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Original Article

Effectiveness of the Brazilian version of the Dangerous Decibels® educational program

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Abstract

Objective: To evaluate the effectiveness of a Brazilian version of the Dangerous Decibels® educational program in increasing students' knowledge and positively changing their attitudes and intended behaviors related to NIHL prevention and to decrease exposures to loud sounds and the barriers related to hearing protective strategies (HPS). *Design:* This is a prospective longitudinal controlled study. *Study sample:* Third to fifth graders (n = 220) filled out a baseline questionnaire; participated in a 60 minutes Dangerous Decibels® classroom presentation; answered a follow-up questionnaire immediately after the presentation; worked with their teachers on an activity booklet about hearing health ten weeks later; and filled out a three-months follow-up questionnaire. Students that did not receive health hearing education served as a control group (n = 51). A mixed analysis of variance was performed, with time as the within-subjects independent variable, and the intervention as the between-subjects independent variable. *Results:* The study group exhibited significant short- and long-term improvements in knowledge, attitudes, and intended behavior related to NIHL and acoustic trauma prevention, and in decreased exposures to loud sounds and barriers to the use of hearing protective strategies. *Conclusions:* This study demonstrated the effectiveness of a Brazilian version of the Dangerous Decibels classroom program with an additional supplementary workbook intervention.

Key Words: Hearing conservation; pediatric; noise; behavioral measures

Several studies have reported that children and adolescents can be exposed to hazardous levels of recreational and environmental sounds that could be associated with typical noise-induced hearing loss (NIHL) audiograms (Niskar et al, 2001; Biassoni et al, 2005; Martínez-Wbaldo et al, 2009; Cone et al, 2010; Shargorodsky et al, 2010), acoustic trauma (Plontke et al, 2002; Segal et al, 2003), and tinnitus (Serra et al, 2005; Coelho et al, 2007; Cone et al, 2010; Martínez-Wbaldo et al, 2009; Shargorodsky et al, 2010).

Although the actual auditory risks for the average child or adolescent are not yet completely established (Morata, 2007; Erlandsson et al, 2009), over the past 30 years several studies have recommended the implementation of NIHL-prevention education in schools (Roeser, 1980; Lass et al, 1986; Costa et al, 1988; Knobloch & Broste 1998; Martin et al, 2006; Folmer, 2008; Johnson & Meinkle, 2008; Martínez-Wbaldo & Soto-Vázquez, 2009). Educating children before they develop undesirable habits and behavior is a better solution than educating adults to reverse a habit that is already established (Eavey, 2006).

Unfortunately, basic hearing-conservation information is still absent from most school curricula all over the world. According to Folmer (Folmer et al, 2002) the lack of hearing-conservation programs in schools could be a result of the absence of public awareness about the hazardous effects of excessive sound and the consequences of hearing loss; lack of effective dissemination of existing hearing-conservation programs, curricula, and materials; and lack of a mandate from school boards and state and/or federal health agencies.

Classroom educational programs have been adopted to successfully increase knowledge about potential dangers of loud sound exposures and the importance of using hearing protection (Roeser et al, 1983; Lass et al, 1986; Chermak & McCarthy 1991; Blair et al, 1996; Griest et al, 2007; Martin et al, 2013) and to improve attitudes, and intended behaviors regarding sound exposure (Griest et al, 2007; Martin et al, 2013), though gains deteriorated to some degree over time after the interventions (Knobloch & Broste, 1998; Griest et al, 2007; Berg et al, 2009; Martin et al, 2013).

Despite the variety of existing hearing-conservation programs and campaigns (Folmer, 2008), few studies evaluated the outcome of hearing-conservation programs for scholars (El Dib et al, 2006). A cluster-randomized controlled trial that evaluated the efficacy of a three-year-long hearing conservation program directed at students who were involved in farm work showed that students that

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Abbreviations

HPD	Hearing protector device
HPS	Hearing protective strategies
NIHL	Noise-induced hearing loss

took part in the hearing conservation program reported more frequent use of hearing protection devices (Berg et al, 2009). However, there was no documented evidence of a reduced level of NIHL over three years among young people assigned to the hearing conservation program group.

