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Strategies for optimizing balance in physical education lessons in primary school students

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ABSTRACT

Introduction: A basic objective of physical education is to ensure the acquisition of motor skills by optimizing balance which is a fundamental psychomotor component for daily activities, together with coordination, so that improving it from the early stages of the child results in better physical performance and favors his willingness to engage in non-sedentary activities. The aim of this review is to summarize the scientific literature that has examined the importance and impact of exercise in the development of balance in primary school children. *Methods:* To conduct this study, a systematic search of the electronic databases Pubmed, Web of Science, ProQuest and Scopus was conducted to identify relevant literature. Titles and abstracts of all records were checked for eligibility according to, inclusion and exclusion criteria, the process of study selection was documented in the PRISMA 2009 flowchart, in addition a Google Scholar search was performed to find additional literature. *Results*: The literature search identified a total of 680 studies potentially suitable for balance analysis, after title screening and full text eligibility analysis, a total of 10 articles remained suitable for inclusion. Data from a total of 1549 subjects including 865 boys and 684 girls were eligible for analysis, the quality assessment showed that the majority of included studies met most of the assessment tool criteria for these studies (age, sex, height and weight). *Conclusions:* The relationships between balance and other motor skills and the impact of regular physical activity on the maintenance of different types of balance is one of the main reasons why this motor skill should be improved and developed during the process of teaching physical education using physical education content.

***Keywords**: optimization, physical education, balance, primary school.*

Rezumat

Introducere: Un obiectiv de bază al educaţiei fizice este acela de a asigura dobândirea unor abilităţi motorii prin optimizarea echilibrului care este o component psihomotrică fundamentală pentru activitățile zilnice, alături de coordonare, astfel că îmbunătățirea acestuia încă din primele etape ale copilului are ca rezultat performanţe fizice mai bune şi favorizează disponibilitatea acestuia de a se implica în activităţi nesedentare. Scopul acestei recenzii este de a rezuma literatura ştiinţifică care a examinat importanţa şi impactul exerciţiilor fizice în dezvoltarea echilibrului la elevii din ciclul primar. *Metode:* Pentru a realiza acest studiu, a fost efectuată o căutare sistematică în bazele de date electronice: Pubmed, Web of Science, ProQuest şi Scopus, pentru a identifica literatura relevantă. Titlurile şi rezumatele tuturor înregistrărilor au fost verificate, pentru eligibilitate, în conformitate cu, criteriile de includere şi excludere, procesul de selecţie a studiilor fiind documentate în diagrama de flux PRISMA 2009, în plus efectuându-se o căutare în Google Scholar pentru a găsi literatură suplimentară. *Rezultate:* Căutarea literaturii a identificat un total de 680 de studii potenţial adecvate pentru analiza echilibrului, după depistarea titlurilor şi analiza eligibilităţii textului integral, au rămas un total de 10 articole adecvate pentru includere. Au fost eligibile pentru analiză datele unui total de 1549 de subiecţi dintre care 865 de băieţi şi 684 de fete, evaluarea calităţii a arătat că majoritatea studiilor incluse au respectat majoritatea criteriilor instrumentului de evaluare pentru aceste studii (vârstă, sex, înălţime şi greutate). *Concluzii:* Relaţiile dintre echilibru şi alte abilităţi motorii, precum şi impactul activităţii fizice regulate asupra menţinerii diferitelor tipuri de echilibru reprezintă unul dintre principalele motive pentru care această abilitate motrică ar trebui să fie îmbunătăţită şi dezvoltată în timpul procesului de predare a educaţiei fizice prin utilizarea conţinuturilor de educaţie fizică.

***Cuvinte cheie**: optimizare, educaţie fizică, echilibru, ciclul primar.*

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Introduction.

Psychomotor skills are considered in the literature as a complex function, a skill that integrates both aspects of motor activity and manifestations of perceptual functions (Neagu, 2012).

Psychomotor education is mainly oriented towards the development of the child's motor skills, their knowledge of body schema, awareness and development of body laterality, spatial and temporal orientation, static and dynamic balance, kinesthetic sense and finally the ability to mentally represent motor ideograms are particularly important in this period of their ontogenetic development (Neagu, 2012).

To the extent that a deficiency or abnormality will limit or even prevent efficient execution, intervention should be made in the early years of primary education. Improving body control will lead to the acquisition of motor behaviours that will be fundamental for the pupils' integral development, balance is fundamental for motor development (Turati, et al., 2015) and has a relevant role in recreational activities (Goodway & Robinson, 2015).

