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SUMARIO / SUMMARY / RESUMO

Editorial

With this new issue 2, 2023, of MLS Sport Research magazine we finish the publication dossier for the year 2023, consolidating our commitment to our readers. In this issue, 5 articles are presented that also highlight the multidisciplinary vocation of the journal in addressing various topics, in which physical activity and sports, both from the perspective of health, sports performance or Physical Education, is the guiding element. All this, through studies and literature reviews, cross-sectional studies, experiments or intervention programs. First, an interesting systematic review on the benefits of physical exercise as an adjunctive anti-cancer therapy, particularly in breast cancer, is described. In another paper, the socializing effect of children's play behavior in preschool children is analyzed. In addition, an interesting expert agreement study on some of the characteristics of sparring programming in amateur and professional boxing is presented. Another study describes a new tool, the Repeat Jump Ability (RJA), to assess peak power, average power and fatigue index in active non-athletic adults. Finally, a novel cross-sectional study, we delve into the knowledge of dermatoglyphic characteristics as an indicator in the selection of athletes, taking into account their genetic sporting potential and general genetic predisposition required for the sport they practice. With this new issue, the MLS Sport Research journal maintains its commitment to consolidate as a scientific resource for the multidisciplinary study of physical activity and sport, and invites researchers to send us their studies and papers for the next issue.

Dr. Pedro Ángel Latorre Román
Dr. Álvaro Velarde Sotres
Editors in chief

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BENEFITS OF PHYSICAL EXERCISE IN WOMEN DIAGNOSED WITH INVASIVE BREAST CANCER. A SYSTEMATIC REVIEW

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Abstract. The aim of the study was to analyze the benefits that physical exercise produces in women diagnosed with invasive breast cancer and are between stages I to IIIA, receiving chemotherapy, radiotherapy, or both simultaneously. The PubMed and Google Scholar databases were consulted until April 2022, yielding a total of 29,410 results. After applying the exclusion criteria, the number of selected articles that provided relevant data for the study was reduced to seven. The authors suggest that practicing aerobic training for a period of twelve to sixteen weeks at a rate of two days a week, in sessions lasting less than one hour and intensities of between 60%-80% of the HRmax generated beneficial adaptations. Similarly, practicing strength training at intensities between 60%-80% of 1RM, generated improvements in health status, psychological parameters and decreased pain symptoms and fatigue, among others. The study concludes that the practice of physical exercise by these patients, in the modalities of aerobic or strength training in a supervised and personalized manner, was beneficial, totally safe, and generated benefits such as the reduction of the sensation of fatigue, the reinforcement of the musculature, or the contribution to the daily physical activity did not decrease, which implicitly led to an improvement in the quality of life.

Keywords: breast cancer, aerobic training, strength training, health, chemotherapy, radiotherapy and side effects.

BENEFICIOS DEL EJERCICIO FÍSICO EN MUJERES DIAGNOSTICADAS DE CÁNCER DE SENO INVASIVO. UNA REVISIÓN SISTEMÁTICA

Resumen. El objetivo del estudio fue analizar los beneficios que el ejercicio físico produce en mujeres diagnosticadas de cáncer de seno invasivo y se encuentran entre las fases I a IIIA, recibiendo tratamiento de quimioterapia, radioterapia o ambos simultáneamente. Las bases de datos de PubMed y Google Académico fueron consultadas hasta abril de 2022 arrojando un total de 29.410 resultados. Tras aplicar los criterios de exclusión fijados, el número de artículos seleccionados que aportaban datos relevantes para el desarrollo del estudio se redujeron a siete. Los autores demostraron que practicar ejercicio aeróbico durante un periodo de entre doce y

dieciséis semanas a razón de dos días semanales, en sesiones inferiores a la hora de duración y en las que se realicen ejercicios a intensidades entre el 60%-80% de la FCmáx generaba adaptaciones beneficiosas. De igual manera, practicar entrenamiento de fuerza a intensidades entre el 60%-80% de la 1RM, generó mejoras en el estado de salud, los parámetros psicológicos y disminuyó los síntomas de dolor y la fatiga, entre otros. El estudio concluyó que la práctica de ejercicio físico en estas pacientes, incluyendo las modalidades de entrenamiento aeróbico o de fuerza de manera supervisada y personalizada, resultaba beneficioso, totalmente seguro y generaba beneficios tales como: la disminución de la sensación de fatiga, el refuerzo de la musculatura o la contribución a la adherencia de actividad física diaria, lo que resultó en una mejora en su calidad de vida.

