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The Functionality of Cross Training Practitioners

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Jéssica Aparecida Pedroso de Sousa
Discente do curso de graduação de Terapia Ocupacional da Universidade Estadual Paulista - UNESP.
ORCID: 0009-0004-9383-2777

Danielle dos Santos Cutrim Garros
Doutora em Ciências da Saúde. Docente e pesquisadora da Universidade Estadual Paulista - UNESP.
ORCID: 0000-0003-1525-0056
E-mail: danielle.garros@unesp.br

ABSTRACT
Cross Training is a strength and fitness program, with constantly varied exercises, high intensity, and functional movements. Compared to other contact sports such as soccer, judo, and basketball, this type of training does not have higher rates of injuries. The objective was to present functional aspects of the upper limbs of individuals practicing "Cross Training". Methodology: 19 individuals between 20 and 59 years of age, Cross training practitioners with a minimum time of 6 (six) months of practice were included. As exclusion criteria, individuals who presented some lesion at the time of data collection. The following instruments were used for data collection: an upper limb dynamometer to assess handgrip strength; a goniometer to measure the range of motion of the shoulder, elbow, and wrist joints; a test of the box and blocks for evaluation of manual dexterity. Conclusion: the practitioners presented good fine motor coordination and handgrip strength, however, 42% of the practitioners presented hyper-medial rotation of the elbow, however, the data collected showed a good range of motion of the shoulder of these individuals.

Keywords: Training, Joint goniometry, Muscle strength dynamometer, Motor dexterity, Occupational therapy.

1 INTRODUCTION

Cross Training is a type of broad, general, and comprehensive physical modality that leads to the complete physical development of the practitioner. Exercise increases cardiovascular endurance, muscle fitness, strength, power, and flexibility achieved through strength training and Olympic circuits such as running, strength training, calisthenics, and other options such as rowing, jumping rope, squatting, and jumping (GLASSMAN, 2012; Wolff, 2013).

Potential physical benefits of Cross Training are highlighted by Tibana et al (2015) in their study, however, one cannot disregard the risks of injury in extreme conditioning programs such as the one mentioned. Thus, there has been an increase in the number of scientific studies related to concerns regarding the potential risk of injuries, which may be due to the intensity and repetition of the Cross Training exercises and the technical requirements necessary for safety during the performance of the exercises.

The method is considered one of the most complete because it emphasizes attributes related to health and athletic performance. It was reviewed by several authors, among them Barbosa (2011), who attributes to it, improvement in posture, cardiorespiratory endurance, muscle strength, muscular

endurance, flexibility, agility, balance, and reduction in the appearance of diseases related to a sedentary lifestyle.

The injury in the practice of this referred physical activity is an important situation worthy of concern in the approaches of the research, being an unwanted and unpleasant occurrence in the life of an athlete or practitioner of physical activity. In this modality, some practitioners train at the limit of their own bodies, which can generate pain and discomfort that can lead to interruption in training.

According to Xavier; Lopes (2017) a pattern common to all injuries arises as a result of a combination of several factors, these being divided into:

-Extrinsic factors, those that, directly or indirectly, are related to the preparation or practice of Cross Training. Among them are, errors in the planning and execution of training, aspects of training, duration, strength, balance, and physical condition.

-Intrinsic factors that are those inherent to the organism, including abnormalities or biomechanical and anatomical changes, such as flexibility, history of injuries, bone density, anthropometric characteristics, body composition, and cardiovascular and cardiorespiratory fitness.

Muscle injury is a rupture of muscle fiber in the bony insertion of the muscle-tendon junction, tendon, or musculotendon unit, and is classified by time, type, severity, and location of the injury. (XAVIER; Lopes, 2017)

The injury rate of Cross Training is not considered high compared to other physical exercises or sports, according to Dominski et al (2018). A study by Tibana et al (2015) presented in their study a series of sports and their frequency of injury, among them, training, with 3.1 injuries per 1000 hours. In street racing sports 3.3; In handball 2.5; in triathlon 5.4; in gymnastics 5.45; in football 9.6 and in rugby 26.7 injuries per 1000 hours of exercise, from then on, it is concluded that the non-occurrence of high injuries is due to the absence of factors such as physical contact and training on irregular surfaces, which have already been shown to be associated with sports injuries.

