DOI 10.26773/smj.250607

SportMont

ORIGINAL SCIENTIFIC PAPER

Strength Training with Blood Flow Restriction: Effect on Factors Associated with Sarcopenia in Older Women

Claudia M. Espinosa-Méndez[1], Pedro J. Flores-Moreno[2], Ixchel Reyes-Espejel[1], Jesús A Ortega-González[3]

[1]Meritorius Autonomous University of Puebla, Faculty of Physical Culture, Puebla, México, [2]University of Colima, Faculty of Educational Sciences, Colima, México, [3]Meritorius Autonomous University of Puebla, Clinical Nutrition Department, Puebla, México

Abstract

Sarcopenia is a major health problem for older adults. Traditional muscle strength training can lead to a reduction in sarcopenia, but high loads make it difficult to apply for older adults. The aim of this study was to evaluate the effect of strength training with partial blood flow restriction (PBFR) on factors associated with sarcopenia in older Mexican women. Analytical and longitudinal research with a pre-post quasi-experimental design was carried out. Sixteen older women participated in the study (70.87±5.47 years, height of 150.11±3.69 cm, and a body weight of 66.6±9.9 kg). Muscular strength training with partial blood flow restriction to the lower limbs for 12 weeks was performed. Muscle mass index was evaluated, the general muscle strength was calculated using hand dynamometry; the functionality was evaluated with the time get up and go test and specific strength with the Chair stand test. A statistical difference pre- and post-intervention in the strength of the right hand ($p<0.05$), and the specific strength ($p<0.05$) was found, without changes in the muscle mass index and functionality ($p\geq0.05$). It was concluded that strength training with loads between 20%-50% combined with PBFR, for lower limbs in older adults, generates positive effects on general and specific strength, a parameter related to sarcopenia.

Keywords: *elderly, quality of life, physical condition, blood occlusion, strength, functionality*

Introduction

Currently, the population age curve is increasing worldwide, which imposes the need to implement actions for the health care of an aging society (Domingo-del-Val, 2022). In Mexico, it was estimated that in 2021 there were 12 older adults (OA) for every 100 inhabitants, equivalent to 14.5 million OA, representing 11% of the total Mexican population, with a tendency for this proportion to increase (Consejo Nacional de Población, 2021), so it is necessary to generate health conservation or recovery strategies for this age group.

Among the most important health problems in people over 60 years of age, sarcopenia is considered one of the main disorders associated with morbidity and limitation of daily life activities (Contreras-Hernández, 2021). Its importance is such that it was integrated into the International Classification of Diseases in 2016 (Martín Sierra et al., 2021).

Sarcopenia is described as a multifactorial disorder (Malafarina et al., 2013), among which is the lack of physical activity; characterized by loss of muscle mass, strength and functionality, thus increasing the risk of falls and decreased quality of life of those who suffer from it (Cruz-Jentoft y Sayer, 2019). The prevalence of this disorder worldwide is 5-13% and 50% in people aged 60, 70, and 80 years, respectively, estimating that the percentage will increase by 2025 (Cortés et al., 2018). In Mexico, it was observed that 13% of the population of a sample of more than 5000 OA suffered from sarcopenia (Contreras-Hernández, 2021), in addition it has been indicated that sarcopenia has a higher prevalence in Mexican women compared to men of the same nationality (Espinel-Bermúdez et al., 2018), although worldwide the relationship of sarcope-

Correspondence:

P J. Flores-Moreno
University of Colima, Faculty of Educational Sciences, Avenida Universidad #3 colonia la Víboras, Colima, Colima, México 28040
E-mail: pedrojulian_flores@ucol.mx

nia with sex varies according to the reference classification (Petermann-Rocha et al., 2022).

Traditional muscle strength training can lead to decreased sarcopenia and increased strength; It is suggested that in order to enhance muscle hypertrophy, a considerable volume and multiple repetitions should be used (American Ascociation of Sport Medicine, 2009). However, these specific characteristics, such as the use of high loads (between 60-85%) and a training duration ranging from 50 to 90 minutes, make it difficult to apply them in elderly individuals (Castro-Coronado et al., 2021; Lim & Goh, 2022).