In the early stages of life, balance has its own development, with a strong reorganization at age 6 (Wälchli M, et al. 2018). This ability depends on the senses, the vestibular system and the motor control system (Wälchli M, et al. 2018), which is necessary for future cognitive enhancement, social interaction and other highly complex motor skills for this age range.

In this way, performing daily actions such as walking, running, cycling or simply sitting is ultimately the acquisition of proper postural balance. In the simplest terms, balance can be defined as maintaining the capacity of the body's centre of gravity within the limit of stability determined by the underlying support (Shkuratova, et al., 2004).

Balance is a complex process of maintaining the body's centre of gravity within the weight-bearing base by constantly adjusting muscle activity and joint position (Alonso, et al., 2011) and is mainly divided into static and dynamic balance. The centre of gravity can be defined as the point at which we can calculate the gravitational torque for an object as acting on it. Thus, the limit of stability is the sway angle that takes it off its base of support. Proper balance will allow a person to perform activities or movements efficiently and effectively with minimal risk of falling - two types, consisting of static balance and dynamic balance (Conner et al., 2019).

Static balance is the ability of the body to maintain balance in a stationary position when standing on one leg or standing on a balance board (Condon & Cremin, 2014).

Balance has been found to improve greatly from the age of two to 18 years (Demura et al.,2008), with primary education (PE) being one of the ideal stages to work on it (Martin Ruiz, 2018).

Children's balance matures gradually from age 7; however, development is individual and balance control does not reflect adult ability until age 16. The most important transitions in motor development usually occur by age 10, with balance control established between ages 7-10. Dynamic and static balance ability and skills are critical components of basic motor ability and fundamental movement skills.

Control of body balance (or postural balance) is considered an important indicator of correct sensory-motor system functioning and therefore needs to be assessed, thus control of posture (body orientation and alignment) and balance depends primarily on the ability of the visual, somatosensory and vestibular systems to indicate the spatial position of each body.

Postural control depends on the interplay of biomechanical constraints (e.g. size and force), dynamics (e.g. direction and magnitude of movement), movement strategies (e.g. ankle control, hip control, stepping, etc.) and previous experience (Horak, 2006).

Identifying the most appropriate exercise approaches could provide opportunities not only to improve physical fitness and motor skills in children and adolescents, but also to optimise balance skills at the same time.

The aim of this systematic review of the scientific literature is to analyse research on improving balance in physical education lessons for primary school students.

The objective of this study is to present an up-to-date review of the scientific literature on improving balance in physical education lessons for primary school students.

The following **hypothesis** was made: there is a correlation between balance, age, gender and anthropometric data in children aged 6-10 years, which will optimise and make postural control more reliable.

Methods

We conducted a systematic review of the literature in accordance with PRISMA Extension for Scoping Reviews (PRISMA-ScR), and no bias risk assessment and critical appraisal of the literature was conducted in this systematic scoping review.

Data collection

To conduct this study, a systematic search of the electronic databases Pubmed, Web of Science, ProQuest and Scopus was
performed to identify relevant literature and duplicates were eliminated. Titles and abstracts of all records were checked for eligibility according to, inclusion and exclusion criteria, the study selection process and reasons for exclusion of records are documented in the PRISMA 2009 flowchart, in addition a Google Scholar search was performed to find additional literature.

The search criteria included terms such as 'optimization', 'physical education', 'balance', 'primary cycle', as well as a combined search of these keywords, along with the option to identify them in the abstract.

Eligibility criteria

Inclusion criteria were as follows: (i) healthy children (6-11 years); (ii) an exercise intervention of at least three sessions; (iii) include an experimental and a control group; (iv) results on static and dynamic balance; (v) published in English or Spanish language/literature; (vi) available in full-text version; (vii) articles that were written for the purpose of the research.

Exclusion criteria were as follows: (i) involved participants with pathological/developmental impairments; (ii) used interventions without exercise; (iii) evaluated the effects of interventions without an experimental group; (iv) did not implement any measures of the psychomotor components involved; (v) were books, reviews, editorials, cross-sectional studies or conference abstracts; (vi) duplicate items appearing in different databases; (vii) articles not related to the discipline of physical education.

