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Normative Data of Handgrip Strength in Macedonian Children and Adolescents According to Chronological and Biological Age

Datos Normativos de la Fuerza de Prensión Manual en Niños y Adolescentes Macedonios Según la Edad Cronológica y Biológica

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SUMMARY: The handgrip strength is used as a means of individual's health prediction during life. It is used as an indicator of the nutrition status, bone fragility, presence of sarcopenia and it correlates with certain diseases and clinical complications. The research goal was to analyze the results of the hand dynamometry test, based on the chronological and biological age, and to offer normative and referent standards about children and adolescents from the Republic of North Macedonia. The study was conducted on a sample of 4031 respondents of both sexes at the age 6-14 years. In order to achieve the research goals, the measured characteristics were of the weight, height, sitting height and handgrip strength. The body mass index and biological maturity values (APHV) were obtained by using formulas. On the basis of the obtained results, it can be concluded that statistically significant differences in handgrip strength are established between the boys and girls of all age categories. Also, statistically significant differences between boys and girls are established in the hand dynamometry test of all APHV levels. In general, the use of the APHV allows a better categorization of the performance of the studied children and adolescents. With boys, the correlation between the chronological age and test was 68 %, and with girls - 77 %. The normative referent standards of the hand dynamometry test are presented in percentiles for both sexes. Thye hand dynamometry test's results during childhood and adolescence should be analyzed and interpret on the basis of biological age, and not on the chronological age. These tools can help specialists who work with children and adolescents in ethnic and epidemiological context.

KEY WORDS: Biological age; Maturity status; Handgrip strength; Children; Adolescents; Normative data.

INTRODUCTION

Handgrip strength (HGS) can be measured quickly and easily non-invasively, using portable hand dynamometers (Peolsson *et al*., 2001). The test is widely applicable in many areas of medicine and sports science in order to assess isometric muscle strength of the hand and forearm (Roberts *et al*., 2011). Since hand grip strength is positively correlated with the total muscle strength in young healthy subjects, the test can be used as an indicator of total body strength with this population (Wind *et al*., 2010). Handgrip strength has been used as a means of the individual's health predictor throughout their life (Ortega *et al*., 2012). It is used as an indicator of nutritional status, bone fragility and the presence of sarcopenia (Sayer *et al*., 2013). In addition, the test also correlates with certain diseases and clinical complications (Bohannon, 2001) and can predict mortality in both adults and children (Leong *et al*., 2015).

As a result, in the literature a growing number of studies are appearing proposing the use of normative reference standards to evaluate the results obtained from the hand dynamometry test throughout different stages of life and different regions in the world (Häger-Ross & Rösblad, 2007; Saint-Maurice *et al*., 2015; Ramírez-Vélez *et al*., 2017; Ortega *et al*., 2023). In general, normative reference standards are developed on the basis of chronological age. At the same time, it is widely accepted that the variation between individuals of the same chronological age during puberty is large (Iuliano-Burns *et al*., 2001), to our knowledge, there are very little research works which have defined normative reference standards for the hand dynamometry test based on biological age (Gómez-Campos *et al*., 2018; Bim *et al*., 2021).

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Namely, the study of handgrip strength in relation to chronological and biological age may provide relevant information. It can also help to prevent them confusing effects between and within individuals once chronological intensity and duration during puberty are identified for each adolescent since considerable variation could occur between individuals. The use of international normative reference standards is inadequate because they do not take into account the differences in physical characteristics, race, cultural and ethnic specifics between regions (Häger-Ross & Rösblad, 2007).

The hypothesis of this research is that the results obtained from the hand dynamometry test distributed according to chronological age may be confounded with biological maturation because girls mature approximately two years before boys (Malina *et al*., 2004). In this sense, the results of this study could help to develop normative reference standards for both chronological and biological age.

Therefore, the objectives of this research were the following: a) analysis of the hand dynamometry test results in relation to chronological age, b) analysis of the results of the hand dynamometry test in relation to biological age and c) proposal of normative reference standards for children and adolescents from the Skopje region in the Republic of North Macedonia.

