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Physical education in school children with partial or complete hearing loss to improve gross motor skill development

Educación física en escolares con debilidad o pérdida auditiva para mejorar el desarrollo motor grueso

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Abstract
The objective was to evaluate the effect of a physical education program in schoolchildren with hearing loss or weakness on gross motor development (GDM). The physical education program was conducted for four months, with sessions five times a week, communicating through Mexican sign language and applying tasks that emphasized motor coordination. Before and after the intervention, gross motor development was assessed with the TGMD-2 test. Inferential statistics with analysis of variance (ANOVA) 2x2 showed double significant interaction between groups and measurements (p = 0.05), showing effectiveness in the participating subjects.
key words: physical education, motor development, hearing impairment, disability.

Resumen
El objetivo fue evaluar el efecto de un programa de educación física en escolares con debilidad o pérdida auditiva sobre el desarrollo motor grueso (DMG). El programa de educación física se condujo durante cuatro meses, con sesiones cinco veces por semana, comunicándose mediante la lengua de señas mexicana y aplicando tareas que enfatizaron la coordinación motora. Antes y después de la intervención se evalúo el desarrollo motor grueso con el test TGMD-2. La estadística inferencial con análisis de varianza (ANOVA) 2x2 mostró doble interacción significativa entre grupos y mediciones (p=0.05), mostrando efectividad en los sujetos participantes.
Palabras clave: educación física, desarrollo motor, discapacidad auditiva, discapacidad.

1. Introduction

Hearing loss is established as a total or partial deficit of the assessed perception of the loss of hearing in each ear and is part of the International Classification of Functioning, Disability and Health (ICF) (OMS, 2016). Based on the World report on disability, the number of people with this condition is growing, and said growth is mainly in vulnerable populations. The World Health Organization (WHO) establishes an correlation between disability and child development in early childhood (covering prenatal age, up to eight years), which is crucial for an optimal well-being and growth, being a key influence on the subsequent life cycle of an individual (WHO, 2012). It is also reported that children with the impairment are less likely than their non-disabled counterparts to enroll, stay in

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school, and complete its successive courses (Varguillas Carmona & Bravo Mancero, 2018). To minimize this situation, the United Nations Educational, Scientific and Cultural Organization (UNESCO) proposes, as policies that guarantee quality physical education in schools, to focus inclusive methodologies that generally promote and sensitize the values of physical education, and should be elaborated and used to normalize the participation of students, parents and community members (McLennan, & Thompson, 2015).

It has been referenced that people with partial or complete hearing loss have the difficulty of learning their own language, continuing with basic education, participating in activities normal for their age, and of daily life (Franco, & Panhoca, 2008). The association between the development of a child in early childhood (stage from prenatal development to eight years of age) and disability are crucial for optimal well-being and growth, and is a key influence on the subsequent life cycle of an individual (WHO, 2016); Motor coordination, in a child with hearing impairment, can manifest itself with vestibular disorders affecting dynamic and static balance, consequently manifesting itself in learning difficulties in motor coordination compared to children without disabilities of the same age, this according to the authors Suarez et al., (2007), Rajendran and Roy (2011), Walicka-Cupryś et al., (2014).

Research that addresses disability in physical education in educational institutions has been performed by Ocete, Pérez and Coterón (2015), Felipe, Garoz and Tejero (2018), the result of which has been to facilitate inclusion of students. Therefore, according to Kurkova, Scheetz, & Stelzer (2010), Cawthon, (2009) and Hintermair (2010), physical education teachers require special communication, competencies, and didactic strategies to facilitate understanding in the teaching-learning process; with materials and resources such as: lip reading, sign language, manuals, and graphics, among others, for students to improve their learning process.

Jiménez and Araya, (2010) evaluated GDM through TGMD-2 (Ulrich, 2000), confirming that more physical education time improves GDM in children, on the other hand, descriptive research performed by Luarte, Poblete & Flores (2014) Poblete-Valderrama, Morilla & Quintana (2015), compared GDM in children who perform physical education with those who do not, showing lower levels of GDM in the latter, in the same way, the results of a quasi-experimental study finds significant differences in GDM of children participating in a motor intervention (Jiménez and Araya, 2009).

When reviewing the state-of-the-art in Mexico, we were unable to find research that clarifies these effects on children with the impairment. In the case of the present research, schoolchildren with partial or complete hearing loss present a diagnosed damage to the vestibular system, due to weather a pathological manner or a congenital disease, and an adapted specific educational attention is required to learn movements that decrease their deficit in coordinative abilities. however, systematic reviews report that a small proportion of children and young people with hearing impairment (28%) comply with the amount recommended by the WHO (Chunxiao, Justin, & Lifang, 2019), Therefore, in the present study, an adapted physical education program with a duration of four months was applied, evaluating GDM in children with partial or complete hearing loss who do not perform physical education and then comparing it with children with the same conditions who do practice it.