As for flexibility, which conceptually is the maximum possible movement of the involved joint and requires good mobility and elasticity of the tissues that surround the joint, such as muscles, tissues, and skin. (BADARÓ; SILVA; BECHE, 2007) The decrease in flexibility is a limiting factor of athletic performance, in addition to increasing the chance of injuries, such as muscle tension. However, for Bertolla et al (2007), excessive flexibility can cause joint instability, leading to joint sprains, osteoarthritis, and joint pain. Training that requires joint stretching brings benefits such as the reduction of muscle strains and stretches, muscle restoration after activity, body awareness, and coordination. (CONCEPTION; DAYS, 2004)

The upper extremities are very important in the life of any person as they are heavily involved in functional activities and activities of a functional nature. Only humans can manipulate objects and

perform manual labor with strength and balance. (MOURA; BARROSO; FERREIRA; MÁRMORA, 2015) For the upper limb to have its functionality within the normal expected patterns, it must be able to reach and manipulate objects so that it can perform all the daily activities, to then live efficiently. (CAVACO; ALOUCHE, 2010).

Manual dexterity is perceived as the ability of the hands and fingers to perform tasks that require precise movements such as handling moving objects that require speed, endurance, and strength. Dexterity, on the other hand, requires mastery of small objects and the ability to perform prescribed operations. Some assessment tools can be used to quantify an individual's manual competency performance. (GARROS; BARION; SAINTS; ROCK , 2019)

Considering both mobility and range of motion, it is very important that the limbs can move and that there is the force throughout the range of motion to perform most daily and professional tasks. Impairments in performance, skill, and manual competence can limit occupational function, so the knowledge of these functions in the performance of activities is a research interest for occupational therapists, since, according to the Code of Professional Ethics of Physical Therapy and Occupational Therapy, the same it assists the man, participating in the promotion, treatment, and recovery of his health. (TROMBLY; PODOLSKI, 2005; COFFITO, 2013)

2 GOALS

The objective was to present functional aspects of the upper limbs of individuals practicing "Cross Training".

3 METHOD

The study was conducted with 19 Cross Training subjects aged 20 to 59 years, with practice time exceeding 72 hours of training in 6 months. As exclusion criteria, individuals with restrictions in the performance of exercises by medical recommendation, that is, who present some clinical diagnosis that compromises physical performance.

The research was carried out in two Box's, that is, the space in which the training takes place, in a city in the interior of the state of São Paulo.

To identify the functionality, data collection was performed through the evaluations of the functions of strength, manual dexterity, and range of motion.

To evaluate the grip strength was used the device known as JAMAR® Dynamometer, measures the handgrip strength. The measurements obtained follow for clinical documentation and use for scientific research. Therefore, the dynamometry of handgrip strength is not limited to the evaluation

of the upper limb but is also a functional monitoring of the parameter of the general health status in adult individuals. (CASTRO; OAK; Smith, 2004; OLIVE TREE; MOREIRA, 2009)

For the assessment of grip strength, the American Society of Hand Therapists (ASHT) recommends that the patient sits comfortably and that the shoulder is adducted, the elbow at a 90º angle, the forearm in a neutral position, and, finally, the wrist position can vary from 0° to 30º of extension. Despite the various other positions that promote the maximum grip strength index, the standardized ASHT position is still recommended in most handgrip test studies.

Manual dexterity (DM) was assessed using the Box and Blocks (CBT) test developed, standardized, and validated by Mathiowetz et al (1985). The instrument consists of a wooden box 53.7 cm long, containing a part higher than the edges of the box and which divides the box into two equal compartments and has 150 wooden blocks, in a cube shape of 2.5 cm on each side. The method was made from the positioning of the box in front of the subject, which should pass cube by cube, from one side to the other in 1 timed minute, the result is the number of blocks passed per minute.