MATERIAL AND METHOD

Participants. The research was conducted on a sample of 4031 children and adolescents from the Skopje region in the Republic of North Macedonia, aged between 6 and 14 years. The total sample of respondents was divided into two subgroups according to sex (subgroup n=2024 boys and subgroup n=2007 girls). These two subgroups were divided into nine groups, according to chronological age (6, 7, 8, 9, 10, 11, 12, 13 and 14 years). The average age of the respondents of both sexes was 10.1±2.4 years. The study included all students whose parents agreed to participate in the project, who were psychophysically healthy and who regularly attended physical and health education classes. The respondents were treated in accordance with the Declaration of Helsinki (Edinburgh 2013 revision). The protocols were approved by the Ethics Commission at the Ss. Cyril and Methodius University from Skopje. The measurements were carried out in March, April and May 2019, in standard school conditions of the regular classes of Physical and Health Education.

A**nthropometric Measures.** Anthropometric measurements were carried out according to the methodology of the International Biological Program (IBP), recommendations of the World Health Organization (WHO). Weight was measured using a medical decimal weighing scale. Height and sitting height were measured with a telescopic height measuring instrument (Martin's anthropometry). During the measurement, the children were in underwear and barefoot. Body mass index was calculated as body weight in kilograms divided by the square of height in meters.

HGS Measurement. Using a Takei TKK 5101 digital dynamometer (range, 1-100 kg), handgrip strength was measured. The handle is adjusted to provide an optimal grip for the child according to the hand size. Child squeezes gradually and continuously for at least 2 seconds, performing the test twice (alternately with both hands) allowing short rest between measures. The elbow must be in full extension and avoiding contacting with any other part of the body with the dynamometer, except the hand being measured. Both hands are measured twice. The best result is recorded in kilograms, accurate to 0.1 kg, e.g., a result of 24 kg scores 24.

Maturity State. Biological maturation was determined using the method proposed by (Mirwald *et al*., 2002). This is an indicator of somatic maturation that represents the maximum growth period in height during adolescence. Multiple regression equations by sex were used to estimate age at peak height velocity (APHV). Height, sitting height, leg length (height - sitting height), decimal age and their interactions were also included. Biological age was created based on one-year intervals represented as -6 to 2 APHV with boys and -5 to 3 APHV with girls. The used equations are:

Boys: Maturity status: APHV (years)
= -9.236 + ((0.0002708 x (leg length x sitting height)) + (-0.001663 x (age x leg length)) +
(0.007216 x (age x sitting height)) + (0.02292 x ((weight/height) x 100).

Girls: Maturity status: APHV (years)
= -9.376 + (0.0001882 x (leg length x sitting height)) + (0.0022 x (age x leg length)) + (0.005841 x (age x sitting height)) + (-0.002658 x (age x weight)) + (0.07693 x ((weight/height) x 100).

Statistical Analysis. The normal distribution of the variables was determined by the Kolmogorov-Smirnov test. Basic descriptive statistical parameters (arithmetic mean and standard deviation) were calculated for all variables. Sex differences were determined by Student's t-test for independent samples. To determine the relationship between chronological and biological age with the hand dynamometry test, a simple linear regression analysis (Pearson's coefficient and R2) was calculated. The reference standard percentiles for the hand dynamometry test results about each sex were formed by the LMS method. The method is based on the assumption that at each level of covariability the data has a normal distribution, where the percentiles for each age category are summed based on age specificities, and, in advance, the data is normalized using the Box-Cox transformation (symmetry correction) if necessary. Percentile reference standards and curves were created using the LMSChart Maker Pro version 2.3 software package (The Institute of Child Health, London). The following percentiles normative standards were calculated: p3, p10, p15, p25, p50, p75, p85, p90, and p97. For all of the cases, the significance was less than 1 %. All comparisons were performed using SPSS 22.0 for Windows (IBM Corporation, New York, NY, United States).