On the other hand, it has been studied that training with partial blood flow restriction (PBFR) generates positive effects on muscle size and strength without the need to use high intensities, obtaining favorable results using low-intensity work (Cristina-Oliveira et al., 2020). PBFR is a technique that consists of using a compression device near the muscle to be worked, performing sets with weights lower than those usually recommended to promote hypertrophy and increase muscle strength. This training technique can be carried out using a common elastic bandage or through more advanced devices, such as a pressure cuff (Villalba, 2022). Although the benefits of this type of strength training in different populations are known, its application in elderly women is still sparsely explored, the physiological and biomechanical specifications to older women and the effects that PBFR training can have on this specific population group have not been addressed, therefore, the objective of this study was to evaluate the effect of strength training with PBFR on factors associated with sarcopenia (strength, functionality and muscle mass index) in woman Mexican older adults, belonging to the programs of the National System of Integral Development of the Municipal Family of Puebla (SMDIF). The aim of this study was to evaluate the effect of strength training with partial blood flow restriction (PBFR) on factors associated with sarcopenia in older Mexican women

Methods

This is an analytical, longitudinal research with a quasi-experimental pre-post design that evaluated the effect of a 12-week PBFR training in lower limbs (LL) on factors associated with sarcopenia (strength, functionality, and muscle mass) in 16 older adults.

Participants

The participants were 16 elderly women (70.87±5.47 years, height of 150.11±3.69 cm, and a body weight of 66.6±9.9 kg), incorporated into SMDIF program in the municipality of Puebla, Mexico; selected through convenience sampling and with the following inclusion criteria: being a woman, being over 60 years old, belonging to the SMDIF program, medical leave to exercise. Exclusion criteria: hypertension, diabetes, circulatory conditions, and/or having any medical restriction to perform physical exercise.

Materials and instruments

Although there is no consensus on universal diagnostic criteria for sarcopenia, existing proposals include measurement of muscle mass, muscle strength, and functionality (Montero-Errasquín & Cruz-Jentoft, 2022). Therefore, for the present study, it was determined to establish the presence of sarcopenia by relating three tests: Dynamometry, the most clinically used method to determine muscle strength (Muresan et al.,2020; Rodrguez-Rejn et al., 2019). The measurement of hand grip strength was used, which also serves to anticipate independence and mobility in older adults, since it is directly related to the amount of muscle mass (Agüero et al., 2017), a digital hand dynamometer SMEDLEY T-19 (Solid, England) was used.

Muscle mass index, which was obtained through the formula MMI = Kg of muscle/height m2. To calculate the MMI of the participants it was used the ENFA® method (Nutritional Assessment by Anthropometric Fractionation), proposed by Drinkwater and Ross (1980), which allows for a precise estimation of muscle mass. This approach is based on a kinetoanthropometric model, integrating 25 anthropometric measurements, including height in a bipedal and sitting position (expressed in centimeters), body weight (in kilograms), seven body circumferences, seven skinfolds, and eight bone diameters. To optimize the accuracy and reproducibility of the data, the anthropometric evaluations were carried out by a single trained evaluator, who performed three consecutive measurements per variable, establishing the average of the records obtained as the final value, with a precision of one tenth of a unit. To obtain the measurements, high-precision and methodological quality instruments were used, including a SECA® 213 stadiometer (Bad Homburg, Germany), a SECA® 813 digital scale (Bad Homburg, Germany), a Delux stainless steel metal measuring tape (Gráculus®), a PCA-01 scientific caliper (Gráculus CronoDiet®), a Gráculus Antropometría® MEX anthropometer, and a high-precision anthropometer (Gráculus CronoDiet®). During the evaluation process, strict adherence to the ENFA® methodological standards was guaranteed, ensuring the validity, reliability, and reproducibility of the results, thus contributing to a rigorous and scientifically supported anthropometric characterization in the field of clinical nutrition.