To evaluate the range of joint motion, the goniometry method was performed. (WHIT E, 1997) For the range of motion, the joints of the shoulders, elbows, and wrists were established.

Measurements of the range of motion were made in an active-assistive manner. While the individual was required to perform the movement, the evaluator maintained the movement orientation and appropriate postural position. The examiner manually positioned and fixed the goniometer. The techniques described respected the suggestions of the Association of Orthopaedic Surgeons (AAOS).

The methodology adopted for data collection was the practice, through the instruments mentioned above, in a single time.

The project was approved by the Ethics and Research Committee under number 5.048.609, with CAAE: 48306921.10000.5406. All of them signed the Free and Informed Consent Form.

The analysis of statistical data was performed through tabulation and statistical analysis of frequency through the Statistical Package for the Social Science (SPSS) statistical program.

4 FINDINGS

The study was conducted with 19 individuals practicing Cross Training of 2 boxes from a city in the interior of the state of São Paulo, among these, 8 were female and 11 male, aged between 20 and 59 years. Among these 17 were right-handed and 2 were sinister, as shown in Table 1.

Table 1: Distribution of the total sample of the 19 subjects: gender, age, and dominance.

Identification Frequency %
GENDER
Female 08 42%
Male 11 58%
AGE
20 to 30 to 09 47%
31 to 40 to 04 21%
41 to 50 to 04 21%
from 50 to 02 11%
DOMINANCE
Right-handed 17 89%
Claim 02 11%

SOURCE: Authors, 2022.

According to Table 2, it was observed through the block box test that of the 19 practitioners, 10 individuals reached from 80 to 87 blocks/me with the right and left hand, evidencing excellent manual dexterity.

Table 2: Manual dexterity.

Identification	Frequency	%
MANUAL DEXTERITY		
Right Side		
73 to 76 blocks/min 04 21%		
80 to 87 block/min	10 53%	
90 to 96 blocks/min 04 21%		
105 blocks/min	01 5%	
Left Side		
69 blocks/min	01 5 %	
70 to 76 block/min 07 37%		
80 to 87 blocks/min	10 53%	
90 blocks/min 01 5 %		

SOURCE: Authors, 2022.

About what is presented in Table 3, referring to handgrip strength, 32% have from 20 to 28 kgf and 1 person has 60 kgf with the right hand. Already with the left hand add 2 people who have 54 kgf, thus pointed out in Table 3.

Table 3: Grip strength.

Identification	Frequency	%
GRIP STRENGTH (kgf)		
Right Side		
20 to 28 06 32%		
30 to 38 05 26%		
40 to 48 04 21%		
50 to 54 03 16%		
60	01	5%

Left Side		
12 to 18 02 11%		
20 to 28 06 32%		
30 to 38 05 26%		
40 to 46 04 21%		
54	02	11%

SOURCE: Authors, 2022.

Table 4 presents the results of the measurement of the shoulder range of motion, and most practitioners present 180º of right flexion, 180º to 185º of left flexion, 50º to 65º of right and left extension, from 170º to 175º of right abduction and 180º of left abduction, from 60º to 65º right and left medial rotation, of 90º right and left lateral rotation.

Table 4: Shoulder joint amplitude: flexion, extension, abduction, internal rotation, and external rotation.

Identification Frequency % _____
Flexion D
150th 01 5%
160º to 165º 04 21%
170° to 175° 06 32 %
180º 08 42 %
Flexion E
160º to 165º 04 21%
170º to 175º 05 26%
180º to 185º 08 42%
190th 02 11%
Extension D
35th 01 5%
40th 03 16%
50th to 55th 04 21%
60th to 65th 04 21%
70th to 75th 05 26%
80th 02 11%
Extension E
30th 02 11%
40th to 45th 03 16%
50th to 55th 04 21%
60th to 65th 05 26%
70th to 75th 03 16%
80th 02 11%
Abduction D
160º to 165º 05 26%
170th to 175th 08 42%
180th 06 32%
Abduction E
150th to 155th 02 11%
160º to 165º 02 11%
170º to 175º 05 26%
180º 08 42%