RESULTS

The anthropometric measures of body weight, height, sitting height and body mass index are shown in **Table I.** Body weight values were similar in both sexes at 6, 10, 11 and 12 years of age. From 7 to 9 and 13 and 14 years, boys show greater body weight values than girls ($p<0.001$). In body height, no statistically significant differences were determined between the two sexes at the age of 6 to 8 years and from 10 to 12 years. At the age of 9, 13 and 14, the boys show greater body height values than girls ($p<0.001$). At the age of 6, 10, 11 and 13 years, no statistically significant differences in sitting height between the two sexes were determined. At the age of 7, 8, 9 and 14 years, boys show greater values of sitting height compared to girls. However, at the age of 12, girls show higher values of sitting height compared to boys ($p<0.001$). Regarding BMI, no significant differences were found between the two sexes at the ages of 6, 10, 1 2, 13 and 14 years. At the age of 7, 8, 9 and 11 years, boys show higher values of body mass index compared to girls ($p<0.001$). Biological age (APHV) varied between -5.2 and 0.8 for males, and significant differences occurred in females for all age groups between both sexes.

The results' comparisons obtained from the handgrip strength test in both sexes in terms of the chronological age (CA) and biological age (APHV) are shown in Figure 1. The inspection of the graph shows that statistically significant differences in handgrip strength were determined between boys and girls in all age categories ($p<0.001$). Also, statistically significant differences between the boys and girls were determined in the hand dynamometry test at all APHV levels. In general, the use of the APHV allows a better categorization of the performance of the tested children and adolescents.

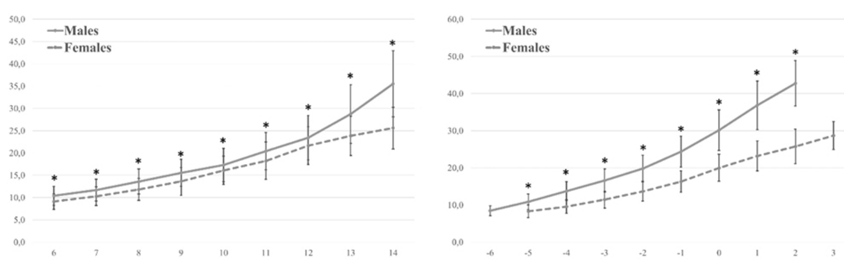

Fig. 1. Handgrip strenght arranged by chronological and biological age.

Table I. Anthropometric characteristics of the sample studied.

Age (years)	n	Body weight (kg)		Standing height (cm)		Sitting height (cm)		BMI (kg/m²)		Biological age (APHV)	
		X	SD	X	SD	X	SD	X	SD	X	SD
Males											
6.0-6.9	130	26.3	5.1	122.2	5.1	67.0	3.0	17.5	2.6	-5.2#	0.3
7.0-7.9	185	29.8#	7.4	126.9	6.1	69.5#	3.3	18.3#	3.4	-4.6#	0.4
8.0-8.9	237	32.9#	8.1	132.5	6.2	71.3#	3.4	18.5#	3.4	-4.0#	0.4
9.0-9.9	263	37.4#	9.0	138.0#	6.6	73.6#	3.4	19.5#	3.7	-3.4#	0.4
10.0-10.9	247	42.0	11.0	143.8	7.4	75.8	3.9	20.1	3.7	-2.7#	0.5
11.0-11.9	275	46.2	12.2	149.0	7.8	78.0	4.0	20.5#	4.3	-2.0#	0.6
12.0-12.9	229	51.1	13.3	155.3	8.0	80.7#	4.4	21.0	4.2	-1.2#	0.7
13.0-13.9	232	57.1#	13.3	162.4#	8.3	84.0	4.7	21.5	4.1	-0.3#	0.7
14.0-14.9	226	64.3#	13.3	169.4#	7.4	88.0#	4.2	22.4	3.9	0.8#	0.7
Females											
6.0-6.9	145	26.1	5.9	121.8	5.1	66.6	3.0	17.4	2.8	-4.2	0.4
7.0-7.9	240	28.0	6.3	126.2	5.6	68.2	3.0	17.6	3.1	-3.6	0.5
8.0-8.9	272	31.4	7.6	131.9	6.3	70.7	3.2	17.9	3.2	-2.9	0.5
9.0-9.9	247	35.3	9.2	136.8	6.9	72.7	3.7	18.6	3.7	-2.1	0.5
10.0-10.9	217	42.1	10.6	144.6	7.8	76.2	4.1	19.9	3.9	-1.1	0.6
11.0-11.9	251	44.5	10.6	149.8	7.3	78.6	4.0	19.6	3.7	-0.4	0.6
12.0-12.9	217	50.0	11.2	155.4	7.0	81.8	3.9	20.5	3.6	0.5	0.6
13.0-13.9	211	53.9	10.6	159.6	6.3	84.1	3.5	21.1	3.8	1.3	0.5
14.0-14.9	387	56.9	11.2	160.8	6.8	85.4	3.7	22.0	4.1	1.9	0.5