The time get up and go test was used to evaluate functionality, which covers balance and gait, it is used as a standard to assess the propensity to fall and as an integral component in the complete geriatric evaluation. The time in seconds was registered using a TYR Z-200 Stopwatch (Gálvez-Cano, et al., 2010).

Additionally, the Chair stand test was used to evaluate lower extremity strength, recognized as an indicator of muscle performance, functional fitness, flexibility, and aerobic endurance. It is a simple test that involves moving from sitting to standing, the participants performed the maximum number of repetitions in a 30-second interval. This test is also used as a predictor of falls and impairment in daily activities (Mehmet et al., 2020).

Procedure

For the development of this research, the guidelines of the Declaration of Helsinki were followed; in addition, the procedures were approved by the Ethics Committee of the Faculty of Physical Culture of the Meritorious Autonomous University of Puebla (no. CEI220418). A meeting was held with the OA who attends the SMDIF programs, with the intention of inviting them to participate in the study. The PBFR training strengthening program was presented, and the doubts that arose were clarified. OA who agreed to participate in the study, signed an informed consent.

The lower extremity strength of each participant was evalu-

ated by the Chair stand test before starting the 12-week training period, and after it, the presence of sarcopenia was also evaluated by: dynamometry, MMI, and the Time get up and go test.

Experimental Treatment

The PBFR strength training protocol consists of 30–35-minute sessions 3 times a week for 12 weeks and it was carried out as follows: Prior to each session, a 10-minute warm-up was carried out, which included cephalocaudal lubrication with joint movements in periods of 10 seconds of each body segment, as well as aerobic exercises with intensity corresponding to 30% of the reserve heart rate. Then a tourniquet-type cuff was applied to the upper end of the thigh, adjusted in a way that partially limits arterial blood flow with a continuous application (13 cm elastic bands were used and flow restriction was determined by clinical criteria such as pain and numbness). To ensure the PBRF the restriction pressure must be high enough to block venous return from the muscles, but at the same time low enough to allow arterial blood flow (Bahamondes-Ávila et al., 2020). The strengthening activities with PBRF were developed in the form of strength circuits and 1 minute per exercise was executed in each section of the circuit; based on previous studies, it was decided to use loads of between 20% and 50% of the 1RM (Bahamondes-Ávila et al., 2020.), without a certain number of repetitions. The exercises were performed in such a way that the OA could complete them with the highest possible quality (Andres et al., 2020), with 1-minute breaks at the end of each circuit. The main part of the training lasted 15-20 minutes, and finally, a 5-minute cooldown was applied

Statistical analysis

Descriptive statistics, including minimum, maximum, mean, and standard deviation, were used to describe the study population. To identify differences between pre- and post-measured, a Wilcoxon non-parametric statistical test was applied. Absolute reliability was calculated using the typical measurement error (TME), the coefficient of variation (CV%), and the smallest worthwhile change (SWC) (Hopkins, 2000). Statistical significance was set a priori at $p<0.05$. IBM SPSS v 21 program was used for statistical analysis

Results

Descriptive variables

The study population consisted of 16 women with an average age of 70.87±5.47 years, and height of 150.11±3.69 cm, and a body weight of 66.6±9.9 kg.

Variables of Interest

The group of the study showed significant changes after the 12 weeks of PBFR (Table 1 and 2) in right-hand strength (DRigth, 18.16±5.07; 18.59±4.86; $p<0.05$; difference 0.05, TME 0.37, CV% 2.00, SWC 0.10), and chair test (12.25±2.08; 16.37±3.87; $p<0.05$, difference 2.7, TME 1.92, CV% 13.42, SWC 0.54). Not been like in the timed up-and-go test (8.87±1.03; 8.86±1.02; $p\geq0.05$, difference 0.4, TME 0.25, CV% 2.87, SWC 0.07). At last, the time spent on the PBFR strength training program was not sufficient to induce changes in MMI (9.61±1.44; 9.75±1.48; $p>0.05$, difference 0.4, TME 0.28, CV% 2.92, SWC 0.08).

