

ORIGINAL ARTICLE

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## Educational strategy using the Mexican sign language to improve motor coordination development in children with hearing disabilities

*Estrategia educativa utilizando la lengua de señas mexicana para mejorar desarrollo coordinativo motor en niños con discapacidad auditiva*

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## ABSTRACT

**Objective:** To evaluate the effect of an adapted physical education program using Mexican sign language in children with hearing impairment on motor coordination.

**Materials and methods:** The design of the study was quasi-experimental, with convenient sampling, involving twenty-two children with an average age of  $10 \pm 1.8$  years, diagnosed with hearing impairment, from two schools of the city of Mexicali, Baja California. Mexico. The participants were randomly divided into an experimental group ( $n = 11$ ) and a control group ( $n = 11$ ). The motor coordination was evaluated using the KTK test (Kiphard Körper-koordinationstest für Kin-

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dergarten and Schiling, as per the German acronym), through the tests, balancing movements of backs, jumps on one foot, lateral jumps and transposition on a platform. This physical education program was achieved during 5 months, 2 times a week, 50 minutes per session and Mexican Sign Language was utilized and a series of tasks to emphasize motor coordination.

**Results:** Analysis of Variance was applied in order to compare the study variable (ANOVA), mixed  $2 \times 2$ . A significant interaction between the two groups (experimental and control) was observed; showing a positive measuring significance in motor coordination ( $p=0.01$ ).

**Conclusion:** An adapted physical education program using the Mexican sign language applied during 5 months can influence an improvement on motor coordination on hearing impaired children.

**Keywords:** disability, physical education, motor development.

## RESUMEN

**Objetivo:** Evaluar el efecto de un programa de educación física adaptado utilizando la lengua de señas mexicana en niños con discapacidad auditiva sobre el desarrollo coordinativo motor.

**Materiales y métodos:** El diseño del estudio fue cuasi experimental, con muestreo por conveniencia; participando 22 estudiantes (edad  $10 \pm 1.8$  años), diagnosticados con discapacidad auditiva, de dos escuelas de la ciudad de Mexicali, Baja California (México). Los participantes fueron divididos aleatoriamente en un grupo experimental ( $n=11$ ) y un grupo control ( $n=11$ ), a los cuales se les evaluó el desarrollo coordinativo motor mediante el test de coordinación corporal para niños KTK. El programa de educación física tuvo una duración de 5 meses, adaptando una programación de clases 2 veces a la semana, con una duración de 50 minutos por sesión, comunicándose con los alumnos mediante la lengua de señas mexicana y una serie de tareas para resaltar la coordinación motora.

**Resultados:** Para comparar las variables de estudio se utilizó el test de análisis de varianza (ANOVA) mixta  $2 \times 2$ , y se observó una interacción significativa entre grupo experimental y control, lo cual demostró una significancia positiva en el desarrollo coordinativo motor ( $P=0.01$ ).

**CONCLUSIÓN:** La aplicación de un programa de educación física adaptado durante cinco meses puede influenciar una mejora en la coordinación motora en niños con discapacidad auditiva.

**Palabras clave:** discapacidad, educación física, desarrollo motor.

## INTRODUCTION

The Sustainable Development Goals (SDGs) were established by the United Nations (UN) to fight against extreme poverty in its various dimensions; there are 17 goals, among which are health, well-being and quality education (1); in these two areas it has been reported that a small proportion of children with hearing impairment, only 28% meet the amount of physical activity recommended by the World Health Organization (WHO) (2); similarly, the WHO mentions that the number of people with disabilities is growing and is considered a vulnerable population with fewer possibilities than their non-disabled counterparts to enter basic education, remain in it and pass through successive school cycles (3).

Hearing impairment occurs in people due to damage to the vestibular system, either due to a congenital condition or a pathology, presenting a total or partial limitation to hear sounds in one or both ears, and according to systematic reviews and meta-analyses can affect language development, cognitive and motor skills (4,5). In the case of motor development, a study has correlated in children with disabilities the presence of low levels of school academic performance and low levels of motor coordination development (6). Regarding movement and the educational environment, the United Nations Educational, Scientific and Cultural Organization (Unesco) recommends in its manual "Quality Physical Education: A Guide for Policymakers" to ensure inclusive methodologies in schools, developed by the school community to promote and raise general awareness of the values and norms of inclusion (7).

The WHO refers to the association between the presence of disability and the development of the child in early childhood (stage that includes prenatal development up to eight years of age) with its optimal wellbeing and growth, being a key influence in the subsequent life cycle of an individual.