X: Mean. SD: Standard deviation. BMI: Body Mass Index. # Significant difference $p<0.05$.

The results of linear regression analysis (Table II) showed that chronological and biological age (APHV) are related to the handgrip strength test in children and adolescents of both sexes. In the male respondents, the correlation between chronological age and the handgrip strength test is 0.82 and it explains the common variability with 68 %, the correlation between biological age; and the handgrip strength test is 0.89 and explains 80 % of the common variability. In the female respondents, the correlation between chronological age and the handgrip strength test is 0.84 and explains the common variability with 70 %; the correlation between the biological age and the long jump test is 0.88 and explains the common variability with 77 %.

Table II. Relationship between handgrip strength and chronological and biological age for both sexes.

Biological age (APHV)	HGS (kg) n	L	M	S	P3	P10	P15	P25	P50	P75	P85	P90	P97
Males													
-6	18	0.5	8.2	0.2	5.5	6.3	6.6	7.2	8.2	9.3	9.9	10.3	11.4
-5	269	0.6	10.8	0.2	7.2	8.3	8.8	9.5	10.8	12.2	13.0	13.6	15.0
-4	362	0.7	13.6	0.2	9.0	10.4	11.0	11.9	13.6	15.4	16.3	17.0	18.6
-3	367	0.8	16.5	0.2	11.0	12.7	13.4	14.4	16.5	18.6	19.7	20.5	22.4
-2	346	0.8	19.9	0.2	13.4	15.4	16.2	17.5	19.9	22.3	23.7	24.6	26.9
-1	268	0.7	24.4	0.2	16.6	19.0	20.0	21.5	24.4	27.3	29.0	30.1	32.9
0	210	0.7	30.0	0.2	20.6	23.4	24.7	26.5	30.0	33.6	35.6	36.9	40.3
1	154	0.8	36.1	0.2	24.8	28.3	29.8	32.0	36.1	40.4	42.8	44.4	48.3
2	30	0.9	42.4	0.2	29.1	33.2	35.0	37.6	42.4	47.3	50.0	51.8	56.2
Female													
-5	35	0.4	8.0	0.2	5.3	6.1	6.5	7.0	8.0	9.1	9.8	10.2	11.4
-4	265	0.6	9.5	0.2	6.3	7.2	7.7	8.3	9.5	10.8	11.6	12.1	13.3
-3	357	0.7	11.4	0.2	7.4	8.6	9.2	9.9	11.4	12.9	13.8	14.3	15.8
-2	285	0.8	13.7	0.2	8.9	10.4	11.0	11.9	13.7	15.4	16.4	17.1	18.7
-1	268	0.9	16.4	0.2	10.8	12.6	13.3	14.4	16.4	18.5	19.6	20.4	22.3
0	263	0.9	19.8	0.2	13.1	15.2	16.1	17.3	19.8	22.2	23.5	24.4	26.5
1	297	1.0	23.0	0.2	15.3	17.8	18.8	20.3	23.0	25.7	27.2	28.2	30.6
2	215	1.1	26.0	0.2	17.4	20.2	21.3	23.0	26.0	29.0	30.5	31.6	34.2
3	22	1.2	28.8	0.2	19.6	22.6	23.8	25.6	28.8	32.0	33.7	34.9	37.6

L: Lambda. M: Mean and S: Sigma. biological age was calculated in years to estimate age at peak height velocity (APHV).