Dangerous Decibels® is a program that uses educational outreach, museum exhibits, and research to encourage and study hearing health and public health with the aim of reducing the incidence of NIHL and related tinnitus (Martin et al, 2006; Martin, 2008). Topics covered by the educational activities include the sources of potentially hazardous sounds, the consequences of being exposed to such sounds, and ways to protect the ears (Martin et al, 2013). The classroom presentation is one of the most important components of the Dangerous Decibels program. It is an interactive presentation that intends to change knowledge, attitudes, and intended behaviors in children from kindergarten through twelfth grade (Martin et al, 2006) through education about noise-induced hearing loss prevention. Children participate with "hands-on" activities that offer a multimodality learning experience (Martin et al, 2006). The Dangerous Decibels classroom presentation includes the physics of sound, normal function of hearing, pathophysiology of noise-induced hearing loss, consequences of hearing loss and methods of hearing loss prevention. Principles of health communication theories were used to develop, apply, and design the evaluation of the program (Sobel & Meikle, 2008).

The aim of this study was to evaluate the outcomes of a translated and culturally adapted version of the Dangerous Decibels classroom presentation for third to fifth grade Brazilian children.

Methods

Design

This prospective cross-sectional study was designed to evaluate the outcomes of the Brazilian-Portuguese version of the Dangerous Decibels educational presentation. The study was carried out in Campinas, a southeastern Brazilian town with 1.1 million inhabitants, between April 2011 and September 2012.

Participant protection

The present study was approved by the ethics committee of research of the University of Campinas (number 1159/2011). Approval was also obtained from the district school board. Formal consent for participation by each student in this study was not required by the ethics committee of research. Instead, an informal consent form with a description of the study was sent home. Parents and guardians were required to send the form back to the classroom teacher only if they did not want their child to participate.

Participants

The evaluation of the Dangerous Decibels classroom presentation was conducted using a study group (students who received the intervention) and a control group (no-intervention comparison group) consisting of third- to fifth-grade students of two schools of Campinas (Brazil). Because the effects of students' communication among themselves are unknown, we decided not to implement a randomized design for this study, but to have the study and control groups in different schools.

The study group consisted of seven classrooms (220 students) from one public school, and the control group consisted of three classrooms (51 students) from another public school in the same neighborhood. Children with mental or psychiatric disabilities were excluded.

Intervention

We followed the Dangerous Decibels script (Martin, 2008), translated to Portuguese and culturally adapted by the first author according to findings about Brazilian children s knowledge and attitudes regarding exposure to hazardous sounds (Knobel & Lima, 2012). Only a few changes were needed to select adequate examples of common children's exposures to loud sounds in Brazilian cultures, such as Mardi Gras and other folk festivals, the use of fireworks to celebrate soccer matches, and New Year's Eve (cf. 4th of July). Also, snowmobiling (used as an example of loud sound, but not used in Brazil), a pickle (used to talk about the shape of the body of a hair cell, but not common in most houses), and firearms (very few people hunt in the country) were changed to quad bikes, candle, and fireworks, for example.

The educational topics and the "hands-on" activities in the classroom presentation were intended to communicate three main educational messages:

1. What are sources of dangerous sounds?
2. What are the consequences of exposure to dangerous sounds?
3. How can I protect myself from dangerous sounds?

The Dangerous Decibels classroom presentation was given by an educator certified after taking a Dangerous Decibels educator training workshop. The classroom presentation took about 60 minutes. About 10 weeks after the presentation, children from the study group received a seven page booklet with information, and writing and drawing activities about all the topics covered by the Dangerous Decibels classroom presentation (Table 1). In one of the activities the students were asked to write a story based on a short comic strip showing hair cells of children before, during, and after they dropped squibs. All the students were invited to submit their compositions to a literature contest organized and judged by the authors.