190th 02 11%
Medial rotation D
30th 01 5%
50th to 55th 02 11%
60th to 65th 05 26%
70th to 75th 02 11%
80th 01 5%
90th 07 37%
110th 01 5%
Medial rotation E
40th 01 5%
60th to 65th 07 37%
70th to 75th 03 16%
80º 03 16%
90th 04 21%
100th 01 5%
Lateral rotation D
70th 02 11%
80th 01 5%
90th 16 84%
Lateral rotation E
65th 01 5%
70th to 75th 02 11%
80º to 85º 02 11%
90th 13 68%
110th 01 5%

SOURCE: Authors, 2022.

Most practitioners presented elbow range of motion with 130º to 135º of right flexion and in the left 140º to 145º, 90º of right and left supination, and 90º of right and left pronation, represented in Table 5.

Table 5: Elbow joint amplitude: flexion. Forearm: supination and pronation.

Identification Frequency % _____
Flexion D
115th 01 5%
130º to 135º 06 32%
140th to 145th 11 76%
150th 01 5%
Flexion E
120th to 125th 05 26%
130th to 135th 04 21%
140th to 145th 09 47%
150th 01 5%
Supination D
60th to 65th 02 11%
70th to 75th 02 11%
80º 01 5 %
90th 14 73%

Supination E
65th 01 5%
70th to 75th 03 16%
80th 01 5%
90th 14 73%
Pronation D
30th 01 5%
75th 01 5%
80th 01 5%
90th 16 85%
Pronation E
45th 01 5%
70 to 75º 03 16%
80th 01 5%
90th 14 73%

SOURCE: Authors, 2022.

Table 6 shows the wrist range of motion.

Table 6: Wrist joint amplitude: flexion, extension, radial deviation, and ulnar deviation.

Identification Frequency % _____
Flexion D
40th 01 5%
50th 01 5%
60th to 65th 05 26%
70th to 75th 07 37%
80º to 85º 04 21%
90th 01 5%
Flexion E
35th to 40th 02 11%
50th 01 5%
60th to 65th 05 26%
70th to 75th 05 26%
80º to 85º 05 26%
90th 01 5%
Extension D
50th 01 5%
70th 02 11%
80th to 85th 08 42%
90th 08 42%
Extension E
60th 01 5%
70th to 75th 03 16%
80th to 85th 08 42%
90th to 95th 07 37%
Ulnar deviation D
0th 01 5%
40 to 45º 02 11%
50th 06 32%
60th to 65th 04 21%

70th to 75th 05 26%	
80th 01 5%	
Ulnar deviation E	
30th to 35th 02 11%	
40 to 45º 03 16%	
50th to 55th 04 21%	
60th to 65th 05 26%	
70th to 75th 04 21%	
80th 01 5%	
Radial deviation D	
20th to 25th 04 21%	
30th to 35th 09 47%	
40th to 45th 05 26%	
55th 01 5%	
Radial deviation E	
20th to 25th 04 21%	
30th to 35th 09 47%	
40th to 45th 03 16%	
50th to 55th 03 16%	

SOURCE: Authors, 2022.

From the results presented, it is possible to observe the functional profile of Cross Training practitioners, which was discussed in the later session.

5 DISCUSSION

Table 1 shows a higher frequency of males, which was also presented in the systematic review study by Dominski et al (2018) with a total of 3,307 study participants, 2,244 men, and 871 women. In the same study, the mean age of the research participants ranged from 26.8 to 38.9 years, with an age range of 18 to 69 years, corroborating this study that also presented the largest number of practitioners from 20 to 30 years and the age range between 20 and 59 years.

Garros et al, (2019) conducted a study evaluating 27 older adults. Between the ages of 60 and 92 in a long-term care facility. The analysis of the results of the Functional Health Assessment Questionnaire (HAQ) and the Block Box Test (TCB) showed a relationship between manual dexterity and activities of daily living in elderly residents of a long-term care facility. It can be observed that the lower the performance in the test of the box and blocks the worse the result in the HAQ, which indicates worse functioning in daily life. The study reported that the more blocks transported with the left hand and right hand, the lower the quotient of the HAQ functional test, that is, the better the functional capacity and the performance of manual dexterity in daily activities.