The distribution of the normative reference percentile values about the chronological and biological age are shown in Tables III and IV and in Figures 2 and 3. In both cases, the mean values increase as chronological and biological age increase.

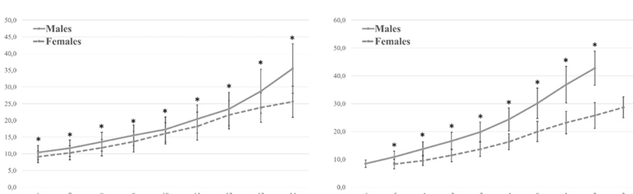

Fig. 2. Smoothed centile curves for handgrip strenght (P3, P10, P15, P25, P50, P75, P85, P90, and P97) by chronological age for males and females. The solid lines indicate P3, P10, P15, P25, P50, P75, P85, P90, and P97: Percentiles.

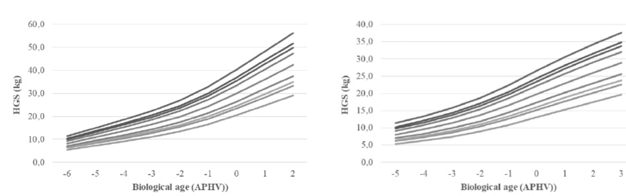

Fig. 3. Smoothed centile curves for handgrip strenght (P3, P10, P15, P25, P50, P75, P85, P90, and P97) by biological age for males and females. The solid lines indicate P3, P10, P15, P25, P50, P75, P85, P90, and, P97: Percentiles

Table III. Percentile values for handgrip strength by sex and chronological age.

Handgrip strength (kg)	Chronological age (years) R	R^2	SEE	p	Biological age (APHV) R	R^2	SEE	p
Males	0.82	0.68	5.02	0.000	0.89	0.80	3.96	0.000
Females	0.84	0.70	3.55	0.000	0.88	0.77	3.14	0.000

Table IV. Percentile values for handgrip strength by sex and biological age.

Chronological age (years)	HGS (kg) n	L	M	S	P3	P10	P15	P25	P50	P75	P85	P90	P97
Males													
6.0-6.9	130	0.6	10.3	0.2	6.6	7.7	8.1	8.9	10.3	11.7	12.5	13.1	14.5
7.0-7.9	185	0.7	11.7	0.2	7.5	8.8	9.3	10.1	11.7	13.4	14.3	15.0	16.6
8.0-8.9	237	0.6	13.4	0.2	8.6	10.0	10.7	11.6	13.4	15.3	16.4	17.2	19.0
9.0-9.9	263	0.6	15.3	0.2	9.7	11.4	12.1	13.2	15.3	17.5	18.7	19.5	21.7
10.0-10.9	247	0.6	17.3	0.2	11.1	12.9	13.7	14.9	17.3	19.8	21.3	22.2	24.7
11.0-11.9	275	0.5	20.1	0.2	12.9	15.0	15.9	17.3	20.1	23.0	24.7	25.9	28.9
12.0-12.9	229	0.4	23.7	0.2	15.2	17.7	18.8	20.4	23.7	27.3	29.3	30.8	34.4
13.0-13.9	232	0.4	28.5	0.2	18.3	21.2	22.5	24.5	28.5	32.9	35.4	37.2	41.8
14.0-14.9	226	0.3	34.0	0.2	21.8	25.3	26.8	29.2	34.0	39.3	42.4	44.6	50.3
Female													
6.0-6.9	145	0.4	8.9	0.2	5.9	6.8	7.2	7.8	8.9	10.2	10.9	11.4	12.7
7.0-7.9	240	0.6	10.2	0.2	6.6	7.7	8.1	8.8	10.2	11.7	12.5	13.1	14.6
8.0-8.9	272	0.7	11.8	0.2	7.4	8.7	9.3	10.1	11.8	13.5	14.4	15.1	16.8
9.0-9.9	247	0.7	13.6	0.2	8.5	10.0	10.7	11.7	13.6	15.7	16.8	17.6	19.5
10.0-10.9	217	0.7	15.9	0.2	9.9	11.7	12.5	13.6	15.9	18.2	19.5	20.4	22.7
11.0-11.9	251	0.7	18.4	0.2	11.6	13.7	14.5	15.9	18.4	21.1	22.6	23.6	26.1
12.0-12.9	217	0.8	21.1	0.2	13.5	15.8	16.8	18.3	21.1	24.1	25.7	26.8	29.5
13.0-13.9	211	0.8	23.6	0.2	15.3	17.9	18.9	20.5	23.6	26.7	28.4	29.5	32.4
14.0-14.9	207	0.9	25.8	0.2	17.1	19.8	20.9	22.6	25.8	29.0	30.7	31.9	34.7