2. Methodology

2.1. Participating Subjects

The participating subjects were students from the two educational institutions of the city of Mexicali Baja California, Mexico, that offer educational services to people with diagnosed hearing impairment, taking into account the ICF of Disability and Health established by the WHO.

In total, 38 students from the two educational institutions participated, with an average age in years of 7.4, who were randomly divided by a simple draw (Miot, 2011) into two groups classified as: A control group (CG) with 15

students (men n = 11, and women n = 4), who didn't take part in any physical education classes, and an experimental group (EG) with 23 students (men n = 15, and women n = 8), who took part in an adapted physical education program.

The exclusion criteria were: Having any type of acute or chronic pathology that could impede physical activity, and attending at least 90% of the total sessions of the program during the 4 months of intervention. The inclusion criteria were: Collaborate voluntarily in the study with the consent of parents or guardians, being an enrolled student with a minimum of 3 months of antiquity in the participating schools, having been medically diagnosed with partial or complete hearing loss; not having systematically participated for at least three months before the intervention and being able to perform activities of daily living without the help of third parties.

The study was performed in compliance with Reglamento de investigación y el manual de procedimientos para el desarrollo de proyectos de investigación (research regulations and the procedures manual for the development of research projects) of the Autonomous University of Baja California, Protocol n. 149/1835 (UABC, 2018). Following the ethical principles of research involving human subjects of the declaration of Helsinki, taking into account the participation of children and young people (Rupali, 2005). Under a quasi-experimental methodological design with non-probability sampling for convenience (Thomas, Nelson, & Silverman, 2015).

2.2. Assessment and Intervention Process

TGMD-2 was utilized to determine the gross motor skill development quotient, from the measurement of 12 tests that assess the coordination between the trunk and extremities to perform motor actions, which are divided into:

Locomotive Skills	**Manipulative Skills**
1. Running	Batting stationary ball
2. Galloping	Stationary bouncing
3. Jumping alternating one foot	Catching
4. Jumping to the front	Kicking
5. Horizontal jumping	Throwing
6. Sliding	Rolling a ball

TGMD-2 is a reliable and validated instrument for ages between 3 and 10, the measurements of the participating subjects were recorded with a SONY handycam video camera model DCR-SX40, then reproducing the recordings to assess the performance of two attempts of each subject in each test, thus determining a score under the criteria marked by the protocol as follows:

Adjustment to remove redundancy

1. Running: Moving constantly with one step and that both feet leave the ground for an instant at each step.
2. Galloping: Performing three walking times quickly and naturally.
3. Jumping alternating one foot: Jumping a minimum distance with each foot.
4. Jumping to the front: Moving to perform all associated skills, jumping on an object.
5. Horizontal jumping: Performing a horizontal position jump.
6. Sliding: Sliding in a straight line from one point to another.
7. Batting stationary ball: Batting a stationary ball.

8. Stationary Bouncing: Bouncing a basketball a minimum of four times with the dominant hand before catching the ball with both hands without moving from place.
9. Catching: Catching a ball that has been thrown.
10. Kicking: Kicking a stationary ball with the dominant leg.
11. Throwing: Throwing a ball with the dominant arm at a spot on a wall.
12. Rolling a ball: Rolling a ball between two obstacles with the dominant arm.

For assessment, if the subject performs the movement pattern correctly, a value of 1 is established, otherwise the evaluator marks a 0, then the total score is determined to obtain the gross motor skill development quotient and interpret comparatively according to the instrument classification tables in 7 categories as follows: 1.-Very superior, 2.-Superior, 3.-Above age, 4.-Withinn age, 5.-Under Age, 6.-Poor and 7.-Very Poor.

The adapted physical education program was conducted in the facilities of the participating schools, it was performed for 16 weeks of intervention, 5 sessions each week corresponding to a total of 80 physical education classes, which lasted 50 minutes. During the program, communication with students using the Mexican sign language was established to provide feedback and establish clear and simple instructions, recommended in mexican education context (Serafín De Fleischmann & González Pérez, 2011). In physical education classes, a series of tasks were implemented as didactic strategies, which emphasized coordinative physical abilities, primarily gross motor skills, and dynamic and static balance with the use of implements and materials that promote play through movement.

