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Director: Fernando Emilio Valladares Fuente

Email: fernando.valladares@upr.edu.cu

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Original article

## The strength growth rhythms in Ecuadorian children from 6 to 12 years old, male and female gender

Los ritmos de crecimiento de la fuerza en niños ecuatorianos de 6-12 años, sexo masculino y femenino

Taxas de crescimento de força em crianças equatorianas de 6-12 anos de idade, sexo masculino e feminino

Paul Isaías Marcillo Iza<sup>1\*</sup>  <https://orcid.org/0000-0001-9363-3437>

Jorge Washington Tipán Gualotuña<sup>1</sup>  <https://orcid.org/0000-0002-7470-6087>

Edgardo Romero Frómeta<sup>1</sup>  <https://orcid.org/0000-0001-5991-9327>

<sup>1</sup>University of the Armed Forces ESPE. Ecuador.

\*Corresponding author: pimarcillo@espe.edu.ec

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## ABSTRACT

For the selection of probable sports talents, several determination procedures have been presented with indicators, based on physical capacities, including strength. Strength makes it possible to oppose endurance by means of muscular tension. This is a physical capacity, the basis of sports performance, so it is useful to establish its evolution in the stages of sports initiation from a specialized methodological perspective. Therefore, the purpose of the research is to determine the dynamics of the growth times of the strength capacity, in the age group between 6-12 years old in both genders. A descriptive-analytical type of research is used, three strength determination tests are applied (jump without impulse running, 30s abdominals and 30s elbow flexion) to a representative sample of 412 girls and 633 boys between 6-12 years of age from the 24 provinces of Ecuador, determining the growth rates of the physical capacity of strength in Ecuadorian children in the mentioned age range, both genders.

**Keywords:** Strength; Tempos; Growth; Ecuadorian infants; Age groups; Sports initiation.

## RESUMEN

Para la selección de probables talentos deportivos, se han presentado diversos procedimientos de determinación con indicadores, a partir de las capacidades físicas, incluyendo la fuerza. La fuerza permite oponerse a una resistencia por medio de una tensión muscular. Esta es una capacidad física, base del rendimiento deportivo, por lo que es útil establecer su evolución en las etapas de iniciación deportiva desde una perspectiva metodológica especializada. Por ello, el propósito de la investigación es determinar la dinámica de los tiempos de crecimiento de la capacidad de fuerza, en el grupo etario entre 6-12 años de edad en ambos géneros. Se emplea una investigación de tipo descriptivo-analítica, se aplican tres *test* de determinación de fuerza (Salto sin carrera de impulso, Abdominales en 30s y Flexiones de codo en 30s) a una muestra representativa de 412 niñas y 633 niños entre los 6-12 años de edad de las 24 provincias del Ecuador, determinándose los ritmos de crecimiento de la capacidad física de fuerza en niños ecuatorianos en el rango etario mencionado, ambos géneros.

**Palabras clave:** Fuerza; Tempos; Crecimiento; Infantes del Ecuador; Grupos etarios; Iniciación deportiva.

## RESUMO

Para a escolha dos prováveis talentos desportivos, foram apresentados vários procedimentos para a determinação de índices baseados nas capacidades físicas, entre os quais, a força. A força torna possível opor resistência por meio de tensão muscular. Esta é uma capacidade física, a base do rendimento desportivo, e é por isso que é útil para estabelecer a sua evolução nas fases de iniciação desportiva a partir de uma perspectiva metodológica especializada. Por conseguinte, o objectivo da pesquisa é determinar a dinâmica dos tempos de crescimento da capacidade de força no grupo etário entre os 6-12 anos de idade em ambos os sexos. É utilizado um tipo descriptivo-analítico de investigação, aplicando três testes para determinar a força (saltos sem corrida de impulso, sit-ups em 30s e flexões de cotovelo em 30s) a uma amostra representativa de 412 miúdas e 633 rapazes entre os 6-12 anos de idade das 24 províncias do Equador, determinando as taxas de crescimento da capacidade física de força das crianças equatorianas na referida faixa etária, ambos os sexos.



**Palavras-chave:** Força; Tempos; Crescimento; Crianças equatorianas; Grupos etários; Iniciação desportiva.

## INTRODUCTION

The success of obtaining high performance athletes in the future in any sport discipline begins with the search and selection of potential sports talent, (Frómeta, Cuayal, & Jácome, 2019; Calero-Morales, 2019), such process is initiated through physical activity and Physical Education that the infant performs outside or within their school schedule (Morales. & Taboada, 2011; Calero & Suárez, 2005).