L: lambda. M: mean. and S: sigma.

DISCUSSION

From the analysis of the handgrip strength test in relation to chronological age, it can be concluded that boys, unlike girls, show better results in all age categories, and these differences increase with age increasing. The greatest differences in the test result are observed at the age of 14 years (the boys achieve better results by 9.94 kg on average in contrast to girls), and the smallest differences in the test result are observed at the age of 6 years (boys achieve better results by 1.29 kg on average than girls). Similar results have been obtained in a number of previous studies dealing with this issue (Cohen *et al*., 2010; Tremblay *et al*., 2010; Ortega *et al*., 2011; Laurson *et al*., 2017). Also, when analyzing the results of the test in relation to biological age, it can be concluded that boys, unlike girls, in all biological age categories show better results in the test, and these differences increase with increasing biological age (APHV). Similar results were obtained in the research carried out by (Gómez-Campos *et al*., 2018).

Namely, the results of the research indicate that the use of chronological age has certain limitations when analyzing handgrip strength during the process of growth and biological maturation. Thus, the range of variability between individuals of the same chronological age during somatic growth is large, and is particularly pronounced during puberty (Iuliano-Burns *et al*., 2001).

Furthermore, research results indicate that biological age explains handgrip strength in higher percentages than chronological age. When biological age is used, the explanation for handgrip strength is 12 % greater in boys and 7 % in girls. The results indicate that biological maturation has a significant influence on the tests about muscle strength during puberty (Jones *et al*., 2000). Moreover, during adolescence, adipose tissue is predominant in girls, while muscle mass increases significantly in boys (Castilho & Barras Filho, 2000). In this connection, it is well known that sexual dimorphism in body composition is largely due to the action of sex steroid hormones. Previous research studies have established that sex differences in body composition are manifested from fetal life, and differences in estrogen and testosterone are evident before external signs of puberty appear, which results in value differences obtained by the hand dynamometry test.

As a result, the control of biological maturation is a powerful indicator for the classification of work groups, especially when it comes to variables related to physical capacities resistance, strength and speed (Malina *et al*., 2004).

Generally, the research results suggest that the diagnosis, classification, or monitoring of handgrip strength in children and adolescents may be more accurate if biological age is controlled. However, in clinical and epidemiological practice, professionals who deal with this problem tend to use international standards that are obtained from transversal research studies based on chronological age.

In this context, based on our results, normative reference standards have been defined by this study in assessing handgrip strength based on the chronological and biological age with children and adolescents from the Skopje region in the Republic of North Macedonia. These normative reference standards could help establish thresholds for identifying the strength levels for both sexes.

Namely, in the past few years, the evaluation of the palm dynamometry test has attracted considerable attention from researchers and health professionals. The palm dynamometry test is used as an indicator of nutritional status (Corish & Kennedy, 2000), sarcopenia and bone fragility (Dodds *et al*., 2014). Furthermore, the hand dynamometry test is used to control various types of trauma, congenital problems and degenerative diseases (Molenaar *et al*., 2008). It is also used to monitor health-related physical fitness (Ortega *et al*., 2012), including to provide important cultural information so as to make comparisons with other regional, national and international pediatric populations.