Table 2 offers data that show a good performance in the manual dexterity of individuals practicing Cross Training. Comparing with the study by Mendes et al (2001) that evaluated manual dexterity with the CBT test in normal individuals and patients with multiple sclerosis, verifying that

normal individuals between 15 and 65+ years obtained a right-hand average of 65.99/min and with the left hand reached 64.52/min on average. On the other hand, the Cross Training practitioners obtained superior results, with an average of 89/min with the right hand, a total of 23.01/min more than the parameters of Mendes et al (2001), and with the left-hand average was 79.5/min with 14.08/min more, evidencing that the practitioners were able to obtain greater fine motor coordination, highlighting the need for more research that relates this modality with manual dexterity.

Table 3 presents handgrip strength of the right handgrip (HGS) with an average of 40 Kgf and with the left hand 33 Kgf, showing that practitioners have a good palmar grip, functionally contributing to the ability to perform various activities of daily living (ADLs), work or leisure, thus Carvalho; Soares (2004) determines that the ability to produce muscular force provides in ADLs. Soares et al, (2012) state is the most important human physical valence and is related to functional capacity. HGS is directly related to ADLs, and a decline severely limits the individual as far as ADLs are concerned. (CASTRO; OAK; Smith, 2004; OLIVE TREE; Moreira, 2009)

In general, grip strength increases with age, peaking between 25 and 39 years of age and gradually decreasing with each passing year 17, 32, 40, 44 (FIGUEIREDO, 2006). For Carter, Poster et al apud Matsudo (2001), the size of type II fiber decreases with age, while the size of type I fiber (slow contraction) is less affected. Type II fibers contribute to reaction time, especially reaction time, which is very important in responding to day-to-day emergencies.

Functionally, muscle weakness suggests coincidence with loss of muscle tissue, however, Gallahue; Ozmun (2001) highlight that the loss of muscle mass and muscle atrophy are changes associated with physical inactivity. Leite (1996) states that people without workouts lose about 10% of their muscle mass by the age of 50. From then on, at the age of 80, the process of atrophy visibly accelerates.

A systematic review study, conducted by Dominski et al (2018), reported that the shoulder was the region most affected by injuries. Gender was associated with the rate of injuries, with men having more injuries than women, and the presence of previous injuries associated with new injuries. Cross Training has been sought after by people already practicing other types of physical exercise or sport. The study also points out that people with previous injuries are 3.75 times more likely to acquire new injuries from the practice of Cross Training. Regarding the shoulder, it was also observed that athletes with previous injuries are eight times more likely to injure the site compared to athletes with healthy shoulders.

The fact that most studies have found no association between the occurrence of injuries and age/age group reinforces the recommendation of Weisenthal et al (2022), who state that Cross Training is a physical training program that can be safely practiced by individuals of a wide age range – 18 to

69 years, provided that they are carried out in a safe environment. Also in this study, 41% of shoulder injuries were highlighted among the analyzed practitioners, and the Olympic gymnastics movements were present in this modality, being the cause of this type of injury It is usually associated with decreased stability of the scapulothoracic joint. Scapular dyskinesia impairs the range of motion of this joint and overloads the glenohumeral joint. This is usually associated with a muscle imbalance, mainly due to weakness in the muscle fibers of the serratus anterior and the inferior trapezius.

According to a study by Summit et al (put the year), among the gymnastic movements that caused the injury (25 of 46), practitioners reported pull-ups with kipping, ring muscle-ups, push-ups, and ring dips. In addition to the exercises derived from gymnastics, the typical Olympic lifts that make up Cross Training, such as the overhead squat, put the shoulder joint in extreme flexion, abduction, and internal rotation, increasing the risk of injury. Due to the high incidence of shoulder injuries found in the studies, practitioners and professionals who supervise the execution of these movements should pay attention to factors such as excess of exercises and insufficiency of technique in the practice of gymnastics and pay attention to the Olympic lift. Athletes cite 35% and 20% chances, respectively, as the cause.