Measurement instruments

We used a questionnaire similar to the one used by other authors to evaluate the Dangerous Decibels outcomes (Griest et al, 2007), but translated to Portuguese and culturally adapted to Brazilian children in the same way the classroom presentation was. We added some extra questions related to classroom noise that will be discussed elsewhere. Identical questionnaires were completed prior to, immediately post-intervention, and three months after intervention. Retained knowledge and changes in attitudes, intended behaviors and previous exposures to hazardous sounds, the use of appropriate hearing protective strategies, peer and family pressure, and barriers were also evaluated.

The response format of most items required students to select from a list of potential answers including items that were on

Table 1. Topics and activities of each page of the booklet.

Page	*Topic*	*Text (t)/Illustration (i)*	*Activity*
1	Sound is vibration	(i) ear, vibration produced by a tuning-fork and a sound wave.	Have you ever been close to such a loud sound that you felt like your chest was trembling? Why does it happen?
1	The importance of hearing	–	Draw: (a) sounds that you don't like to hear, (b) sounds that you'd like to keep hearing even when you get really old, (c) the way a hard of hearing person may feel like.
2–3	Anatomy and physiology of hearing	(t) how our ear works (i) ear anatomy, organ of Corti and hair cells	Cut the separated pieces of the ear (pinna, ear canal, tympanic membrane, ossicles, and cochlea) and paste it in the correct position. Then, draw the auditory nerve and the auditory path to the brain.
4	Time × intensity in dB	(i) "thermometer" of sounds (t) box with NIOSH recommendation for the safe time of exposure according to the intensity of the sound.	Take a look at the "thermometer" of sounds and at the box that shows the safe exposure time according to the intensity of the sound. How long is it safe to be exposed to loud music at 100 dB, fire crackers at 140 dB, a rock concert at 110 dB, and a mixer at 70 dB? How long have really been around those sounds?
5	Physiology on NIHL	(1) a short comic strip showing health and "happy" hair cells/hair cells scared by a very loud sound/broken and dead hair cells	Bebel and his cousin dropped squibs to celebrate their soccer team victory. Write a story telling what happened to their hair cells. All the students were invited to submit their compositions to a literature contest organized and judged by the authors.
6	Protect your ears and attitude	(i) the three Dangerous Decibels' signs (walk away, turn it down, protect your ears)	Imagine that you are in a very cheerful party, but the music is loud, around 94 dB. Draw how you could protect your hearing and still enjoy the party.

a five-point Likert-type scale (strongly agree to strongly disagree) or closed-choice items (yes/no/not sure and check all that apply).

Procedure and data acquisition

The authors had three weekly meetings with the school teachers of the study group to explain the aims and the importance of the study to the students and to increase their commitment to the study, since they were responsible for administering the program questionnaires and the activity booklet. Teachers from the control group were only informed about the study and how to administrate the questionnaires.

All students (study and control groups) were administered the baseline questionnaires by their own teachers prior to classroom presentations. Approximately 20–25 minutes were required to complete the questionnaires. Study group classrooms were then given the Dangerous Decibels program presented by the first author. At the conclusion of the presentation, the teachers administered a post-presentation questionnaire to students in the study group. The control group classrooms did not receive the educational program and therefore did not complete a post-presentation questionnaire.

Approximately 10 weeks after the presentation, children from the study group worked on the activity booklet. All the activities were conducted by the school teachers. Three months after completion of the baseline questionnaire, a follow-up questionnaire was administered to the study and control groups.

Analysis criteria

Comparison of results across questionnaires was analysed at the classroom level rather than at the individual level. To determine the immediate and the long-term effectiveness of the educational program, the mean percentages of correct (or most desired) responses at baseline were compared to mean percentages of correct responses at post-intervention and from the follow-up questionnaire three months after the intervention for the study group using paired *t* tests (parametric) and Wilcoxon matched-pairs tests (non-parametric). Also, the mean percentages of correct (or most desired) responses for the study group at baseline and from the three-month follow-up were compared to the mean percentages of correct responses from the control group using paired *t* tests (parametric) and Wilcoxon matched-pairs tests (non-parametric). Level of significance was set *a priori* to 0.05.