(8). In children with disabilities, as a result of vestibular problems, it has been reported as a limitation of their coordination abilities, mainly postural control (9,10) and dynamic and stationary balance (11).

In the educational field, the physical education teacher can carry out didactic strategies that promote the improvement in the motor development of children with hearing impairment (12-14); therefore, it has been recommended that physical education teachers receive specialized training

from initial stages and on a permanent basis to work with students with hearing impairment (15), favoring an adequate social inclusion to the specific needs of this population.

(16); also as a fundamental element it has been recommended that physical education teachers should have a vocational attitude to work with students with disabilities through movement (17-19), involving pedagogical activities from early ages through play and movement (20). Due to the nature of hearing impairment, in the appropriate teaching process, communication between students and teachers is a fundamental element (21), and different didactic materials, graphics and corporal expression are used to favor comprehension and understanding between the actors of the educational process (22-24). For this reason, the objective of this research was to evaluate the effect of an adapted physical education program using Mexican sign language in children with hearing impairment on motor coordination development.

## MATERIALS AND METHODS

### Sample and selection of participants

The research was conducted in compliance with the research regulations and the Manual of Procedures for the Development of Research Projects of the Autonomous University of Baja California (Protocol n.149/1835); in accordance with the ethical principles of research in human beings of the Declaration of Helsinki (25). Under a quasi-experimental design, with non-probabilistic convenience sampling, manipulating the independent variable to measure its effect on the dependent variables and assess the degree of change produced by the program (26). The participating subjects were students enrolled at the Instituto Pedagógico Auditivo IPAo and the Centro de Atención Múltiple (CAM) Eduardo Huet, in Mexicali, the only schools in the city that offer specialized education to people with moderate to total hearing impairment.

A total of 22 hearing impaired students participated, with an average age in years of  $10 \pm 1.83$ , who were randomly divided, by simple draw, into two groups classified as control group (CG): with 11 students (males  $n=06$  and females  $n=05$ ) not attended with physical education, and experimental group (EG): with 11 students (males  $n=04$  and females  $n=07$ ) who were part of the adapted physical education program. The exclusion criterion was the presence of some type of acute or chronic pathology that could prevent physical activity. The inclusion criteria were: attendance

at 90% of the program sessions, voluntary participation with parental or guardian consent, being an enrolled student (minimum 3 months), not having participated systematically in a physical exercise program 3 months prior to the intervention, and performing activities of daily living without the help of third parties.

### Intervention procedures

The adapted physical education program was conducted in the school facilities; the sessions were directed and supervised by a physical culture professional trained in communicating with Mexican Sign Language; it was carried out for 20 weeks of intervention, adapting 2 sessions each week, corresponding in total to 40 physical education classes, which lasted 50 minutes, divided into 5 minutes of warm-up, 40 minutes of medullar phase and 5 minutes of relaxation.

During the program, in order to give feedback and establish clear and simple instructions communicated with the students using Mexican sign language (27). The didactic strategies implemented were a series of tasks that emphasized coordination skills, primarily gross motor skills, dynamic and static balance, with implements and materials that encouraged play through movement. Likewise, the guidelines for the educational attention of deaf students in basic education, established by the Ministry of Public Education (28), were followed.

### Evaluation instrument

Motor coordination development was determined with the KTK test: “Körperkoordinationstest für Kinder” by Kiphard and Schiling (29) (Body Coordination Test for Children), which has shown reliability when used in people with disabilities (6). The test was evaluated before and after the intervention program in a diagnostic and summative manner, which consisted of performing the following 4 tests:

1. *Displacements in back balance*: Consists of walking backwards on three wooden bars 3 meters long, 3 cm high and of varying widths of 6, 4.5 and 3 cm, counting the number of supports made in three attempts per bar. Counting the steps taken without falling and up to 8 steps in each attempt.
2. *Single-pedal jumps*: The test consisted of jumping foam blocks, 50 cm long by 20 cm wide and 5 cm high, progressively placed one on top of the other, with each leg. The maximum number

of blocks is 12 and the distance for the displacement prior to the jump is 1.50 m, traveled with one leg.

