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Original article

Diagnosis of the strength-endurance of the stabilizer muscles in school tennis players

Diagnóstico de la fuerza-resistencia de los músculos estabilizadores, en los tenimesistas escolares

Diagnóstico da força-resistência dos músculos estabilizadores em tenistas escolares

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ABSTRACT

The work that is presented is based on a descriptive study, of a qualitative and quantitative nature; for this, theoretical methods such as inductive-deductive and analytical-synthetic, as well as empirical methods such as documentary review, observation, survey, interview

and the measurement to obtain the sample data, from the application of the tests were applied. The characteristics of table tennis as a sport were highlighted, as well as the injuries that occur in it. The theoretical bases of the stabilizing muscles were studied, which are those that allow fixing a joint to put certain muscle groups in motion. The sub 13 category tennis players in Havana lack a methodological instrument that supports the strength endurance training of the stabilizer muscles, so the objective of this research was to evaluate the strength endurance of the stabilizer muscles of the sub 13 category tennis players from Havana. The eval -lumbar tennis instrument was designed to assess the level of endurance to strength of the stabilizing muscles of the selected sample. As a result, 100 % of the sample presented a deficient endurance to strength, where the following muscles were found to be weak: rectus abdominis, oblique abdominis, multifidus, quadratus lumborum, intertransversus, serratus anterior, spinal erectors and deltoids in its lateral portion and frontal.

Keywords: Stabilizing muscles, tennis players, muscular strength.

RESUMEN

El trabajo que se presenta parte de un estudio de tipo descriptivo, de naturaleza cualitativa y cuantitativa; para ello, se aplicaron métodos teóricos como el inductivo-deductivo y el analítico-sintético, métodos empíricos como la revisión documental, la observación, la encuesta y la entrevista; además de la medición para la obtención de los datos de la muestra, a partir de la aplicación de los test. Se resaltaron las características del tenis de mesa como deporte, así como las lesiones que se presentan en el mismo. Se indagó acerca de las bases teóricas de los músculos estabilizadores que son aquellos que permiten fijar una articulación para poner ciertos grupos musculares en movimiento. Los tenimesistas categoría sub 13 de La Habana carecen de un instrumento metodológico que sustente el entrenamiento de la resistencia a la fuerza de los músculos estabilizadores, por lo que se propuso como objetivo de esta investigación evaluar la resistencia a la fuerza de los músculos estabilizadores de los tenimesistas categoría sub 13 de La Habana. Se diseñó el instrumento eval-lumbar tennis que permitió valorar el nivel de resistencia a la fuerza de los músculos estabilizadores de la

muestra seleccionada. Como resultados, el 100 % de la muestra presentó una resistencia a la fuerza deficiente, donde se encontraron débiles los siguientes músculos: recto abdominal, oblicuo abdominal, multífidos, cuadrado lumbar, intertransverso, serrato anterior, erectores espinales y deltoides en su porción lateral y frontal.

Palabras clave: Músculos estabilizadores, tenimesistas, fuerza muscular.

RESUMO

O trabalho que se apresenta assenta num estudo descritivo, de natureza qualitativa e quantitativa; Para isso, foram aplicados métodos teóricos como indutivo-dedutivo e analítico-sintético, métodos empíricos como revisão documental, observação, levantamento e entrevista; além da medição para obtenção dos dados amostrais, a partir da aplicação dos testes. Foram destacadas as características do tênis de mesa enquanto esporte, bem como as lesões que nele ocorrem. Foram investigadas as bases teóricas dos músculos estabilizadores, que são aqueles que permitem fixar uma articulação para colocar em movimento determinados grupos musculares. Os tenistas da categoria sub 13 de Havana carecem de um instrumento metodológico que apoie o treinamento de força resistida dos músculos estabilizadores, por isso o objetivo desta pesquisa foi avaliar a força resistiva dos músculos estabilizadores dos tenistas da categoria sub 13 de Havana. O instrumento de tênis eval-lombar foi projetado para avaliar o nível de resistência à força dos músculos estabilizadores da amostra selecionada. Como resultados, 100% da amostra apresentou resistência à força deficiente, onde se encontravam fracos os seguintes músculos: reto abdominal, oblíquo abdominal, multífido, quadrado lombar, intertransverso, serrátil anterior, eretores da coluna vertebral e deltóides em sua porção lateral e frontal.