Table 1. Descriptive data of variables

Variable	Basal	Post-training	p value	Hedges's g effect size (95%CI)
DRight	18.16±5.07	18.59±4.86	0.008	0.018
MMI	9.61±1.44	9.75±1.48	0.078	0.095
Time get up test	8.87±1.03	8.86±1.02	0.050	0.068
Chair test	12.15±2.08	16.37±3.87	0.000	1.350

Note. Values represented in M ± SD and CV. Size interpretation of Hedge´s effect 0.20= small 0.50= medium, 0.80= large

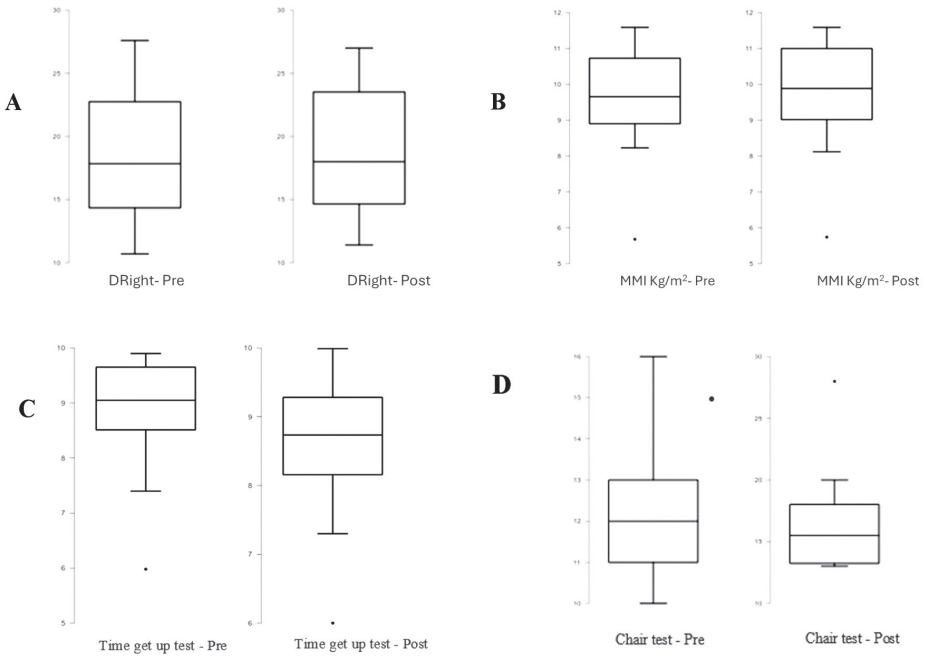

FIGURE 1. Box and whisker plot (A) DRight, (B) MMI, (C) Time get up test (D) Chair test

Table 2. Mean change of variable after physical exercise

Variable	Difference (Post-Pre)	ETM	CV (%)	SWC
DRight	0.5	0.37	2.00	0.10
MMI	0.4	0.28	2.92	0.08
Time get up test	0.4	0.25	2.87	0.07
Chair test	2.7	1.92	13.42	0.54

Note. Sandard measurement error, coefficient of variability (CV), and minimal significant change in the original units in which the variable was measured (SWC)

Discussion

The discussion was based on the different factors that affect sarcopenia, exploring their complexity and variability in the population studied. In addition, the implications for health and quality of life were analyzed, as well as discrepancies with other similar studies. This approach will allow for a deeper understanding about the effect of PBFR training on functionality and strength and will contribute to the formulation of effective prevention and treatment strategies.

PBFR muscle strength and functionality

The sequelae related to sarcopenia, such as deterioration of muscle strength and function, which affects a large population as they age, generate high morbidity (Lim & Goh, 2022), which leads to a decrease in the quality of life and well-being of those who suffer from it. The results of the present investigation point to the improvement of the functionality and strength of the participants in the study, who reported a mean previous 18.16±5.07 and post intervention 18.59±4.86 ($p<0.05$) with which it is possible to benefit the patient, delaying the functional decline curve that brings with it the decrease in muscle strength with respect to age, which affects the ability to independently perform activities of daily living, in addition to reducing the risk of falls and the possibility of suffering musculoskeletal injuries.

