FM system.

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