Palavras chave: Músculos estabilizadores, tenistas, força muscular.

INTRODUCTION

A sports injury is considered as any musculoskeletal problem as a result of training or competition, whether or not it has been evaluated or treated by a health professional (Engebretsen, 2013). For their part, Timpka *et al.* (2014) define a sports injury as any physical or psychological complaint resulting from competition or training, regardless of the need for medical attention or loss of time.

During the practice of table tennis, muscle and tendon injuries also occur, given the characteristics of this sport in relation to the level of physical preparation. In this case, the authors Correa (2014) and Vera *et al.* (2015) who conducted a study on the incidence of injuries in table tennis and agree that the most common are low back pain, bursitis, tennis elbow, patellar tendinitis, contractures and muscle tears.

The authors of the research agree with the above and add that lumbar injuries are among the most dangerous, because they riskily compromise the spinal cord, which is the portion of the central nervous system housed in the vertebral canal and which main function is conduction of the nerve impulses and stimuli that come from the external and internal environment. For this reason, when facing with a lumbar injury, one must be meticulous, given the risk of disability due to vertebral and spinal cord fracture.

One of the main causes of low back injuries is the sudden movements and sudden changes of direction that characterize this sport. Munivrana *et al.* (2015) and Iino & Kojima (2016) estimate table tennis as an intelligent game and intentions with low organization of actions, where the sequence of movements is not known, neither in the development nor in the end of them. This is an opposition sport, which is included within ball sports, according to Pérez de Castro (2005) cited in Sáez (2019).

When analyzing the speed of the ball, it can reach about 180 km/h, that is to say 50 meters per second on a table of only 2.74 meters, thus raising the level of competition where the player only has hundredths of second to analyze, decide and execute the appropriate response (Guerrero *et al.*, 2017).

The aforementioned authors agree that table tennis is a game that is based on the indirect confrontation of players where there is a great variety of motor actions that are carried out in short periods of time. There are several researches on the prevention of sports injuries, among them those of Van Mechelen (1992), Martos (2016), Rodríguez (2015 and 2017) and Rodríguez *et al.* (2021).

Different preventive models that approach this topic were reviewed and the criterion was reached that the Van Mechelen *et al.* (1992) is the simplest model to follow for injury prevention; however, Martos (2016) proposed a series of measures to avoid them in Physical Education, among which can be cited the correct and safe performance of physical exercises, the evaluation of the state and proper use of facilities and materials and the analysis of risk situations that students may perceive.

Guerra *et al.* (2019) conducted a study on eccentric exercises for hamstring injury prophylaxis in sports that involve acceleration and deceleration and concluded that Nordic exercises for prevention can reduce the occurrence of acute hamstring injuries in baseball players.

Meanwhile, Rodríguez (2017) proposed a methodology for the training of stabilizer muscles, named Stabilizer Muscle Training System-Cuban Methodology (SEME-MC). In addition, this author defined that the stabilizing muscles are those that hold a part of the body in place so that another can perform its function in movement, they are the ones that allow maintaining an adequate posture at the time of training, thus avoiding the risk of injuries.

Most of these muscles are located in the trunk or central area of the body (CORE). From the point of view of physical activity, the CORE refers to the muscular complex located in the central part of the body (lumbar-pelvic region) that includes muscles of the abdomen, back, posterior and anterior part of the hip, pelvic floor, and diaphragm (Hibbs *et al.*, 2008).

From the research that is carried out, it is considered that the stabilizer muscles should be trained through a well dosed and planned process, taking into account that they, according to the criteria of the aforementioned authors, contribute to the prevention of injuries and serve support for the technical execution of different elements and skills within the sport.

To refer to the capacity that must prevail in the work and strengthening of the stabilizing muscles in endurance to strength, Collazo (2020) states that endurance to strength is the capacity of an organism to resist the fatigue caused by a certain activity that requires a relatively long strength performance over time and with a moderate pace of execution.

It is assumed that the intention of isometric training, directed at the stabilizing muscles, is to produce the greatest possible tension in them, since it is considered that they present weakness as a result of not specifically planning the training.