The selection of potential sports talent over the years has presented several selection techniques with indicators directly related to physical capacities, such as strength, endurance and speed, among others (Lidor, Côté, & Hackfort, 2009; Tipán & Morales, 2018; Díaz Cevallos, et al., 2017), applied to the desired specialty, being eminently a discard system to avoid training individuals who do not possess the necessary sports skills, which prevents the waste of resources and time allocated to this process by the organizations involved (GarcíaJaime, 2020; Calero., 2012).

Such identification in question focuses on the use and application of tests to study and determine physical and hormonal aptitudes in a specific physical cycle, which make up sports activities close to a focused and high performance practice, in order to promote the talent found (Viru & Viru, 2003; Flores Abad, Arancibia Cid, & Calero Morales, 2014; Flores, Calero, Arancibia, & García, 2014).

The research project of the *Standards for massive detention of potential sports talent in Ecuador*, carried out by researchers such as Romero Frómeta, Chavés Cevallos, Vaca Garcías, Bellacallao Ramos, & Vinueza Tapia, (2014), lays the foundations for the location and detention of potential sports talent, where batteries are established that can be applied to each specialty, some of them published, (Sánchez & Romero, 2018; Altamirano, Trujillo, Tocto, & Romero, 2015; Rubio, Sevilla, & Romero, 2018; Barcia, Alvarado, & Frómeta, 2018; Egas & Romero, 2018; Puente & Romero, 2016) in which sports performance scales are prioritized, with emphasis on anthropometric aspects (Caro, et al., 2019; Maldonado Vaca & Morales, 2017).

In this sense, the anthropometric tests of each specialty, as is the case of the *Basic anthropometric indicators for the detection of potential talent in Ecuadorian taekwondo of both sexes*, carried out by (Rubio, Sevilla, & Romero, 2018), allow those selected who present physical and anthropometric conditions superior to the rest to specialize in a better way in their sports performance, obtaining probabilistically greater achievements in the long term.

Strength training in children is a topic that is constantly debated due to a wide variety of opinions, regarding the benefit or harm of it, as well as the limits and possibilities. This is because there is a popular link between strength training and growth problems, but scientific evidence shows that children and young people who do adequate strength training develop better muscle tone. In addition, muscular endurance is increased, preventing injuries and improving performance in sports activities (Pastor, 2007, p. 4).



The problem lies in knowing what is the correct training in a given age range, since biological maturity presents different evolutionary stages and with it different rhythms of strength. Based on this, an investigation is presented to analyze and describe the rhythms of strength increase in Ecuadorian children aged 6-12 years in the male and female gender, because in this environment there is little exploration and specific data that denote how strength evolves naturally according to age. In addition, it should take into account the anthropometric indices of Ecuadorian boys and adolescents, which is not equal to that of other territories due to ethnic differentiation.

In the exploration on the *Trend of the increase in speed, strength and endurance in infants of Ecuador from 8-12 years old, Morales, Pila Hernández, & Fleitas Diaz, 2014*) mention in the analysis on talent selection, aspects of the rates of increase in physical preparation focused on explosive strength in extremities; it is concluded that this increases in proportion to its maturation. In this situation, values are determined, which have to do with the lapse of each sensitive stage in which infants go through. For this reason, *Moraes & Romero (2005)*, in their research, clarify that the first thing to highlight in order to obtain an optimal selection of probable talents is to differentiate the biological properties of the ages in question.

On some occasions, children and young people may use training to improve their appearance, but it merits the proper selection of proper training elements to achieve realistic objectives conducive to the age and type of sport practiced, "a correct strength training aimed at children and adolescents, therefore, uses all imaginable forms of training against resistance, whose content should be selected and structured according to its objective" (*Frölich, et al., 2010*, p. 7).

The problem lies in knowing, which is the adequate training for the age, as well as the physical components of children, since they have different characteristics each year of their life and, with this, different strength rhythms. On this basis, a research is proposed to analyze and describe the rhythms of growth of strength in Ecuadorian children from 6 to 12 years old, male and female. This sample is selected because it is in this area where there is a lack of research and specific data showing how strength evolves naturally according to age. By knowing these elements, it will be possible to produce better training plans for children, because in this way it will not be possible to incur in the damages of a poorly designed and inadequate training to the capabilities of young athletes.