3. *Lateral jumps*: The test consisted of jumping from one side to the other, on a platform of 1 m by 0.60 m and over a 2 cm high bar, with both feet together and as fast as possible, for 15 seconds, adding the total number of two attempts. Speed was assessed in alternating jumps.
4. *Transposition on a platform*: The test consisted of moving laterally on two platforms arranged on the floor. The platforms are 25x25 cm wide and 5 cm high. The task was to move standing on the laterally arranged platforms. When moving, the one that was released is picked up with both hands and placed on the other one side, moving towards it, and so on. In a time of 20 seconds, the number of transpositions performed is counted, both those of the platforms and of the body. Two attempts are made and the total number of actions is added up. According to the protocol, in each test the participants achieve a score. The sum of the four measurements will represent the motor coordination development and is compared tubularly according to their age. They are classified into five categories: 1. coordination insufficiency, 2. coordination disturbance, 3. Normal coordination, 4. Good coordination and 5. Very good coordination. The application time of the KTK test was between 40 minutes to one hour for each subject.

### Predictive analysis

The statistical analysis was performed in the Statistical Package for the Social Sciences (SPSS), version 23.0 for Windows (IBM Corporation, New York, USA). The study subjects were characterized with measures of location (mean) and dispersion (standard deviation). Inferential statistics were performed with a 2 x 2 (groups x measurements) mixed analysis of variance (ANOVA) test of motor coordination development. Significance was established a priori at an  $\alpha \leq 0.05$ .

## RESULTS

**Table 1.** Descriptive analysis of the pre and post (M ± SD) of the subjects who participated in the study (n=22) evaluated by the KTK test

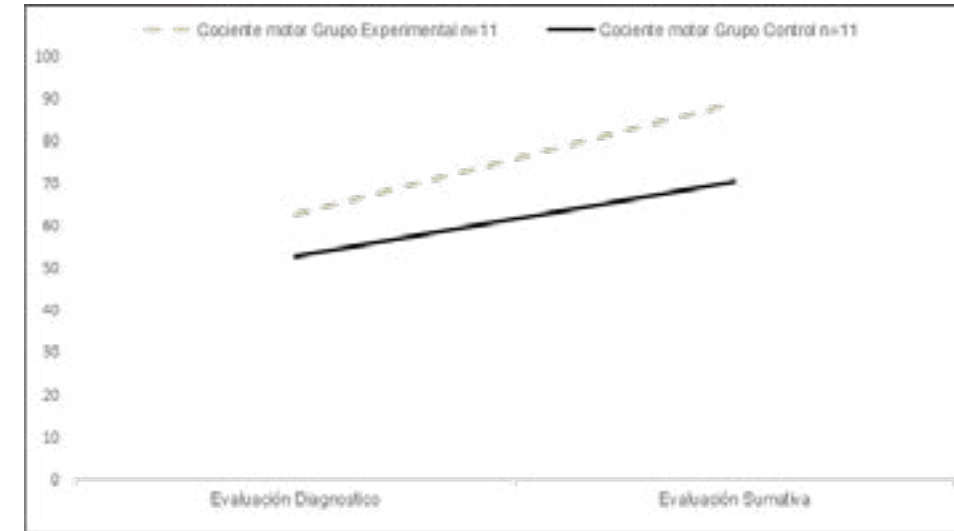
VARIABLE	EXPERIMENTAL Group (n=11)		CONTROL (n=11)	
	Pre	Post	Pre	Post
Balancing in steps	2.91 ± 2.76	6.16 ± 4.34	2.70 ± 2.48	3.46 ± 2.76
Lateral jumps	12.86 ± 3.98	16.36 ± 4.33	11.68 ± 5.57	15.00 ± 6.61
Monopod height (5cm)	2.5 ± 3.07	3.72 ± 2.10	1.61 ± 1.06	2.27 ± 1.45
Transposition platform	4.59 ± 2.17	6.22 ± 2.04	3.5 ± 1.68	5.00 ± 1.48
Motor quotient	22.86 ± 2.85	32.46 ± 4.05	19.49 ± 2.43	25.73 ± 3.21

**Note:** Calculation of the equality of variance using the ANOVA 2x2 repeated measures test (p=0.01), before and after the adapted physical education program, evaluated with the KTK test (29) (p=0.01).

**Source:** own elaboration.

The values obtained after collecting the data by means of the battery (KTK), balance displacement, lateral jump, monkey jump and platform translation, were compared with the table of equivalents, the table of comparison of scores, which presents in the diagnostic evaluations and later in the summative evaluation of the two groups GC and GE, in which a slight difference was presented after the post-test in the control group, which had a physical education teacher, which shows that the program made a significant change favorable to the experimental group (graph 1).