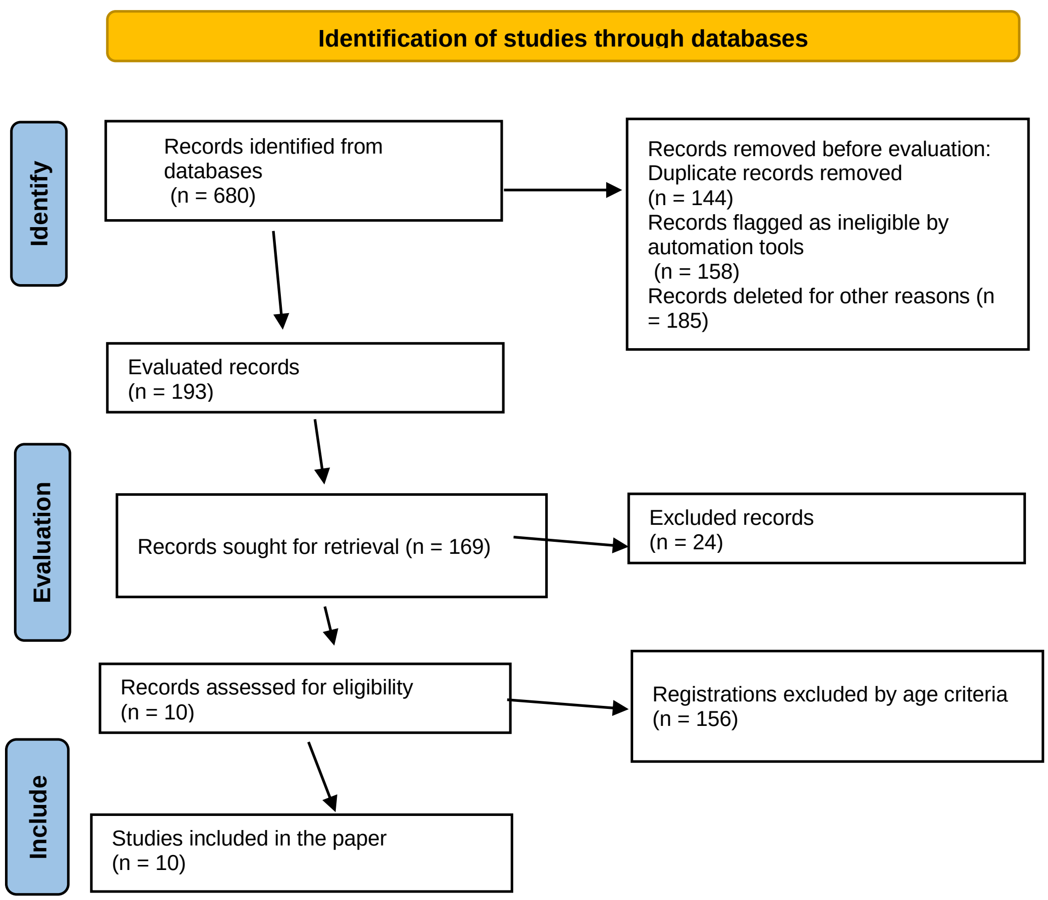

Fig.1 PRISMA 2020 flow chart

Results

The PRISMA flow chart (Fig. 1) illustrates the systematic literature search process and revealed 680 potentially suitable studies for balance analysis, after title screening and full text eligibility analysis, a total of 10 articles remained suitable for inclusion. These articles were published in 2011 (n=1; 10%), 2013 (n=1; 10%), 2014 (n=1; 10%), 2015 (n=2; 20%), 2018 (n=1; 10%), 2019 (n=2; 20%), 2020 (n=2; 20%). There is an increasing trend in the number of articles published on this topic in 2020, some of which are research studies designed by comparing control and experimental groups. Characteristics of the 10 included studies that compared balance performance measures in boys and girls, two examined static stationary balance variables, two studies examined dynamic stationary balance outcomes, and six studies assessed both static and dynamic balance. Data from a total of 1549 subjects were eligible for analysis, including 865 boys and 684 girls.

The quality assessment showed that the majority of the included studies met most of the assessment tool criteria for these studies (age, sex, height and weight). In detail, 5 out of 10 studies met the criteria in terms of quality of study reports, 2 out of 10 studies met only the age and sex criteria, and 3 out of 10 studies met the age height and weight criteria, thus most studies met the above average criteria.