In this sense, (*Harre, 1983*) mentions

"...the rate of increase of performance allows to deduce if the learning capacity and training possibilities of the young athlete exceed the average in the sport he/she has chosen"; the definition of growth time is taken into consideration as a measure that allows to quantify the development of a motor capacity in a determined time, besides knowing the values to be obtained in the sport selection batteries. In this process, we get to know values of strength growth, allowing the analysis of the maximum development of its capacity". (p. 85).

When it comes to children, it is important to understand their growth patterns, because organically children go through an evolution of physical changes, related to height, reach, body weight and muscle tone, until approximately the end of puberty. At this age, hormonal, physiological and neuronal changes also occur in each age range. Training should contemplate all the variables of this process in order to condition the child without



negatively affecting his growth. Similarly, the physical changes that exist are different in females than in males, as the presence of different hormones highly influences this.

For males, the hormones released at puberty favor increased muscle tone. For females, the distribution of growth is concentrated in certain areas such as the hips. Throughout the process from childhood to puberty, the increase in muscle mass does not stop, which becomes total between the ages of 16 and 20 years for females and 15 to 18 years in males (Rhodri & Faigenbaum, 2017, p. 314). It should also consider the anthropometric indices of Ecuadorian children and youth, which is not equal to those of other countries due to ethnic differentiation (Sánchez & Romero, 2018).

Frómeta., Peralta, & Iza, 2019, in their research about the *Trend of growth in speed, strength and endurance in infants from Ecuador aged 8-12 years*, referred Morales, Pila Hernández, & Fleitas Diaz, 2014 and their study carried out on talent selection, where they analyzed the rhythms of growth in physical preparation, focused on the strength-explosive in lower limbs. From here they conclude that strength increases in proportion to their maturation and growth, which determines values that have to do with the period of each sensitive phase that infants go through. The male sex, due to the presence of the hormone testosterone, develops a greater increase in muscle mass than the female sex and, as age advances, this difference becomes even slightly greater.

Espinoza, 2004 in his research "*Practical guide for the anthropometric evaluation of growth, maturation and nutritional status of children and adolescents*" gives us a preamble about the tempos of growth, which not only depend on the genetics of the child, but the interaction with environmental factors, where he grows and how these influence negatively or positively on him. In this way, it can be stated that having a control of these factors, when a possible sports talent has been chosen in any discipline to practice, it will be essential to know what can be changed for a better future projection.

On the other hand, (Morales & Romero, 2005) in their research, clarifies that the first thing that should be emphasized to obtain a selection of possible talents in a suitable way is to distinguish the biological characteristics of the ages in question. Therefore, throughout an exhaustive review of the subject, it was possible to obtain clarification regarding the comments of physiologists who have referred to the characteristics of the school age, which give great importance to the improvement and coordination of movements, therefore, they indicate as an ideal rule, to start a sports practice at an early age.

The National Sports Federation of Ecuador (Fedenador) has a sports selection system and a study already conducted of the growth rates in strength, speed and endurance, covering the ages between 8-12 years of male and female, but this analysis is still incomplete as there are other age ranges of importance for the selection process of potential talents, (Morales S., 2014). Therefore, the purpose of the research is to determine the dynamics of the growth tempos of strength capacity in the age group between 6-12 years of age, both genders.



## MATERIALS AND METHODS

The research is considered to be descriptive and analytical, therefore, its orientation is of mixed type. The mass screening tests include the following test batteries:

1. Jump without impulse run (cm).
2. Crunches in 30 seconds (reps/time).
3. Elbow push-ups in 30 seconds (reps/time).

Based on simple random sampling, 70 healthy girls between 6 and 8 years old, 139 between 9 and 10 years old and 203 between 11 and 12 years old were studied, for a total of 412 girls from the 24 provinces of Ecuador, being this sample representative of the population. In the case of boys, 66 children between 6 and 8 years old, 173 between 9 and 10 years old and 394 between 11 and 12 years old (total 633 children) were studied, making the sample representative of the population under study. The records and processing of the information were carried out by five specialists in the branch of study, and the levels of effectiveness in the records of the information of interest were evaluated at all times.

The data obtained are represented by the mean and standard deviation, being processed by means of the Excel spreadsheet. To obtain the relative and percentage tempo values, the upper age group was subtracted from the lower age group; this was represented by the  $\Delta X$  (delta X) to obtain the growth tempo from one age group to another.