Results

Description of study participants

Participants in this study were third to fifth graders, 43% male and 57% female, ages from 8 to 11 (mean age 9.3 years old, SD 0.706). The distributions of age and gender were similar between study and control groups ($p = 0.800$ for age and $p = 0.736$ for gender, chi-square test).

Self-reported sound exposures tinnitus

On the baseline questionnaire participants reported being exposed at least once during the past year to a wide range of potentially hazardous sounds: playing in a band (5.1%), motorcycle or car races (16.5%), concerts (33.7%), use of noisy recreational vehicles (44.2%), loud music in the car (58.4%), at home (68.7%) and through headphones (61.9%), and parties with loud music (77.5%). The frequencies of each exposure reported by the children are shown in the histograms of Figure 1. Pain or ringing in the ears from sound exposure was experienced by at least 37.6% of the students (28.8% were not sure and 33.7% denied). Tinnitus was a very common symptom: 77.7% experienced it at least some of the time to always (Figure 2).

Role models and influence of friends

The majority of participants (82.0%) said that they thought it was important to their friends to protect their hearing; only 26.3% had seen a parent using hearing protection, and 44.7% had never discussed this with their parents.

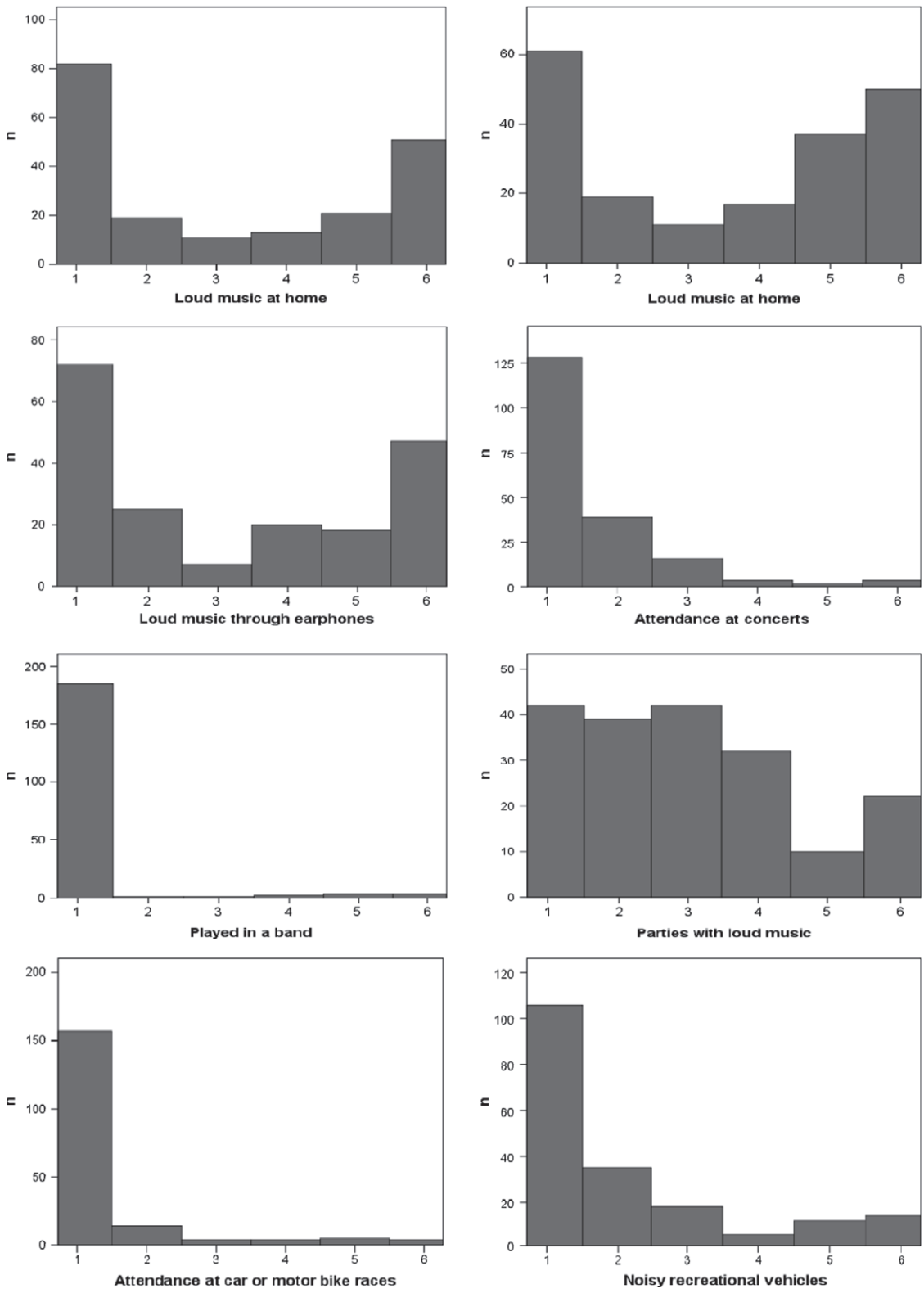

Figure 1. Frequencies of self-reported exposures to loud sounds. 1 = never; 2 = 1 to 3 times a year; 3 = 1 to 3 times a month; 4 = 1 to 3 times a week; nearly every day.

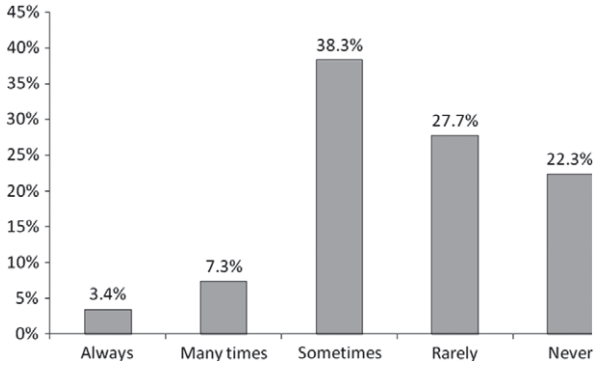

Figure 2. Baseline questionnaire answers to the question: "Do you ever experience ringing or other noises in your ear(s) or head?".

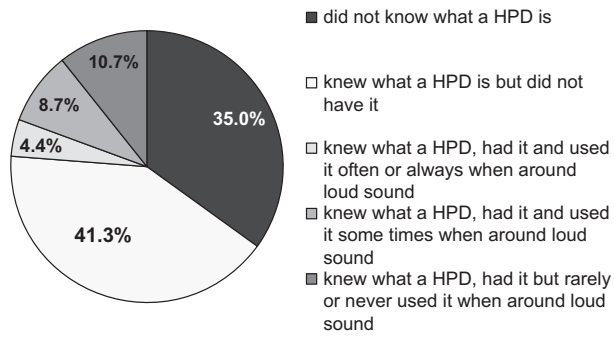

Figure 3. Knowledge and behavior regarding hearing protector devices (HPDs).

Hearing protector devices (HPDs)

One of the barriers we found was the unfamiliarity of the children with hearing protectors, since 35% of them did not know what an HPD is, or had a misconception of it (confusing HPDs with hearing aids or ear protectors for cold weather). Among the ones that knew what an HPD is, most of them did not have access to protectors and very few (4.4%) reported having and using the protectors always or often when around loud sounds (Figure 3).