In the case of the table tennis under 13 categories in Havana, the lumbar injuries that occur are a consequence of inadequate practices by the tennis players. In the preparation plan of the table tennis athlete, the physical preparation of these subjects is dosed and planned; however, it lacks a methodological instrument that allows the evaluation of the endurance to strength of the stabilizing muscles with a preventive purpose against low back injuries in tennis players in this category.

The literature related to the endurance training of the stabilizer muscles in this sport was reviewed and no scientific evidence was found that reveals results about the effectiveness of the training of the stabilizer muscles for the prevention of low back injuries in tennis players this category; therefore, in this study, various researches related to sports injuries focused on ball sports were taken as references, such as those of Guerrero *et al.* (2017), Fu (2018), Team Medically Drugs (2019), Rodríguez *et al.* (2021) and Crespo *et al.* (2021).

The objective of the research, which results are offered in this article was focused on evaluating the endurance to strength of the stabilizing muscles of the sub 13 category tennis players in Havana and in order to carry out this research it was necessary to consult and assume some tests obtained from the authors Vera *et al.* 2015), Lopez *et al.* (2020), Hernández, (2010), Rodríguez *et al.* (2021) and Mendoza *et al.* 2022).

MATERIALS AND METHODS

The research was carried out, from a descriptive study of a qualitative and quantitative nature. The type of design is non-experimental with a pretest for a single group. According to the management of the variables, the research is of minimal control where the phenomenon was analyzed due to its critical and revealing nature, which allowed modifying and expanding knowledge about the object of study.

They were used as scientific methods of the theoretical level, the inductive-deductive one that allowed the use of general and particular premises to identify the problem from practice and make generalizations around the subject matter addressed. The analytical-synthetic one contributed to examine the research topic from the theoretical, scientific and methodological foundations to determine actions that influence the training process of the stabilizer muscles in order to contribute to the prevention of low back injuries in tennis players of the category sub 13 of Havana and the documentary review, for the elaboration of the theoretical framework of the research.

From the empirical level, scientific observation was used to obtain direct information about the studied phenomenon, training sessions of tennis players of the category sub 13 of Havana were observed to verify if there was any space for training of the stabilizing muscles. The application of the survey allowed, through direct and indirect questions, to collect information about the state of the injuries of the tennis players of the sub 13 category of Havana; as well as the knowledge that professionals have about the stabilizing muscles. The interview allowed to know the criteria related to the work of endurance to the strength of the stabilizer muscles and the knowledge that the trainers have about the prevention of injuries in the lower back.

The measurement was carried out at the beginning of the research with the purpose of evaluating the level of endurance to the strength of the stabilizer muscles in the tennis players of the sub 13 category of Havana, for which a test protocol called EVAL was prepared. -LUMBAR TENNIS. The tests that made up the EVAL-LUMBAR TENNIS instrument were: Prone Bridge Test (PP), Right Lateral Bridge Test (PLD), Left Lateral Bridge Test (PLI) and the Trunk Flexor Endurance Test (ABD-40). p).

Prone Bridge Test (PP) is an isometric test to fundamentally assess the anterior and posterior muscular endurance of the CORE (Figure 1).

Fig. - 1. *Prone Bridge Isometric Test*

Right and left lateral bridge test (PLD and PLI), this test requires the activation of the lateral CORE muscles, basically the quadratus lumborum and the internal and external oblique muscles, with low disc compression for a mean time of 94 and 97 seconds for the right and left side, respectively in men; while for women an average of 72 and 77 seconds for the right and left side (Figure 2 and Figure 3)

Fig. 2. - *Right Lateral Bridge Isometric Test*

Fig. 3. - *Right Lateral Bridge Isometric Test*

Test of trunk flexor endurance at 40 degrees (ABD-40 p), this test involves the main trunk flexor muscles, that is, the rectus abdominis, which is a "global" musculature for an average time of 149 and 144 seconds for women and men, respectively. The subject adopts the posture that is observed in figure 4 and will have to maintain the same, without modifying it.

Fig. 4. - *Isometric abdomen test at 40 p*

The population was made up of 15 tennis players, from which a sample of ten tennis players from the sub 13 category of Havana was selected, located in the "Valdés Rodríguez" provincial table tennis school. For the selection, the inclusion criteria were taken into account, which required tennis players who have not been previously influenced by the proposed exercises, the consent of the parents to carry out scientific research with the schoolchildren, not presenting any injury during the research period, be interested in being part of the research, commit to systematically attend the training of the stabilizer muscles and not be doing another type of training simultaneously with the research.