## RESULTS AND DISCUSSION

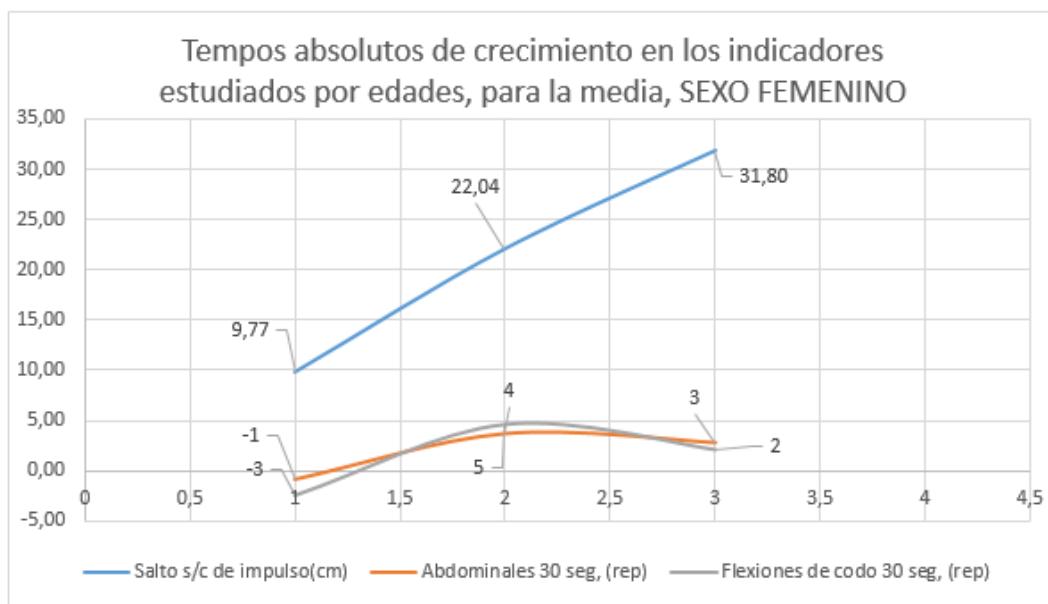
Table 1 shows the data obtained by the female sex in the strength tests applied. For the jump without impulse running, a growth is observed as the age advances, starting at 123.78 cm (6 a 8) and as maximum reached of the studied ages of 155.58 cm (11-12); for the abdominal test in the age group of 6-8, they reach 19 rep in the average, but when reaching the age group of 9-10, they present a decrease of repetitions with 18 rep, later in the age group of 11-12, the value rises again, surpassing with 21 rep; The last test presents a similarity with the results in the same age groups, from 6 to 8 they reach 19 repetitions, from 9 to 10 the value drops to 17 repetitions, and again this value rises to 21 repetitions in the age group from 11 to 10, and then to 21 repetitions in the age group from 11 to 10. 12 (Table 1).



**Table 1.** - General results for each of the indicators studied by age group for the mean, female sex

Indicators	Age groups		
	6 - 8	9 - 10	11 - 12
Jump without impulse stroke (cm)	123.78	133.55	155.58
Crunches in 30 seconds	19	18	21
Elbow bends in 30 seconds	19	17	21

Figure 1 shows the values of the growth rate of the strength of one age group with another. For the first jump *test s/c*, in the first age group of 6-8 with that of 9-10, the growth is 9.77 cm; for the group of 9-10 with that of 11-12, the growth value is 22.04 cm and the growth presented from 6-8 with 11-12 is 31.80 cm, which evidences the development presented by these ages (Figure 1).



**Fig. 1.** - Absolute growth rates in the indicators studied by age for the mean, female sex

In the crunch *test*, in the age group of 9-10, there is a decrease in the growth of strength, then from 11-12, the growth rises again. In the age groups of 6-8 with 9-10, there is a decrease with -1 rep and for 9-10 with 11-12, the growth is 4 rep, ending with the age group of 6-8 years with 11-12 years, the value reached is 3 rep. For the elbow flexions, the same situation is presented, from 6-8 years with 9-10 the value is -3 rep, (it does not present growth but decrease), while 9-10 with 11-12 there is a notorious growth of 5 rep and the value of growth from 6-8 years with 11-12 years is 2 rep.