Comparisons among assessments and between study and control groups

To determine the immediate and the long-term effectiveness of the educational program we looked for changes in groups of questions related to self-reported exposures to loud sounds during the previous three months, knowledge, attitudes, intended behavior, and barriers across questionnaires and between groups. Table 2 shows the *p*-values for the comparisons among baseline, immediate post-presentation and three-month follow-up questionnaires for study and control groups, as well as the comparisons that already existed between groups at the baseline questionnaire and what happened after three months. To better understand the meaning of these *p*-values, the mean percentage of the correct or most desired answers for each group of variables at baseline, immediate post-presentation and three-month follow-up questionnaires for study and control groups are shown in Figure 4.

Discussion

Noise-induced hearing loss and acoustic trauma are disabling and incurable conditions that are preventable in most of the cases. The aim of our study was to evaluate the effectiveness of a translated and culturally adapted version of the Dangerous Decibels classroom presentation for Brazilian children.

Our results support previous findings that elementary school children can benefit from education about hearing loss prevention (Chermak & McCarthy, 1991; Griest et al, 2007; Neufeld et al, 2011; Martin et al, 2013).

The classroom program produced significant, sustained improvements after the presentation without any exception. Within-subjects and between-subjects comparisons showed that the intervention used was effective in enhancing knowledge, attitudes, intended behaviors regarding exposure to potentially hazardous sounds, and the use of hearing protective strategies, as well as in decreasing exposures to loud sounds and barriers to the use of HPDs. On the other hand, only two variables exhibited significant changes after three months for the control group: decrease in knowledge and also in exposures to loud sounds. It is worth noticing that study and control groups were similar in age, gender, and in they all studied in

Table 2. *p*-values for comparisons among questionnaires and between groups for exposures to loud sounds (A); knowledge (B); attitudes (C); intended behavior (D); barriers (E); and total score of all questions (F).

	Comparisons with the baseline questionnaires				
	Study group		*Control group*	*Comparisons between groups*	
	Immediate post-presentation questionnaires	*3 months follow-up questionnaire*	*3 months follow-up questionnaire*	*Baseline questionnaire*	*3 months follow-up questionnaire*
A	–	<0.0001	0.0235^*	0.0001	0.6856
B	<0.0001	<0.0001	0.0420^*	0.3178	<0.0001
C	0.0182	0.0521	0.1074	0.0007	0.0123
D	<0.0001	<0.0001	0.1553	0.9543	<0.0001
E	<0.0001	<0.0001	0.0644^*	0.0066	<0.0001
F	<0.0001	$<0.0001^*$	0.0235^*	0.0580	<0.0001

Wilcoxon signed rank test. *Paired *t* test.