Correlations showed that balancing in static conditions is strongly associated with the ability to perceive and process visual information. Feedback-based balance control under dynamic balancing conditions depends on the motor response to destabilization of the pelvic axis. This suggests the use of a feedforward control strategy. Therefore children have the ability to select different balance strategies (feedback, feedforward or both) depending on the constraints of a given task (Butz et al. 2015; Rodriguez-Negro & Yanci 2019).

The results of the measurements showing balance performance, in star, right-footedness in boys are significant in terms of intergroup, intragroup and group*test relationships, and the results of the measurements showing balance performance, in star, left-footedness in boys are significant in all parameters except the results of the lateral direction measurements in terms of intergroup, intragroup and group*test relationships. Results of measurements showing right-footed star balance performance in girls are significant on the anterior direction compared in terms of intergroup, intragroup and group*test relationships, and results of measurements showing left-footed star balance performance in girls are significant for all parameters except results of measurements on the medial and posterolateral direction compared in terms of intergroup, intragroup and group*test relationships (Genc & Kizar 2020).

At the same time, the articles included in the research revealed that the mean and standard deviation values of participants' height, body weight, age, body mass index (BMI), anticipation time, and simple, auditory and choice reaction times are in a significant correlation with static and dynamic balance (Libardonia et al. 2018; Connera 2019).

Table I Results of selected studies

No	Author(s)	Group size	Methods	Results
1.	Harun Genc, Oktay Kizar (2020)	A total of 31 volunteer students aged 7 to 10 years participated in the study, 9 boys and 7 girls formed the experimental group (MEG and FEG) and 8 boys and 7 girls formed the control group	The distribution of descriptive characteristics of the participants (age, height and weight, body mass index - BMI) was determined. The study investigated whether there was a significant difference between the static and dynamic balance performance characteristics of the groups and the recorded values. Anthropometric measurements and balance tests, static (Flamingo test) and dynamic balance (Star balance test) were applied.	According to the values of the star balance test applied before and after exercise, a statistically significant increase was observed in both MEG and FEG ($p < 0.05$). In our study, a statistically significant increase was observed in both experimental groups (MEG and FEG) in both right and left leg tests, according to the values of the other balance test flamingo balance test (p <

		(MCG and FCG), the research lasted 8 weeks, 3 times/week.		0.05). A statistically significant increase was observed in the experimental groups (MEG and FEG) in both tests for both the right leg and the left leg according to the values of the Flamingo balance test ($p < 0.05$).
2.	Sarah M. Butz, Jane K. Sweeney, Mitchell J. Rauh, (2015)	A sample of 160 typically developing children aged 5 to 12 years was recruited.	The study was exploratory, using a correlational design to examine dynamic balance (DB) in children using 3 balance scales: the Pediatric Reach Test (PRT), the Pediatric Balance Scale (PBS) and the Timed Up and Go (TUG). The correlational design allowed identification of relationships between age, gender, and children's balance skills, with each participant performing the same 3 DB assessments in random order.	Mean PBS scores increased with increasing age between years 5 and 7 and then stabilized between years 8 and 12. Mean PRT scores also increased with increasing age, with the exception of ages 9 and 10. There was a significant negative correlation between age and balance scores on the TUG test, with children aged 5 taking longer to complete this test compared to 12-year-olds A significant positive correlation was found between age and balance scores on the PRT, with 5-year-olds achieving a shorter distance than 12-year-olds. Significant positive correlations were found between age and balance scores on the PBS for children aged 5 to 7 years, children aged 8 to 10 years and 11 to 12 years achieved the same value on the PBS.
3.	Luis Araya Guzmán, Freddy Vergara González, Iván Arias Jorquera, Hiff Fabré Oyaneder, Mario Soxo Campoverde, Cristóbal Muñoz Bornand (2014)	The sample consisted of 92 first graders, 49 of whom belonged to a municipal school and 43 to a subsidized private school, and an inclusion-exclusion protocol was used to select the sample, which consisted of the following ages between 6.0 and 6.9 years, and no motor disabilities (hemiplegia, paraplegia, etc).	Balasch Static Equilibrium Test and Balasch Dynamic Equilibrium Test were used to collect information using the observational method, the research had a descriptive non-experimental quantitative design, and the nonparametric Mann-Whitney U test was used to compare groups.	The results show significant differences ($p<0.05$) in favour of the municipal school in the static balance test, while the opposite is true in the dynamic balance test for the subsidized private school students which shows statistically significant differences ($p<0.05$).