Table 2 shows the relative percentage tempo, which is so for the first jump *test* s/c the age group of 6-8 years with that of 9-10 years present a 7.89 % in growth and the age group between 9-10 years with 11-12 years is 16.58 % and the growth that is presented from 6-8 years with 11-12 years is 20.44 % (Table 2).

**Table 2.** - Relative percentage growth rates in the indicators studied by age, for the mean, female sex

Trend	Age groups		
	ΔX6A8-9A10	ΔX9A10-11A12	ΔX11A12-6A8
Jump without impulse stroke (cm)	7.89	16.50	20.44
Crunches in 30 seconds	-4.94	21.10	13.13
Elbow bends in 30 seconds	-13.14	27.43	9.66

In the second *test*, the comparison of the age group 6-8 with 9-10 years presents a decrease of -4.94 % on average, but the value increases in the age range between 9-10 years with 11-12 years by 16.50 %, being the difference in growth from 6-8 years with 11-12 years of 13.13 % growth.

The third flexion *test* applied to the female sex shows the following values in the comparison of the age groups 6-8 with 9-10 years, a high decrease of -13.14 %, while the growth of the age group 9-10 with 11-12 years rises by 27.43 %, ending with the age range from 6-8 years with 11-12 years where there is a 9.66 % growth in strength.

Table 3 refers to the data obtained in the strength *tests*, which, when processed in the different performance evaluation tests for the male sex in the different age groups studied, yielded the following results (Table 3).

**Table 3.** - General results for each of the indicators studied by age group for the mean, male sex

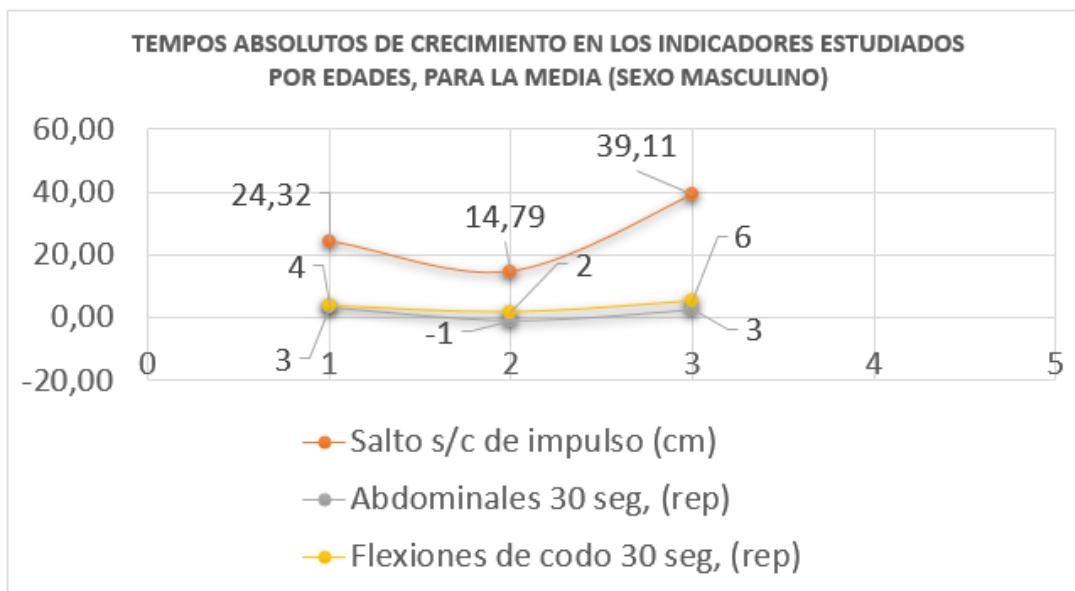
Indicators	Age groups		
	6 - 8	9 - 10	11 - 12
Jump without impulse stroke (cm)	115.77	140.09	154.88
Crunches in 30 seconds	16	19	18
Elbow bends in 30 seconds	13	17	18

For the jump *test* without impulse running measured in (cm), there is a very noticeable increase, evidenced in the marks (Table 3), from 115.77 cm (6 to 8 years old) to 140.09 cm (9 to 10 years old); Therefore, a much higher mark in the age group (11 to 12 years)



with 154.88 cm, in addition, it is the case of the abdominal test with a higher mark in the age group of 9-10 years (19 repetitions), than the slightly different data in age groups 6-8 years with (16 repetitions). Therefore, ages 11-12 years with (18 repetitions). In the case of the elbow flexion test, the second best average is obtained in ages 9-10 years with (17 repetitions), which decreases to 13 repetitions in ages 6-8 years, being the best average in this *test* in the age group 11-12 years with (18 repetitions), the same repetitions as in the abdominal test.