2.3. Statistical Analysis

The Statistical Package for Social Sciences (SPSS) version 21.0 for Windows (IBM Corporation, New York, USA), was utilized to descriptively and inferentially analyze the study variable. The studied subjects were characterized as descriptive statistics with measures of location and dispersion, measurement and standard deviation. For each group, the percentage change (Δ%) in the studied variables was calculated according to the procedure indicated by (Vincent, 2012):

$$\Delta\% = \frac{\text{Mediapost - Mediapre}}{\text{Mediapre}}.100$$

As for the inferential statistics, the variable of gross motor skill development quotient was analyzed using the 2 x 2 (groups x measurements), mixed-design analysis of variance test (ANOVA) establishing a priori significance level of $\alpha \leq 0.05$.

3. Results

The descriptive statistics can be observed in Table 1, where the studied values of the variables from TGMD-2 gross motor skill development test assessment in participating schoolchildren are presented.

Based on the values measured in the locomotor and manipulative skills tests, the gross motor skill development quotient was assessed, and according to the TGMD-2 protocol, the comparative interpretation was performed according to the instrument's classification tables, in the categories 1.-Very superior, 2.-Superior, 3.- Above age, 4.-Within age, 5.- Under Age, 6.- Poor and 7.-Very Poor. Within the assessed students, classification of the diagnostic assessment and of the summative assessment of the intervention can be seen in Figure 1.

Table 1

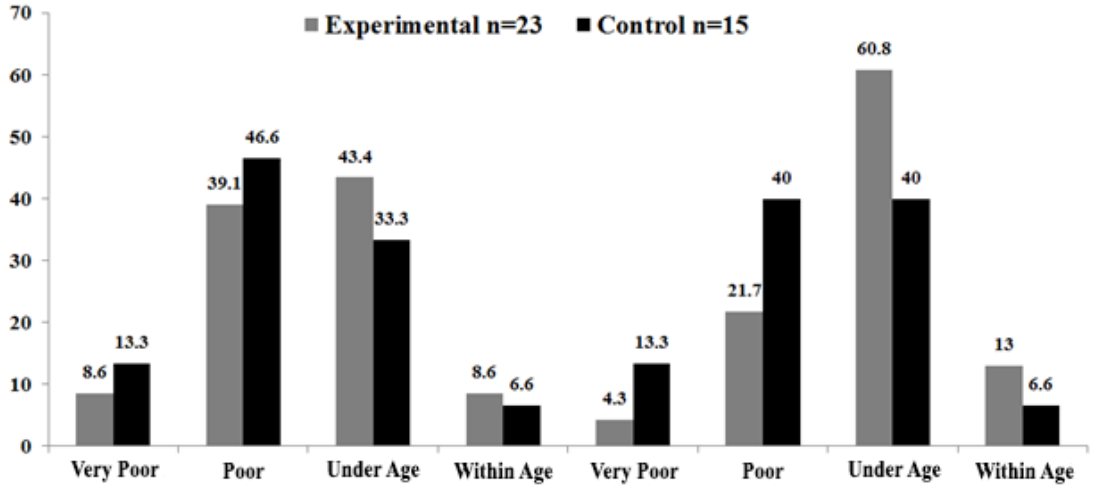
Descriptive statistics of TGMD-2 application.

	Experimental (n=23)		Control (n=15)	
Variables	Pre	Post	Pre	Post
1.-Running	7.5±0.5	8.8±0.6	7.0±0.9	7.4±1.2
2.-Galloping	6.7±1.1	7.8±1.0	6.6±0.7	6.8±0.5
3.-Jumping alternating one foot	8.2±0.7	9.3±0.6	8.3±0.6	8.8±0.9
4.-Jumping to the front	6.3±0.8	7.5±1.1	7.1±0.7	7.7±0.8
5.-Horizontal jumping	7.2±0.8	8.4±0.6	7.3±1.3	7.6±0.7
6.-Sliding	7.3±1.2	8.1±0.9	7.1±1.6	7.4±0.5
Locomotive Quotient	43.2±0.7	49.9±0.7	43.4±0.6	45.7±0.7
7.-Batting stationary ball	8.4±0.7	8.9±0.7	8.1±0.9	8.5±0.7
8.-Stationary bouncing	6.1±1.3	7.3±0.5	6.1±0.7	6.7±0.7
9.-Catching	6.3±0.9	7.1±0.6	6.2±1.3	7.2±1.5
10.-Kicking	7.1±1.1	8.6±0.9	7.2±0.9	7.3±0.6
11.-Throwing a ball	8.1±0.6	8.9±0.6	7.9±0.6	8.2±0.6
12.-Rolling a ball	7.9±1.3	8.6±0.8	7.6±0.9	8.1±0.8
Manipulative Quotient	43.9±0.9	49.4±0.8	43.1±0.8	46.0±0.7
Gross Motor Skill Development Quotient	87.1±0.2	99.3±0.1	86.5±0.2	91.7±0.2

Note: The presented values of the evaluated subjects are mean standard deviation (±) of the locomotor skill (1-6), and manipulative skills (7-12) from TGMD-2, obtaining the gross motor skill development quotient (Ulrich, 2000).