RESULTS AND DISCUSSION

The five professionals surveyed are of university level, for 100% of the total, three of them are table tennis coaches, one field tennis coach and an orthopedist with 13 years of experience in that specialty. The four trainers are unaware of the content referring to the stabilizing muscles, as well as their location in the body and their importance for the prevention of low back injuries, which represents 80 % of the respondents. However, the orthopedic specialist did demonstrate knowledge about the stabilizing muscles and also about the injuries that arise in table tennis as a result of the sporting gesture for 20 % of the respondents.

100 % of the respondents stated that it is necessary to prevent injuries in sports, however, none reported that improvement courses or diplomas have been taught for their training in terms of injury prevention and the periodization of training for athletes. stabilizing muscles.

An interview was applied to 28 table tennis players of different categories. 100 % stated that at no time did they practice specific exercises for strength endurance training of the stabilizer muscles, nor did they know the actions that can be performed to prevent low back injuries.

Also, it was possible to verify that the most frequent injuries that affect tennis players in the sub 13 category of Havana were bursitis, tennis elbow, patellar tendonitis and the lumbar area, low back pain, herniated discs and muscle contractions, in the lumbosacral zone; These results coincide with those of other researchs such as the case of Pluim (2017), Crespo *et al.* (2021) and Rodríguez *et al.* (2021) (Table 1).

Table 1. - *Data obtained from the kinanthropometric measurements carried out for the characterization of the sample*

Subjects	Sport Age	Biological Age	Weight (kg)	Height	BMI (kg/m²)
1	3 years	12	40	1.43	19.56
2	4 years	12	46	1.45	21.87
3	2 years	11	38	1.39	19.66
4	1 year	11	39	1.34	21.71
5	1 year	12	45	1.42	22.31
6	3 years	12	42	1.41	21.12
7	4 years	12	35	1.38	19.37
8	5 years	13	41	1.44	19.77
9	3 years	12	40	1.41	20.11
10	3 years	12	40	1.38	21
Average	3 years	12	40.60	1.41	20.65

Table 1 represents the selected sample. The subjects are schoolchildren with an average of 12 years of biological age and three years of sports age, all of them are male; the average weight was 40.60 kg, the BMI was 20.65 kg/m² of weight according to the standard grade and weight of the BMI table, for a height of 1.41 m. None presented injuries at the time of the research, however, seven of them presented lumbar injuries in stages prior to our research (Table 2).

Table 2. - *Test evaluation scale (PP, PLD, PLI, ABD - 40 p), which were validated by experts*

Working range	Assessment	Legend
0 – 30:	Very badly	mm
31 – 59	Bad	m
60 – 89:	Good	B.
90 or more:	Very good.	MB

Table 2 represents the scale of values to exercise a criterion and functioned as an assessment instrument that allowed each subject to be awarded a grade, according to the execution time of each applied test. It should be noted that to validate it, the same test had to be measured on more than one occasion and that the results were as similar as possible in both measurements. The criteria of experts and specialists were applied (Table 3).

Table 3. - *Results of the descriptive statistics of dispersion frequency and central tendency of the tests that evaluate the endurance to strength of the stabilizing muscles in the research sample*

n=10	mean	SEM	SD
PP	38.45	3,760	12.80
PLD	22.84	1,830	5,765
PLI	24.36	1,660	5,324
ABD 40 º	46.55	1,340	13.05

The results shown in Table 3 express the trend of the average values between the measurements and fulfill the purpose of the tests, since they provide times of endurance to the strength of the stabilizing muscles in correspondence with the muscular development of the tennis players who were part of the research.

In the Prone Bridge test, the general average was 38.45 seconds, with a poor rating for the level of endurance to strength of the muscles involved: rectus abdominis, multifidus, spinal erectors and deltoids. 100 % of the sample presented times of less than 59 seconds. The standard error of the mean was 3,760 and it was found to be below 10, which represents the dispersion that the mean of a sample of values would have if they continued to take samples. The standard deviation represents the variation in the values of a variable and the variability

of individual observations. The interpretation is that in the test for children the test results deviate on average from the mean by 35.41 seconds/hundredths.