The findings of this study are consistent with the results of previous research, which report increases in strength after PBFR training (Centner et al., 2019). The risk of falls represents one of the most common health problems in people over 60 years of age, and its impact is directly linked to decreased functionality. In this context, the assessment of gait and balance emerges as an essential and effective component to identify those individuals at risk of falls, and the practical form for this assessment is the Get Up and Go Test (Terra Jonas et al., 2014). Regarding the results of this test in this study, it is shown that no statistically significant results were achieved, but it is necessary to mention that despite not having a significant impact on physical activities, slight modifications can influence the improvement of the quality of life of older adults, remembering that autonomy in the execution of daily activities, considered as independence, it has a positive relationship with mental well-being (Segovia Díaz de León & Torres Hernández, 2011), on the other hand, Carol et al., (2022), explains that practically 9 out of 10 people who took the functional execution tests presented, as the get up and go test, may present values suggestive of fragility, a situation that could very likely lead to the fact that those people who would not be candidates to take the functional execution tests, may present some degree of fragility in relation to their established dependency situation, cognitive impairment, advanced illness or some other end-of-life situation.

PBFR and muscle mass

In contrast, even though a study from Flores-Garcia (2019) showed results of muscle hypertrophy in only 6 or 8 weeks of training with PBFR RPFS, in the present study of 12 weeks, a significant result was not achieved in this area. This result may be due to the way in which muscle mass was measured, which was generalized in the context of measuring sarcopenia (by dynamometry) and not through a measurement of specific perimeters that indicated hypertrophy in a particular region (González Pérez et al., 2019), as proposed by Alva, et al in 2014 to be evaluated through the measurement of calf circumference (CC) and mean muscle circumference of the arm (MMCA), observing in the comparison between the results that in 37.5% of the participants there was agreement in the diagnosis of sarcopenia. Even Yeguez and Sánchez (2019) cite that "the World Health Organization (WHO) recommends the use of CC, since it considers that it provides the most sensitive measure of the muscle mass of the elderly, considering it greater than the circumference of the arm." It may also be due to what Loenneke et al. (2012) indicated that the results can vary according to the width of the band used to restrict blood flow. In addition, Karabulut et al. (2010) indicated gains in muscle mass in older women from week 16 onwards. However, despite not presenting statistically significant results, the contribution of PBFR training to maintenance and a slight increase in muscle mass is observed (Centner et al., 2019). The use of training methods such as blood flow restriction is under development; in this regard, this is a study that investigates the effects on a vulnerable population such as older women. Despite the results identified and contributions made to this area of study, there are limitations with respect to the sample size and the lack of a control group, aspects that should be covered by future research with the purpose of highlighting the benefits of this training method.

Conclusions

It is concluded that strength training with loads between 20%-50% combined with PBFR, for lower limbs in women older adults, generates positive effects on some components related to sarcopenia, general strength (handgrip) specific strength (Chair stand test). However, it was not possible to establish a significant difference in terms of muscle mass. These results identify key areas for the research and development of more effective therapeutic strategies with alternative strength training methods like blood flow restriction. Based on these results, key areas are identified for the research and development of more effective therapeutic strategies.

Future studies with this type of training are suggested that are related to the prevention and/or early treatment of sarcopenia, considering it as an opportunity to reduce sequelae and improve the quality of life of those affected by this condition.

Acknowledgments
There are no acknowledgments.

Conflict of interest
The authors declare that they have no competing interests

Received: 18 November 2024 | **Accepted:** 04 May 2025 | **Published:** 01 June 2025

References

Agüero, S. D., Fuentes, J. F., & Leiva, A. V. (2017). Dinamometría, masa muscular y masa grasa braquial en adultos mayores autovalentes [Dynamometry, muscle mass, and brachial fat mass in self-sufficient older adults]. *Revista Española de Nutrición Comunitaria, 23*(4) https://www.renc.es/imagenes/auxiliar/files/RENC_2017_4_03.pdf.