4.	Josune Rodriguez-Negro, Javier Yanci (2019)	The study involved 253 pupils in grades 2 to 5 of primary school in a public school, of whom 110 were boys and 143 girls.	Static and dynamic balance tests were administered in two consecutive physical education sessions, in the first testing session, MABC-2 (Movement Assessment Battery for Children) and Standing Barza (Stork) static balance tests were administered and in the second session, MABC-2 dynamic balance tests were administered.	In the static balance tests there were significant differences between boys and girls in the MABC-2 static test and in the standing Barza (Stork) test with the foot), but not in the standing Barza (Stork) test with the left foot. In the dynamic balance tests there were no differences between boys and girls in any of the dynamic balance tests, neither in the MABC-2 dynamic step test nor in the one-legged jumping test.
5.	Sinan Bozkurt, Oya Erkut, Orkun Akkoç (2017)	A total of 23 11 boys and 12 girls aged between 10 - 12 years, average height was 142.78 cm and average weight was 37.6 kg volunteered for this study, Participants were those who had no neurological diseases, vestibular visual impairment, lower limb injuries or orthopaedic problems and who did not regularly participate in sports apart from a two-hour physical education lesson per week.	The aim of this study is to investigate the relationship between anticipation time, reaction time and balance characteristics. Anticipation time was measured with Lafayette Instrument Company's Bassin Anticipation Timer Model 50575, participants' visual and auditory reaction times were measured using the Newtest (Model 1000), the Y-Balance test was used to measure dynamic balance, and subjects' balance performance was measured using the Balance Error Scoring System (BESS).	Descriptive statistics and the relationship between equilibrium parameters, anticipation time and reaction time were investigated using multiple correlations. The significance level considered was ($p<0.05$). Significant relationships were found between auditory reaction time and 5 mph anticipation time and static and dynamic balance ($p<0.05$), between 3 mph anticipation time and auditory reaction time and reaction time of choice ($p<0.05$), between reaction time of choice and simple reaction time and auditory reaction time ($p<0.05$).
6.	J. García-Liñeira, J.L. García-Soidán, V. Romo-Pérez & R. Leirós-Rodríguez (2020)	This descriptive, cross-sectional study involved 70 healthy children (50% girls) aged between 9 and 12 years. All of them had to complete three times four challenges:	Anthropometric measurements were taken, mass index (BMI) was calculated for each participant, and an accelerometer (GT3+ Actigraph®, USA) was used to measure balance, being chosen because it is triaxial and was placed in the medial lumbar area, specifically coinciding with the fourth lumbar vertebra reflecting CG behavior.	The results show that the tests in older children had a higher internal consistency than those in younger children (vertical axis $r = 0.82$, sagittal axis $r = 0.77$ and perpendicular axis $r = 0.74$). Tests in children aged 8 years or older showed a strong correlation between samples ($r > 0.71$). The three static balance tests obtained reliability values between