Figure 2 shows the values of the tempo of growth of the strength of an age group with another; for the first *test* of jumping s/c, in the first age group of 6-8 years with the 9-10 years the growth is 24.32 cm; for the group of 9-10 with the 11-12 years, the value of growth is 14.79 cm and the growth that is presented from the 6-8 with 11-12 years is 39.11 cm, showing the development that they present in these ages (Figure 2).



**Fig. 2.** - Absolute growth rates in the indicators studied by age, for the mean, male sex

In the crunch *test* of the 6-8 age groups with the 9-year-olds, there is a growth of 3 rep and for the 9-10 years with 11-12 years there is a decrease of -1 rep, ending with the age range between 6-8 years with 11-12 years the value reached is 3 rep. For the elbow flexions, the same situation is presented, from 6-8 with 9-10 years the value is 4 rep, presenting a decrease of 2 rep in age groups of 9-10 with 11-12 years and, consequently, there is a notorious growth of 6 rep in the age groups of 6-8 with 11-12 years.

The table 4 shows the relative percentage tempo, being thus that for the first *test* of jump s/c of impulse the age group of 6-8 with that of 9-10 years presents a 21.01 % in growth, consequently, in the age group of 9-10 with 11-12 years is of 10.56 % and the growth that is presented from 6-8 with 11-12 years is of 33.78 % (Table 4).



**Table 4.** - Relative percentage growth rates in the indicators studied by age, for the mean, male sex

Trend	Age groups		
	$\Delta X_{6a8-9a10}$	$\Delta X_{9a10-11a12}$	$\Delta X_{11a12-6a8}$
Jump without impulse stroke (cm)	21.01	10.56	33.78
Crunches in 30 seconds	21.30	-4.03	16.41
Elbow bends in 30 seconds	31.00	10.63	44.92

In the second test, the comparison of the age group 6-8 with 9-10 years presents a percentage growth of 21.30 % on average, but the value decreases from 9-10 years with 11-12 years by -4.03 %, being the difference of growth from 6-8 with 11-12 years of 16.41 % growth.

The third flexion test applied to the male sex shows the following values in the comparison of the age groups of 6-8 years with 9-10 years a high decrease of 31%, while the growth of the age group of 9-10 years with 11-12 years decreases to 10.63 %, ending from 6-8 years with 11-12 years an increase of 42.92 % of strength growth.

## CONCLUSIONS

In conclusion, it is summarized that in the present study there are differences in the tempos of the development of strength capacity in subjects between 6-12 years of age for both genders, compared with the studies conducted by [Morales, Pila Hernández, & Fleitas Diaz \(2014\)](#) on the standards for evaluating school talents in physical condition between 7-17 years in the State of Portuguesa, Venezuela, which merits a recommendation for the case of the physical capacity of explosive strength, to establish a future comparison between both nations in the age range under study. Similarly, the background information consulted on the growth rates of speed, strength and endurance by [Frómeta, Peralta, & Iza, \(2019\)](#) for the case of the strength capacity, could serve as comparative data to be taken into account in the future, establishing the necessary characteristics in the age range under study with a view to generalizing results that contribute to the design of methodologies for the search and selection of talents. In this sense, and according to the general objective of the research, the growth rates of the physical capacity of strength in Ecuadorian children between 6-12 years of age, both genders, are established.

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The authors declare not to have any interest conflicts.

#### Authors' contribution:

**Paul Isaías Marcillo Iza:** Conception of the idea, literature search and review, instrument making, instrument application, compilation of information resulting from the instruments applied, statistic análisis, preparation of tables, graphs, and images, database preparation, drafting of the original (first version), article correction, translation of terms or information obtained, review of the application of the applied bibliographic standard.

**Jorge Washington Tipán:** Conception of the idea, literature search and review, instrument making, instrument application, compilation of information resulting from the instruments applied, statistic análisis, preparation of tables, graphs, and images, database preparation, drafting of the original (first version), article correction, translation of terms or information obtained, review of the application of the applied bibliographic standard.

**Edgardo Romero Frómeta:** Conception of the idea, instrument making, instrument application, general advice on the topic addressed, drafting of the original (first version), review and final version of the article, article correction, authorship coordinator, review of the application of the applied bibliographic standard





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