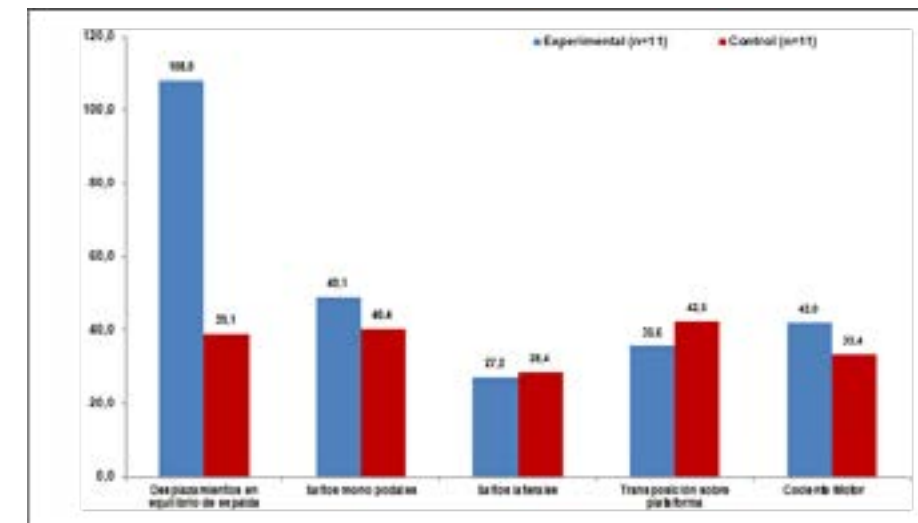
From the total score of the 4 tests of the KTK test, the motor classification was determined (Figure 2), presenting the comparative percentages of the pre and post application of the KTK test (Figure 2).



**Note:** Calculation of the equality of variance using the ANOVA 2x2 repeated measures test (p=0.01), before and after the adapted physical education program, evaluated with the KTK test (29). (p=0.01).

**Source:** own elaboration.

**Graph 1.** Changes in motor quotient in participants (n=22)



**Note:** Calculation of the percentage distribution (%) of the motor quotient classification from the sums of the four tests of the KTK test.

**Source:** own elaboration.

**Graph 2.** Percentage distribution (%) of the motor quotient classification of the participants evaluated before and after the intervention with the KTK test (n=22)

## DISCUSSION

The main result of the study was that five months of an adapted physical education program using Mexican sign language significantly improved motor coordination development in hearing impaired children. This is positive, since descriptive studies have observed coordinative deficiencies in sedentary hearing impaired children when compared to physically active hearing impaired children (10); similarly, the results have shown congruence with a quasi-experimental study that evaluated motor coordinative development in a descriptive manner in hearing impaired children, which unlike this study was conducted for 4 months in 7-year-old children (30), which also improved the equivalent motor age (31).

An intervention in children with disabilities with the objective of investigating the effect of 10 min of physical activity (coordination exercises vs. non-specific physical education lessons) on concentration and attention performance in a school environment revealed greater attention and concentration performance in both groups; with a significantly greater improvement in the group that performed coordination exercises (32); in addition, it has been identified for children with hearing impairment that physical activity of aerobic intensity has shown positive effects on vestibular functioning by remodeling the microstructure of the motor working memory (33). In schools, it has been identified that physical activity with moderate-vigorous intensity in physical education can positively promote health (34,35).

The KTK test is easy to apply, provides information related to motor coordination that can help us diagnose children with movement difficulties and design activities appropriate for the age and condition of the children, is methodologically inexpensive and easy to apply (29), and has shown reliability when used in populations with disabilities (6). In this sense, in the field of physical education it has been widely recommended that physical education teachers be competent in the evaluation of the student and facilitate knowledge with adequate communication (17-19); Therefore, in this research, taking into account the characteristics of the student, emphasis was placed on effective communication through sign language (27,28), with pedagogical elements and didactic strategies and focused on motor coordination (22-24), it has been shown as an important factor in the teaching of physical education in students with hearing impairment the attitude of teachers in the success of the teaching process (36); It has also been recommended that during the school day, didactic strategies should be generated to maximize the amount

of moderate to vigorous physical activity such as recess (37). Recent interventions have shown effectiveness in students' fine and gross motor coordination using similar measurement instruments (38-40), which endorses the importance of this model to be applied or adapted in different contexts of physical education for children with hearing impairment.

## CONCLUSION

In the subjects evaluated, efficacy was identified in the application of a five-month program of adapted physical education using Mexican sign language to improve motor coordination development in children with hearing impairment. In the future, it would be important to conduct more studies that clarify with new designs of educational and health intervention the effects on the conditional and coordinative physical capacities in this population, expand the study by including covariates such as gender, biological maturity and sociodemographic data of the study subjects and have greater references that serve physical education and health professionals who work with children and adolescents with hearing disabilities.

**Conflict of interest:** None.

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