Alva, M. C. V., Camacho, M. E. I., Lazarevich, I., Delgadillo-Velázquez, J., Acosta-Domínguez, P., & Ramírez, A. C. (2014). Evaluación de la masa muscular a través de 2 indicadores antropométricos para la determinación de sarcopenia en ancianas [Evaluation of muscle mass through 2 anthropometric indicators for the determination of sarcopenia in elderly women]. *Ciencias Clínicas*, 15(2), 47–54. https://doi.org/10.1016/j.cc.2015.08.003.

Andrés, J. B., Orcajada, J., & Esteban, J.P (2020). Efectos de la terapia por restricción de flujo sanguíneo en la práctica fisioterápica: Una revisión bibliográfica [Effects of Blood Flow Restriction Therapy in Physiotherapy Practice: A Literature Review]. *Npunto, 32*(3), 105-126 https://www.npunto.es/content/src/pdf-articulo/5fc4d6bf048bfart5.pdf

Asociación Americana del Medicina del Deporte (2009). American College of Sports Medicine position stand. Progression models in resistance training for healthy adults. *Medicine and Science in Sports and Exercise, 41*(3), 687–708. https://doi.org/10.1249/MSS.0b013e3181915670

Bahamondes-Ávila, C., Ponce-Fuentes, F., Chahin-Inostroza, N., Bracho-Milic, F., & Navarrete-Hidalgo, C. (2020). Strenght training with partial restriction of blood flow in older adults with sarcopenia. *Revista Cubana de Salud Pública, 46*(3), 1-18 http://scielo.sld.cu/pdf/rcsp/v46n3/1561-3127-rcsp-46-03-e1105.pdf

Carol, M. S., Peñas, L. B., Sala, L. B., Peñas, M. C. B., Roset, J. A., & Novellas, J. A. (2020). Aplicabilidad y limitaciones de las pruebas de ejecución funcional en el cribado de fragilidad al alta de un centro de atención intermedia [Applicability and limitations of functional performance tests in frailty screening at discharge from an intermediate care facility]. *Revista Española de Geriatría y Gerontología, 55*(4), 212-215.

Castro-Coronado, J., Yasima-Vásquez, G., Zapata-Lamana, R., Toloza-Ramírez, D., & Cigarroa, I. (2021). Características de los programas de entrenamiento de fuerza muscular en personas mayores con sarcopenia [Characteristics of muscle strength training programs in older people with sarcopenia]. *Revisión de alcance. Revista Española de Geriatría Y Gerontología, 56*(5), 279–288. https://doi.org/10.1016/j.regg.2021.05.004

Centner, C., Wiegel, P., Gollhofer, A., & König, D. (2019). Effects of blood flow restriction training on muscular strength and hypertrophy in older individuals: A systematic review and meta-analysis. *Sports Medicine (Auckland, N.Z.), 49*(1), 95–108. https://doi.org/10.1007/s40279-018-0994-1

Consejo Nacional de Población. (2021). *Día Internacional de las Personas de Edad [International Day of Older Persons]*. Gob.mx. https://www.gob.mx/conapo/es/articulos/dia-internacional-de-las-personas-de-edad-284170?idiom=es

Contreras Hernández, V. (2021). Reflexiones necesarias acerca de las actividades recreativas para beneficiar la calidad de vida en adultos mayores institucionalizados [Necessary reflections on recreational activities to benefit the quality of life in institutionalized older adults]. *Dilemas Contemporáneos: Educación, Política Y Valores*. https://doi.org/10.46377/dilemas.v9i.2944

Cortés, W. A. G., Fernández, F. E. M., & Sanmiguel, L. C. O. (2018). Sarcopenia, una patología nueva que impacta a la vejez [Sarcopenia, a new pathology that impacts old age]. *Revista Colombiana de Endocrinología, Diabetes & Metabolismo, 5*(1), 28–36. https://doi.org/10.53853/encr.5.1.339