According to Table 4, most Cross Training practitioners presented shoulder flexion, extension, abduction, and lateral rotation compatible with the AAOS parameters. However, 42% of the practitioners presented medial hyper-rotation, with 90° to 110º of the range of motion of the joint. Even so, the data collected showed a good ROM of the shoulder of these individuals.

The elbow is a joint with a predisposition to developing ROM reduction both by trauma, as well as by injury and inflammation, as explained by Miyazaki et al (2011), where functional ROM is considered, minimum requirements for life daily should have an arc between 130º of flexion and 30º extension and 50° of pronation and supination, so both planes have an amplitude of 100° sagittal and coronal; indicates surgical treatment if ROM is lower than feasible.

The handle provides a lot of flexibility and stability to the hands. It is a very complex structure consisting of 23 bones and 26 joints, an extensive and complex system of ligaments and muscles that allow the mechanism of opening and closing and perform their function of grasping. (GODOY, 2004)

Table 5 shows that 73% to 85% of the practitioners present supination and pronation at the 90° angle. Even being above the parameters of the AAOS at the angle of 80°, as for Table 6, about 78% to 90% of the practitioner's present wrist hyper flexibility, is from 10º to 40º, since the average range of motion for the wrist in extension is 70°, for flexion is 80°, the radial deviation is 20° and for ulnar deviation is 30° when compared to AAOS. The range of motion of these joints does not alter, corroborating the study conducted by Machado et al (2011) that evaluated the functional score by the questionnaire Disabilities of the Arm, Shoulder and Hand (DASH), finding results that The greater

the amplitude of flexion, pronation, supination and radial deviation of the wrist, the better the functional result.

Strength training has become popular, as it promotes important benefits for musculoskeletal fitness, such as increased muscle mass, strength levels, and bone mineral density. These adaptations improve the functional capacity and quality of life of practitioners. Given the above, several studies have indicated Cross Training as a modality that brings benefits to physical health in different age groups, as long as they are practiced in safe environments.

6 CONCLUSION

According to the study, Cross training practitioners presented results superior to the results of scientific studies about fine motor coordination, highlighting the need for more research that relates this modality with manual dexterity. The average handgrip strength shows that practitioners have a good handgrip, functionally contributing to the ability to perform various activities of daily living, work, or leisure. However, even though some of the practitioners presented hyper-medial rotation, the other data collected showed a good range of motion of the shoulder of these individuals, so the physical training that requires stretching of the joints brings benefits such as the reduction of muscle strains and stretches, muscle restoration after the activity, body awareness and coordination. However, this study provided relevant data with tests and evaluations based on the principles of the functionality of the upper limbs of individuals practicing Cross Training, since the results presented were satisfactory, however, it suggests more research aimed at evaluating the functionalities of practitioners of this modality.

REFERENCES

Caporrino, f. A.; faloppa, f.; santos, j. B. G.; réssio, c., soares, f. H. C.; nakachima, l. R.; segre, n. G. Estudo populacional da força de preensão palmar com dinamômetro jamar*. Revista brasileira de ortopedia. São paulo - sp, v.33, n.2, fevereiro de 1998.

Conselho federal de fisioterapia e terapia ocupacional. Resolução n.425. Estabelece o código de ética e deontologia da terapia ocupacional. Coffito, cap.11, art 4º, brasilia - df, 16 maio 2015, seção 1.

Dominski, f. H.; siqueira, t. C.; serafim, t. T.; andrade, a. Perfil de lesões em praticantes de crossfit: revisão sistemática. Fisioterapia e pesquisa, v. 25, n. 2, p. 229–239, jun. 2018.

Drummond, i. S.; cunha, m. P.; reis, c. F. L.; rodrigues, a.; alves, d. A. G. Força de preensão palmar e habilidade manual em funcionários de escritório. Revista brasileira de saúde e segurança no trabalho, lavras, v. 1, n. 2, p. 11-16, 11 fevereiro de 2019.