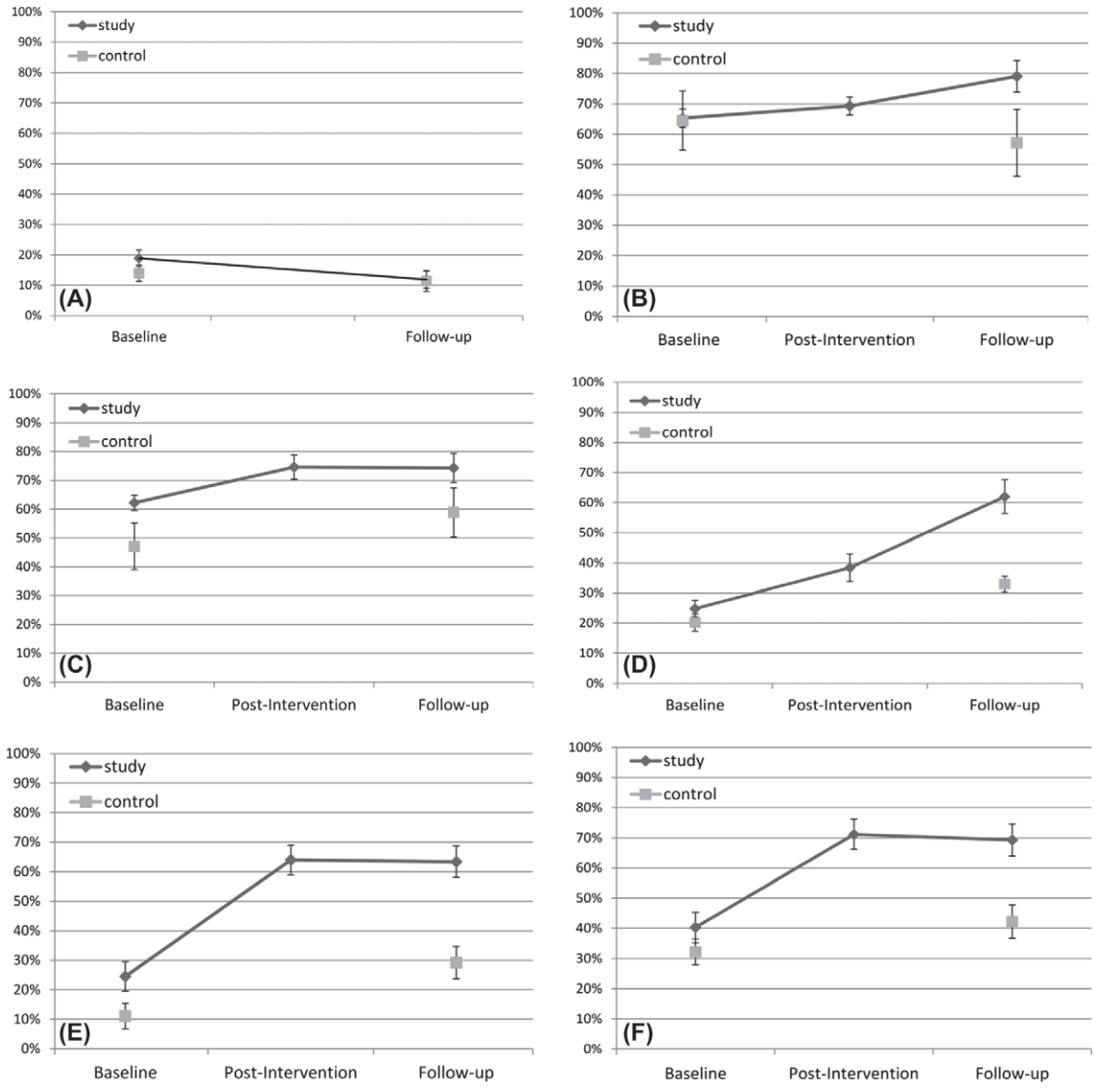

Figure 4. Percentages of desired answers across time and between study and control group for groups questions related to (A) exposures to loud sounds; (B) knowledge; (C) attitudes; (D) intended behavior; (E) barriers; and (F) total score of all questions.

public schools in the same neighborhood, which partially controls the socio-economic status variable. At the beginning of the study their overall scores were also similar, despite the study group had better scores for barriers and attitudes and the control group had fewer exposures to loud sounds. Conversely, after three months their scores were pretty much diverse. Exposures to loud sounds was the only similar group of variables between groups, and that was because the mean percentage of positive answers for exposures to loud sounds decreased from 18.9% to 11.9% in the study group, while on the control group there was a decrease from 14% to 11.4%. The overall immediate and sustained improvements after three months compared positively with previous studies for knowledge based items (Chermak & McCarthy, 1991), for behavior based items (Neufeld et al, 2011) and for attitudes, intended behavior, and knowledge (Martin et al, 2013).

We did not have a separate study group to evaluate the possible positive effect of the use of the booklet and the literature contest. Nonetheless, we are inclined to suppose that the maintenance of the gains related to attitudes and barriers over three months and, especially the improvements from post-intervention to the three-month follow-up regarding knowledge and intended behavior are directly linked to the use of such reinforcements.