Cristina-Oliveira, M., Meireles, K., Spranger, M. D., O'Leary, D. S., Roschel, H., & Peçanha, T. (2020). Clinical safety of blood flow-restricted training? A comprehensive review of altered muscle metaboreflex in cardiovascular disease during ischemic exercise. *American Journal of Physiology-Heart and Circulatory Physiology, 318*(1), H90–H109. https://doi.org/10.1152/ajpheart.00468.2019

Cruz-Jentoft, A. J., & Sayer, A. A. (2019). Sarcopenia. *The Lancet, 393*(10191), 2636–2646. https://doi.org/10.1016/s0140-6736(19)31138-9

Domingo-del-Val, D. (2022). Efectos de un entrenamiento multicomponente y posterior confinamiento (COVID-19) en personas mayores [Effects of multicomponent training and subsequent confinement (COVID-19) in older people]. *Apunts Educación Física y Deportes, 150*, 10–19. https://doi.org/10.5672/apunts.2014-0983.es.(2022/4).150.0

Espinel-Bermúdez, M. C., Sánchez-García, S., García-Peña, C., Trujillo, X., Huerta-Viera, M., Granados-García, V., … Arias-Merino, E. D. (2018). Factores asociados a sarcopenia en adultos mayores mexicanos: Encuesta Nacional de Salud y Nutrición [Factors associated with sarcopenia in Mexican older adults: National Health and Nutrition Survey]. *Revista Médica Del Instituto Mexicano Del Seguro Social, 56*(1), 46–53. https://www.redalyc.org/articulo.oa?id=457754907008

Flores-García, L. A. (2019). El entrenamiento con oclusión vascular como alternativa en rehabilitación muscular [Vascular occlusion training as an alternative in muscle rehabilitation]. *Revista de Sanidad Militar, 73*(3–4), 234–242. https://doi.org/10.35366/sm193_4g

Gálvez Cano, M., Varela Pinedo, L. F., Helver Chávez, J., Cieza Zevallos, J., & Méndez Silva, F. (2010). Correlación del Test "Get Up And Go" con el Test de Tinetti en la evaluación del riesgo de caídas en los adultos mayores [Correlation of the "Get Up And Go" Test with the Tinetti Test in the assessment of the risk of falls in older adults]. *Acta Médica Peruana, 27*(1), 08–11. http://www.scielo.org.pe/scielo.php?pid=S1728-59172010000100003&script=sci_abstract

González Pérez, D. A., Retamal, M. C., & Villena Pereira, J. A. (2019). Efectos del entrenamiento con restricción del flujo sanguíneo sobre el tejido muscular y óseo: un estudio piloto [Effects of blood flow restriction training on muscle and bone tissue: a pilot study]. *Archivos de Medicina del Deporte, 37*(2), 92-98.

Hopkins, W. G. (2000). Measures of reliability in sports medicine and science. *Sports Medicine*, *30*, 1-15. https://doi.org/10.2165/00007256-200030010-00001

Karabulut, M., Abe, T., Sato, Y., & Bemben, M. G. (2010). The effects of low-intensity resistance training with vascular restriction on leg muscle strength in older men. European *Journal of Applied Physiology, 108*(1), 147–155. https://doi.org/10.1007/s00421-009-1204-5

Lim, Z. X., & Goh, J. (2022). Effects of blood flow restriction (BFR) with resistance exercise on musculoskeletal health in older adults: a narrative review. *European Review of Aging and Physical Activity, 19*(1), 15. https://doi.org/10.1186/s11556-022-00294-0

Loenneke, J. P., Fahs, C. A., Rossow, L. M., Sherk, V. D., Thiebaud, R. S., Abe, T., Bemben, D. A., & Bemben, M. G. (2012). Effects of cuff width on arterial occlusion: implications for blood flow restricted exercise. *European Journal of Applied Physiology, 112*(8), 2903–2912. https://doi.org/10.1007/s00421-011-2266-8

Malafarina, V., Uriz-Otano, F., & Gil-Guerrero, L. (2013). Valoración y tratamiento nutricional de la sarcopenia [Nutritional assessment and treatment of sarcopenia]. *Revista Española de Geriatría Y Gerontología, 48*(4), 153–154. https://doi.org/10.1016/j.regg.2013.03.005