Figure 1

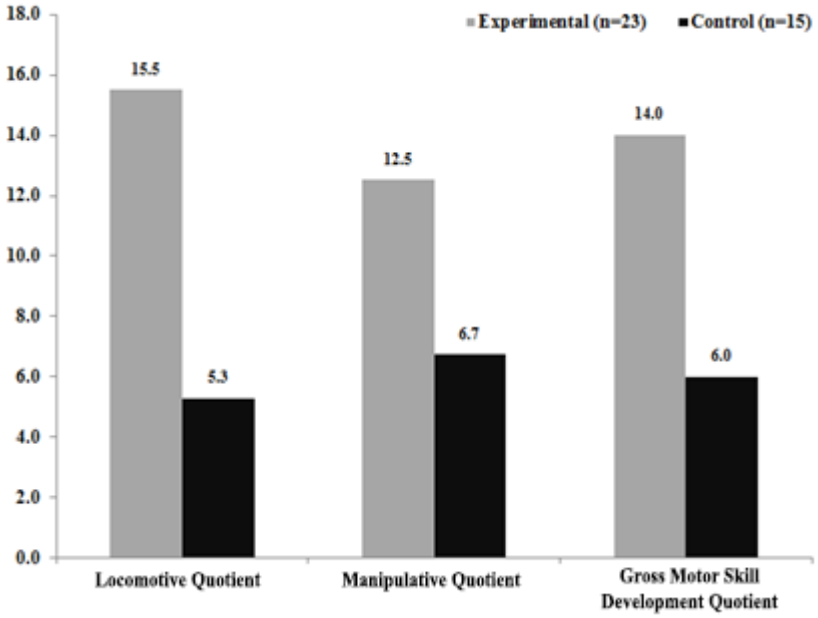
Percentage distribution (%) of the gross motor skill development quotient classification of the assessed students before and after the intervention



Note: Calculation of the percentage distribution (%) of the gross motor skill development quotient from the values of the TGMD-2 locomotive and manipulation skills tests (Ulrich, 2000).

The percentage change (Δ%) results for gross motor skill development quotient of each studied group [(Mediapost - Mediapre) / Mediapre] x 100. Can be observed in Figure 2.

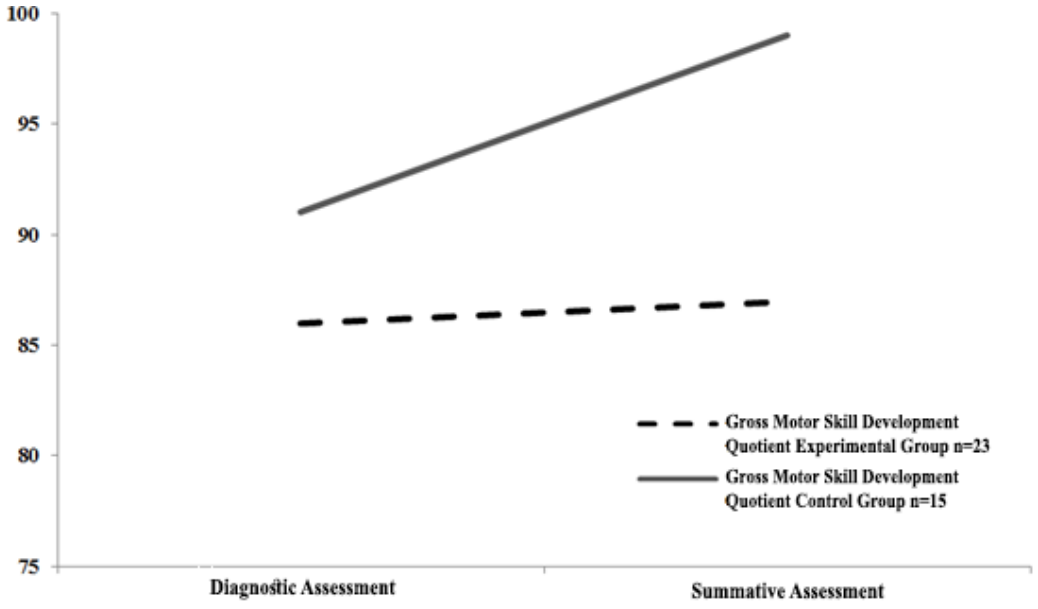
Figure 2
Percentages change (Δ%) changes of the motor gross skill development quotient (n = 38).