In the case of the Right Lateral Bridge Test, the average was 22.84 seconds and 100 % of the sample was evaluated as very bad. This informed us of a high weakness of the internal and external oblique muscles, serratus anterior, and quadratus lumborum. The standard error of the mean was 1.830, which means that the sample is not very dispersed, where the individual result oscillates practically in the same time range between the subjects. Meanwhile, the standard deviation was 5.765 and represents that despite the average time they took in this test, the result tends to deviate by about 5.76 seconds.

As a result of the application of the Left Lateral Bridge Test, the average time was 24.36 seconds and 100 % of the sample was classified as very bad, which informed us of a high weakness of the internal and external oblique muscles, serratus anterior and quadratus lumborum, but a greater dominance of that hemisphere of the body was also evidenced with respect to the other hemisphere, given that 70 % of the subjects are left-handed. The standard error of the mean was 1,660, this indicated the level of dispersion of the sample in this test and in this case the sample was slightly dispersed, where the individual result oscillated practically in the same range of time, as in the another hemisphere previously analyzed. Meanwhile, the standard deviation was 5.324 and represents that, despite the average time they took in this test, the result tends to deviate from that time.

In the Abdomen Isometry test at 40p, the average yielded a result of 46.55 and 80 % of the sample was classified as bad, which represented subjects in an unfavorable condition. However, there were 2 subjects who qualified well in this test and it means that they present a good endurance to the strength of the stabilizer muscles evaluated. This data informs us that up to that moment, the abdominal obliques, rectus abdominis, iliopsoas, intertransversus , and serratus anterior muscles were found to be weak.

The standard error of the mean was 1,340, which showed a low level of dispersion, according to the values obtained. For its part, the standard deviation was 13.05 and means that when performing the test at other times, the variation tends to deviate by 13.05 seconds more, with respect to the group mean for this exercise (Table 4).

Table 4. - *Results of the height and weight correlation for each of the tests that evaluate the endurance to strength of the stabilizing muscles in the research sample*

variables	PP	PLD	PLI	ABD - 40 º
Weight	Rho=0.730 Decision (Ho) P=0.000 Decision (H1)	Rho=0.492 Decision (Ho) P=0.000 Decision (H1)	Rho=0.108 Decision (Ho) P=0.000 Decision (H1)	Rho=0.640 Decision (Ho) P=0.565 Decision (H1)
Size	Rho=0.719 Decision (Ho) P=0.000 Decision (H1)	Rho=0.435 Decision (Ho) P=0.370 Decision (H1)	Rho=0.143 Decision (Ho) P=0.320 Decision (H1)	Rho=0.530 Decision (Ho) P=0.025 Decision (H1)

Table 4 shows the correlation of weight (kg) and height (cm) on the applied tests. The objective of the correlation through Spearman `s Rho was to determine if there is any relationship between the collated variables and to analyze if it influenced the result. The weight of the children had a highly significant relationship for the PP (p=0.000), PLD (p=0.000), PLI (p=0.000) tests and the significant relationship in the ABD 40 p test (p=0.045) , which was influential in the results. The height of the children had a very significant relationship for the PP test (p=0.000) and a significant relationship in the ABD 40 p test (p=0.025) was influential in the results. It has no relationship in the PLD test (p=0.370) and PLI (p=0.320) which did not influence the results.

The previous results are related to the studies by McCurdie (2017), Fu (2018), Díaz and González (2019), Rodríguez *et al.* (2021) and Rodríguez *et al.* (2022) who found a negative correlation between the related variables. París-Zamora (2019) found the non-existence of a statistically significant relationship between the study variables using Spearman`s Rho. Meanwhile, Cairns *et al.* (2000) and Jonathan et al. (2005) in their research showed a significant and non-significant correlation between the variables collated.

CONCLUSIONS

The most frequent table tennis injuries reported in this study were bursitis, tennis elbow, low back pain, herniated discs, contractures, and muscle tears. The EVAL-LUMBAR-TENNIS instrument, together with its scale of values, diagnosed deficiencies in the endurance to strength of the rectus abdominis, oblique abdominis, multifidus, quadratus lumborum, intertransversus, serratus anterior, spinal erectors, and deltoid muscles in their medial and frontal portions.

The results obtained show that the lumbopelvic region of the tennis players of the sub 13 category of Havana was found to be weakened and the probability of lumbar injury could be demonstrated due to the weakening of that area.

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