In general, the normative reference standards defined in this study can be used and include in physical education programs in the Republic of North Macedonia. They can also serve as a basis for developing comparative notes in the course of time. Their use and implementation are a reasonable alternative in terms of expenses and can be easily administered simultaneously to a large number of respondents.

In addition, the proposed normative reference standards can be used to compare individual parameters with those of a certain population and determine whether the individual falls into the appropriate category. In this context, the percentiles proposed in this study establish three categories (<p15 as low, p15 to p85 as acceptable, and >p85 as elevated). For example, lower percentiles are associated with instances of weakness and/or frailty and can give signals about health of children and adolescents. On the other hand, higher percentiles are associated with better strength levels. This shows greater participation in physical active (Cossio-Bolaños *et al*., 2016) and, as a result, a better level of of HGS performance.

Furthermore, it is necessary to point out that the data collection process was carried out by highly trained professional staff, using standardized measuring instruments and control of the measurement conditions in order to increase the validity and reliability of the measurements. This was a guarantee for a high degree of stability when performing the hand dynamometry test. In addition, the LMS method was used to create the percentiles of normative reference standards. This allowed smoothed curves and a more effective estimation of the extremes of the percentiles (Ku?aga *et al*., 2011). However, due to the simple regression analysis, it is possible that the obtained results show a certain regression error. This can be interpreted as a possible reverse causation. Therefore, these findings should be interpreted with caution.

CONCLUSION

Based on the obtained results, it can be concluded that the results obtained from the hand dynamometry test during childhood and adolescence should be analyzed and interpreted based on the biological age and not on the chronological age. However, despite this the percentile normative reference standards in the present study were defined about both chronological and biological age for the hand dynamometry test in students of both sexes. These tools can help professionals working with children and adolescents in ethnic and epidemiological contexts.

KASTRATI, A.; GASHI, N.; GEORGIEV, G. & GONTAREV, S. Datos normativos de la fuerza de prensión manual en niños y adolescentes macedonios según la edad cronológica y biológica. *Int. J. Morphol., 42(1)*:147-153, 2024.

RESUMEN: La fuerza de prensión se utiliza como medio para predecir la salud del individuo durante la vida. Se utiliza como indicador del estado nutricional, fragilidad ósea, presencia de sarcopenia y se correlaciona con determinadas enfermedades y complicaciones clínicas. El objetivo de la investigación fue analizar los resultados de la prueba de dinamometría manual, con base en la edad cronológica y biológica, y ofrecer estándares normativos y referentes sobre niños y adolescentes de la República de Macedonia del Norte. El estudio se realizó en una muestra de 4031 encuestados de ambos sexos con edades comprendidas entre 6 y 14 años. Para lograr los objetivos de la investigación, las características medidas fueron el peso, la altura, la altura al sentarse y la fuerza de prensión. El índice de masa corporal y los valores de madurez biológica (APHV) se obtuvieron mediante fórmulas. Sobre la base de los resultados obtenidos, se puede concluir que se establecen diferencias estadísticamente significativas en la fuerza de prensión manual entre niños y niñas de todas las categorías de edad. Asimismo, se establecen diferencias estadísticamente significativas entre niños y niñas en la prueba de dinamometría manual de todos los niveles APHV. En general, el uso del APHV permite una mejor categorización del desempeño de los niños y adolescentes estudiados. En los niños, la correlación entre la edad cronológica y la prueba fue del 68 %, y en las niñas, del 77 %. Los estándares normativos referentes de la prueba de dinamometría manual se presentan en percentiles para ambos sexos. Los resultados de la prueba de dinamometría manual durante la infancia y la adolescencia deben analizarse e interpretarse en función de la edad biológica y no de la edad cronológica. Estas herramientas pueden ayudar a los especialistas que trabajan con niños y adolescentes en un contexto étnico y epidemiológico.

PALABRAS CLAVE: Edad biológica; Estado de madurez; Fuerza de agarre; Niños; Adolescentes; Datos normativos.

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