Note: Formula of percentage change (Δ%) [(Mediapost – Mediapre) / Mediapre] x 100.
Of the gross motor skill development quotient.

The inferential statistics showed with the 2x2 ANOVA test of repeated measures for gross motor skill development quotient a doubly significant interaction between the groups and measurements ($p = 0.05$), establishing a priori significance level of $\alpha \leq 0.05$. Which can be observed in Figure 3.

Figure 3
Changes in gross motor skill development quotient in studied participants (n = 38).



Note: Formula of equality of variance using the repeated measures 2x2 ANOVA test (p = 0.05), before and after the adapted physical education program, evaluated with the TGMD-2 (Ulrich, 2000).

3.1. Discussion

The purpose of the study was to assess the effect of an adapted physical education program in schoolchildren with partial or complete hearing loss on GDM. Having as main result that four months of participation by schoolchildren diagnosed with hearing impairment, in accordance with the ICF of Disability and Health established by the WHO, significantly improved gross motor skill development assessed by TGMD-2.

These results are favorable, since it is considered that children with hearing impairment who perform less physical activity have lesser deficiencies in postural control and coordination abilities according to Jafarnezhadgero, Majlesi and Azadian (2017), and Ebrahimi, Movallali, Jamshidi , Rahgozar and Haghgoo (2017).

Descriptive research in children without an impairment Poblete-Valderrama et al., (2015), have observed that the values of gross motor skill development are greater when performing physical education, in turn, according to our knowledge, there is no reference comparison with children with hearing impairment regarding gross motor skill development assessed with TGMD-2, but when comparing the present results, 9% of the subjects were classified within age, while in undiagnosed children with an impairment, 41% (Luarte et al ., 2015).

In another research performed by Jiménez and Araya, (2009), which evaluated gross motor skill development with TGMD-2 in children who participated for two months in a motor education program found significant improvements, in the same way, another study performed by Burns, Fu, Fang, Hannon and Brusseau (2017), with the same intervention time focused on improving motor coordination, showed significant differences, which is consistent with the results of the present research.

TGMD-2 is reported as a valid and reliable instrument (Ulrich, 2000), it is inexpensive, with easy to use procedures and provides useful information on gross motor skill coordination of children in a school setting, has been widely used (Schembri et al., 2015; Kezić, Šimunović, & Kalinski, 2020), can identify movement difficulties and serve to design specific programs and activities for the improvement of motor development, where with similar assessment instruments, significant advances have been found in students with disabilities (Ochoa-Martínez et al., 2018; Ochoa-Martínez et al., 2019). Therefore, according to SEP (Secretariat of Public Education for its acronym in Spanish), in the area of physical education, teaching competencies are recommended in the assessment of students based on the educational model and curriculum (SEP, 2016), taking into account educational environments that favor inclusion at all educational levels, with an adequate attitude from teachers for teaching skills in students (Otondo Briceño, 2018; Camano Carballo et al., 2019).

In this study, during four months of intervention it was emphasized to apply didactic strategies and pedagogical elements focused on motor coordination, considering the characteristics of inability and hearing impairment in students with communication through sign language, addressing one of UNESCO's policies, which mentions that in order to guarantee a quality physical education, schools must focus on inclusive methodologies (McLennan, & Thompson, 2015).

We added the discussion segment, which does presents limitations, since we lacked a control group, did not divide the subjects of the study by gender, and not it wasn't a research with non-probability sampling to extrapolate the results, however, it is expressed that the percentage of people with this type of disability is little compared with the total population, in the same way, there are few schools specialized in educational care for people with hearing impairment.

4. Conclusions

It is confirmed that significant differences in GDM were found in hearing impaired schoolchildren participating in the study when participating in a four-month physical education program. It would be required, in the future, to perform a greater number of studies that clarify the effect on the GDM variable in schoolchildren with hearing impairment, making possible, in addition to this research, greater references that serve to establish curricula that promote teaching-learning processes aimed at improving the GDM of this population, and consequently, greater information for professionals of physical education and health who work around people with hearing impairment.

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