Martín Sierra, J. A., Calderón Loeza, G. Y., Zapata Vázquez, R. E., & Novelo Tec, J. F. (2021). Sarcopenia y factores asociados en los adultos mayores de una unidad de medicina familiar en Yucatán, México [Sarcopenia and associated factors in older adults in a family medicine unit in Yucatan, Mexico]. *Atención Familiar, 28*(3), 191. https://doi.org/10.22201/fm.14058871p.2021.3.79585

Mehmet, H., Yang, A. W. H., & Robinson, S. R. (2020). What is the optimal chair stand test protocol for older adults? A systematic review. *Disability and Rehabilitation, 42*(20), 2828–2835. https://doi.org/10.1080/09638288.2019.1575922

Montero-Errasquín, B., & Cruz-Jentoft, A. J. (2022). Sarcopenia. *Medicine - Programa de Formación Médica Continuada Acreditado, 62*(13), 3643–3648. https://doi.org/10.1016/j.med.2022.08.010

Muresan, B. T., Sánchez Juan, C., Artero, A., Montoro, A., Garcia Miragll, E., Ruiz, Y., … & López-Torrecilla, J. (2020). Tomografía computarizada a nivel de C3 y dinamometría como técnicas de diagnóstico de sarcopenia en pacientes con cáncer de cabeza y cuello [Computed tomography at C3 level and dynamometry as diagnostic techniques for sarcopenia in patients with head and neck cancer]. *Revista Española de Nutrición Humana y Dietética, 24*(2), 90–102. https://doi.org/10.14306/renhyd.24.2.927

Petermann-Rocha, F., Balntzi, V., Gray, S. R., Lara, J., Ho, F. K., Pell, J. P., & Celis-Morales, C. (2022). Global prevalence of sarcopenia and severe sarcopenia: a systematic review and meta-analysis. *Journal of Cachexia, Sarcopenia and Muscle, 13*(1), 86–99. https://doi.org/10.1002/jcsm.12783

Rodríguez-Rejón, A. I., Ruiz-López, M. D., Artacho, R., Rodríguez-Rejón, A. I., Ruiz-López, M. D., & Artacho, R. (2019). Diagnóstico y prevalencia de sarcopenia en residencias de mayores: EWGSOP2 frente al EWGSOP1 [Diagnosis and prevalence of sarcopenia in nursing homes: EWGSOP2 versus EWGSOP1]. *Nutrición Hospitalaria, 36*(5), 1074–1080. https://doi.

org/10.20960/nh.02573

Segovia Díaz de León, M. G., & Torres Hernández, E. A. (2011). Funcionalidad del adulto mayor y el cuidado enfermero [Functionality of the elderly and nursing care]. *Gerokomos, 22*(4), 162–166. https://doi.org/10.4321/s1134-928x2011000400003

Terra Jonas, L., Vitorelli Diniz Lima, K., Inácio Soares, M., Mendes, M. A., da Silva, J. V., & Ribeiro, P. M. (2014). Evaluación del riesgo de caídas en las personas mayores: ¿cómo hacerlo? [Assessing the risk of falls in older people: how to do it?]. *Gerokomos, 25*(1), 13–16. https://doi.org/10.4321/s1134-928x2014000100004

Villalba, F. (2022). Entrenamiento con restricción al flujo sanguíneo [Entrenamiento con restricción al flujo sanguíneo]. *Argentinian Journal of Respiratory & Physical Therapy, 4*(1), 52–56. https://doi.org/10.58172/ajrpt.v4i1.215

Yeguez M., F, Sánchez J., A (2019). Estado nutricional, masa muscular, fuerza y riesgo cardiometabólico en adultos mayores no institucionalizados [Nutritional status, muscle mass, strength and cardiometabolic risk in non-institutionalized older adults]. *Salus, 23*(2), 8-17, 2019. https:////www.redalyc.org/journal/3759/375967530003/html/#:~:text=Masa%20muscular%3A%20se%20consideró%20a,sexos%20(3%2C%2023)