		one-legged balancing with eyes closed and eyes open, one-legged dynamic balancing on a foam mat and normal walking.		0.76 and 0.84. In contrast, the gait test obtained lower and weaker results (0.6 < r < 0.71).
7.	Cillin Condon & Katie Cremin (2013)	The sample consisted of 534 pupils aged 4 to 15 years.	Balance was tested with 6 control trials as well as performing a standing long jump. The children were grouped according to age ranges each age group was tested using the Kolmogorov-Smirnov tests. Height, weight, gender and muscle strength were correlated with balance tests and Mann-Whitney U tests were performed for gender differences.	The balance was tested with 6 control attempts, as well as with a long jump in the legs. The children were grouped according to age ranges, each age group being tested using Kolmogorov-Smirnov tests. Height, weight, sex and muscle strength were correlated with balance tests and Mann-Whitney U tests were performed for gender differences.
8.	Andreea - Gabriela Lazăr (2018)	The experiment was carried out on 30 children aged 6 to 7 years, divided into two groups: an experimental group of 14 children and a control group of 16 children.	The Bruininks-Oseretsky balance assessment tests were used to assess static and dynamic balance: Standing on one foot on the floor. Standing on one foot on a balance bar. Standing on one foot on a balance bar with eyes closed Walking on a line drawn on the floor. Walking on a balance bar.	This research revealed that the results obtained by the experimental group improved the psychomotor components (static balance, dynamic balance) following the use, between the initial and final tests, of movements to music.
9.	Krzysof Graff, Ewa Szczerbik, Malgorzata Kalinowska, Maciej Jaworski Malgorzata Syczewska (2019)	The study involved 228 healthy subjects aged 6 to 18 years (111 boys and 117 girls).	Balance was assessed using the AMTI Accu-Sway Plus ACS platform with Balance Clinic software 1.4.2 All subjects underwent six balance tests: sitting still for 30 s, maximum voluntary body sways in the sagittal plane (antero-posterior - AP test) for 30 s and in the frontal plane (left-right, medio-lateral ML test) for 30 s, these tests were assessed in two situations: eyes open and eyes closed.	In the quiet standing position with eyes open, the median values of the assessed balance parameters showed better balance control in girls than in boys. The results showed lower values of left and right, forward and backward voluntary sways and sway ranges in the AP and ML planes in girls than in boys in all age groups, and no statistically significant differences between the sexes in the eyes-closed test.
10.	Biljana Popeska, Snezana Jovanova - Mitkovska și Kiril Barbareev (2015)	The research was conducted on a sample of 123 boys aged 7 years old, second grade students at five primary schools in Skopje, Republic of Macedonia.	Students were tested on three motor tests used to estimate balance. The following tests were used: Walking on an overturned Swedish bench (RAOSK), Sitting on the narrow side of the bench, sideways (RASKS) and Sitting on the narrow side of the bench lengthways (RASKD). Discrimination, skewness and homogeneity were determined using measures of trend and	The shift from the normal distribution is observed in the tests applied to estimate balance: sitting on the narrow side of the bench, sideways (RASKS) and sitting on the narrow side of the bench lengthwise (RASKD). The values of Spearman-Brown and Cronbach's α reliability coefficients (from 0.89 to 0.93) for all three

			dispersion, and reliability was estimated based on the reliability coefficients Cronbach α and Spearman-Brown`s (SB) p, (coefficients greater than 0.80 are considered significant).	tasks indicate high reliability in the applied tests.

Discussions

Physical activity is important for children's healthy growth and development having a positive effect, and medium level exercises increase children's motor strength such as endurance, strength, flexibility and balance The results obtained in the present study are similar to those found by Ruiz & Richardson (2005), who also obtained better results for girls in terms of static balance, but did not obtain gender differences in terms of dynamic balance in students over 9 years old. Quitério et al. (2018) also found no differences in dynamic balance in students aged 6-7 years.

There is increasing evidence that indicates a critical transition period for the maturation of postural control from the ages of 6–7 years. Suggested that this transitional period may be explained by a change from a ballistic toward a sensory strategy, but the cause remains unknown (Blanchet et al., 2019).

Age was the best predictor explaining the balance score in all SOT (sensory organization test) conditions. When the weight variable was added as a predictor, there was reduced variability in SOT balance scores. Cumberworth et al. (2007), used SOT to assess balance in children, finding no correlation with height and weight, and Nolan et al. (2005), suggested that although postural stability may be partially modified by changes in height and weight, age is the variable responsible for the development of the visual, somatosensory and vestibular systems. Age-related changes due to maturation were found in the study by Rival et al. (2005), who concluded that full maturity of the sensorimotor systems that control balance is not reached until children are 10 years old.

With increased experience and changing muscle torque regulatory abilities, balance skills became more robust (Roncesvalles et al., 2010).

Conclusions

Assessment of static and dynamic balance using motor assessment batteries does not require a large infrastructure or space to perform, provides information about the current state of balance of the assessed subject, is inexpensive and easy to apply. The knowledge of the subjects under study on static and dynamic balance, helps to plan and design an intervention appropriate to their psychomotor and functional conditions related to body balance which is very applicable in school context. It is necessary to recognize the relevance of the instrument to be used, as well as the use of the equipment and the methodology to be used, because through the chosen means particular information is provided to identify the degree of effectiveness of the instrument, the participation of the subject to be assessed, as well as the information to be collected, which is indispensable in the process corresponding to the intervention.

Balance control during the performance of various activities in children is not only an age-dependent process associated with neural maturation, but is also associated with task or environmental constraints, with children being able to select different balance strategies depending on the constraints of a given task. Balance can be predicted by age, as there was a strong association between this variable and balance scores.

The relationships between balance and other motor skills and the impact of regular physical activity on the maintenance of different types of balance is one of the main reasons why this motor skill should be improved and developed during the process of teaching physical education using physical education content.

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