Fernandes, t. L.; pedrinelli, a.; hernandez, j. A. Lesões musculares - fisiopatologia, diagnóstico, tratamento e apresentação clínica. Revista brasileira de ortopedia, são paulo - sp, v.46, n.3, 247-255, 2011.

Garros, d. S. C.; barion, m.a.; santos, c. B.; rocha, a. N. D. C. Destreza manual e a capacidade de desempenho nas atividades de vida diária em idosos, institucionalizados. Temas em saúde, joão pessoa, v.19, n.6, p. 291-305, 2019.

Geraldes, a. A. R.; albuquerque, r. B.; soares, r. M. Carvalho, j.; farinatti, p. T. V. Correlação entre flexibilidade das articulações glenoumerais e coxofemorais e o desempenho funcional de idosas fisicamente ativas. Revista brasileira de fisioterapia, v. 12, n. 4, p. 274–282, 13 agosto de 2008.

Godoy, j. R. P.; barros, j. F.; moreira, d.; junior, w. S. Força de aperto da preensão palmar com o uso do dinamômetro jamar: revisão de literatura. Efdeportes.com, revista digital, v.10, n. 79, dezembro de 2004.

Leite, l. E. A.; resende, t. L.; nogueira, g. M.; cruz, i. B. M.; schneider, r. H.; gottlieb, m. G. V. Envelhecimento, estresse oxidativo e sarcopenia: uma abordagem sistêmica. Revista brasileira de geriatria e gerontologia, porto alegre, v. 15, n. 2, p. 365-380, 01 agosto de 2012.

Mendes, m. F.;tilbery, c. P.; balsimelli, s.; moreira, m. A.; cruz, a. M. B. Teste de destreza manual da caixa de blocos em indivíduos normais e em pacientes com esclerose múltipla. Arquivos de neuro-psiquiatria. São paulo, v.59, n.4, p. 889-894, 28 novembro de 2001.

Miyazaki, a. N.; fregoneze, m.; doneux, p.; santos, l. A. S.; norio, g. D. L.; watanabe, s. L. C. Avaliação dos resultados do tratamento cirúrgico da rigidez pós-traumática do cotovelo de pacientes esqueléticamente maturos. Revista brasileira de ortopedia, v. 45, n. 6, p. 529–537, 2010.

Moraes, v. Y.; faria, j. C. V.; fernandes, m.; raduan-neto, j.; okamura, a.; belloti, j. C. Questionários disability of the arm shoulder and hand e michigan hand: explorando a responsividade e performance diagnóstica em amostra de pacientes ambulatoriais com e sem queixas nas mãos e punho. Revista brasileira de ortopedia, v. 57, n. 3, p. 449–454, 14 de outubro de 2020.

Nascimento, m. F.; benassi, r.; caboclo, f. D.; salvador, a. C. S.; gonçalves, l. C. O. Valores de referência de força de preensão manual em ambos os gêneros e diferentes grupos etários: um estudo de revisão. E f deportes.com, revista digital, buenos aires, v.15, n.151, dezembro de 2010.

Pereira, é. F.; teixeira, c. S.; etchepare, l. S. O envelhecimento e o sistema músculo esquelético. Efdeportes.com, revista digital, buenos aires, v. 11, n.101, p. 101, outubro de 2006.

Wagner, p. R.; ascenço, s.; wibelinger, l. M. Hand grip strength in the elderly with upper limbs pain. Pajar - pan-american journal of aging research, v. 6, n. 1, p. 22-28, 2018.

White, c. C. N. D. J., medida do movimento articular: manual de goniometria. Ed. 2ª, porto alegre: artes médicas, 1997.

Xavier, a. A.; lopes, a.m.c. lesões musculoesqueléticas em praticantes de crossfit. Revista interdisciplinar: ciências médicas - mg, belo horizonte - mg, v.1, n.1, 11-27, 2017.