We observed some alarming results similar to those reported elsewhere: the high prevalence of self-reported exposures to loud sounds (Biassoni et al, 2005; Vogel et al, 2007; Knobel & Lima, 2012; Portnuff et al, 2013), the finding that 37.4% of the students experienced pain or ringing in the ears from sound exposure (Holgers & Pettersson, 2005), and the report of frequent tinnitus (perceived always or many times) by 10.7% of the students, which may be an indicator of cumulative sound exposure.

Many studies investigated the use of HPDs by youth during noisy activities (Crandell et al, 2004; Widén & Erlandsson, 2004a; Berger, 2006; Griest et al, 2007; Erlandsson et al, 2009; Neufeld et al, 2011; Martin et al, 2013). In Sweden, for example, it is a relatively common that earplugs are offered or at a low price or even for free at pop concerts (Widén & Erlandsson, 2004b). However, because the discussion about hearing conservation out of occupational settings is relatively new in Brazil, we had to reconsider and include questions related to the information that our children had about HPDs. This fact illustrates how needful this kind of program is in terms of hearing health education. An additional cause for concern is that more than one third of students had no information about HPDs and, among the ones who knew what a HPD is, only very few (4.4%) had it or used it when around loud sounds. A preliminary study showed even worse results than those reported in this study (Knobel & Lima, 2012). According to Knobel and Lima, 21.8% out of 475 children (mean age 8.3 years old) were familiar with HPDs and only 1.1% owned earplugs and used them only when mandatory (when visiting their parents' workplaces or in shooting classes). At the end of each Dangerous Decibels classroom program presented in this study, the children received ear plugs and with them, instruction on how to use them. As a result, the rate of children who had HPD went from 24% to 100% for all students participating in the study.

The present study is, to the best of our knowledge, the first one to assess the efficacy of a translated and cultural adapted hearing conservation program in children, and one of a few prospective controlled trials to assess the long-term efficacy of a hearing conservation program.

A limitation of the present study was that we had only self-reported sound exposures. In the future, personal dosimeters should be used to record samples of children's actual sound exposure over time. The duration of period between baseline and follow-up was limited to three months. The longer-term impact of this intervention remains unknown. It would also be interesting to have observational data from parents, and objective, long-term measurements of hearing function via audiogram (5 to 10 years follow-up) that would provide a more comprehensive and accurate assessment of the efficacy of the hearing conservation program (Berg et al, 2009). We also consider that future studies could include data collection related to actual use of HPDs and implementation of other hearing protective strategies by study participants.

We intend to urge the public and the private education systems, as well as the public health system to take steps to face the actual need to prevent NIHL, acoustic trauma, and noise induced tinnitus among children. The current Brazilian government has a program named Health in the Schools' Program, which aims to integrate and to coordinate the health and the educational public systems so that students could benefit from health promotion, prevention and health care education. In addition, the Health in the Schools' Program is intended to address vulnerabilities that compromise the full development of children and youth in public schools. It seems that the scenario is favorable to the implementation of a program like the Dangerous Decibels. But, to make it come true, first municipal, state and/or federal managers of health and of education should learn about the urgency of NIHL, acoustic trauma, and noise induced tinnitus prevention. After that, the cities that participate in the Health in the Schools' Program would plan how to deliver the Dangerous Decibels classroom program in the local schools and also to provide audiologists, other health professionals and educators with educator training workshops. Finally, an evaluation system should be implemented so that the long-term results of the program could be evaluated to favor further improvements in the Brazilian version of the Dangerous Decibels.

Conclusions

Hearing conservation programs, such as Dangerous Decibels, are effective in improving knowledge, attitudes, intended behaviors regarding exposure to potentially hazardous sounds and the use of hearing protective strategies, as well as in decreasing exposures to loud sounds and barriers to the use of HPDs.

The prevention of hearing loss is already contemplated by most public health policies around the world, but NIHL, acoustic trauma, and noise induced tinnitus prevention for children and adolescents has to be a specific public health objective.

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