Palabras clave: Cáncer de mama, entrenamiento, quimioterapia, radioterapia y efectos secundarios.

Introduction

Cancer is known as the disease that is generated in any cell of the body as a result of suffering some alteration originated by internal or external causes such as genes inherited from parents (Solidoro, 2006), exposure to certain carcinogenic agents (Walker et al., 2020) or even the food ingested throughout life (Cummings and Bingham, 1998). These changes cause the altered cells, which are called "cancerous", to multiply uncontrollably and may even spread to other parts of the body if the disease is not detected in time (Chaffer and Weinberg, 2011). Mutations usually affect three different types of genes: proto-oncogene, tumor suppressor gene and DNA repair gene. When modifications occur in these structures they are known as oncoinitiators (Martinez, 2011).

The normal cycle through which a cell passes during its lifetime consists of formation and multiplication through cell division. When they age or are damaged, their cycle ends, giving way to the birth of new ones (Weinberg, 1996). However, there are occasions when the cell ages or is damaged, instead of dying, it multiplies uncontrollably, generating the appearance of lumps in the tissues called tumors, which can be malignant or benign. In the case of cancerous tumors, they usually invade nearby tissues and if not treated in time, the damaged cells can spread to other parts of the body through the bloodstream or lymphatic vessels, thus forming new tumors (Aznar et al., 2005). This process is known as metastasis. On the other hand, non-cancerous tumors do not spread to nearby tissues and do not usually recur after removal. However, tumors of this type, in some cases, can reach large dimensions and can even cause death in some cases (INC, 2022; MedlinePlus, 2022)

The most common cancers in our country, according to the Spanish Society of Medical Oncology (SEOM), which puts the total number of cases diagnosed in 2021 at 276,239, were, in this order of incidence, the following: colorectal cancer with 43,581 cases, prostate cancer with 33,764, breast cancer with 33,375 and lung cancer with 29,549 cases. It should be considered that these figures may be biased because of the incidence of Covid-19, since, during the pandemic state, medical oncology consultations and tests were greatly affected (Al-Quteimat and Amer, 2020). Even so, the data obtained are very similar to the number of cases diagnosed in 2020 (REDECAN, 2020). Globally, and during 2020, the types of cancer with the highest incidence were in this order breast, lung, colorectal, prostate and stomach, all with values above one million cases (Ferlay, 2018).

This study focuses specifically on breast cancer, more specifically on invasive breast cancer, differentiating within these several types and the most common being invasive ductal carcinoma and invasive lobular carcinoma (Ramirez, 2018). Typically, within the glandular breast tissue, breast cancer occurs in 80% of cases due to a change in the epithelium lining the ducts, while in 10% of cases it develops in the lobules (Klijn, 2001). The remaining percentage of cases correspond to other less common subtypes (ACS, 2010). Initially, the cancerous tumor is usually confined to one of these two areas, being practically undetectable, asymptomatic and

with little capacity for dissemination, at this point being called stage 0. If the cancerous material is not detected in time, it can invade the surrounding breast tissue and become known as invasive breast cancer, spreading to the lymph nodes and thus initiating a metastasis called regional metastasis, and if the spread of cancer cells continues to advance it will be called distant metastasis (ACS, 2010).

Currently, the treatment of this type of cancer is usually very effective, especially when the disease is detected in early stages (Ginsburg et al., 2020). The most common approach to eradication is usually to combine surgical removal with radiotherapy, targeted biological medication, chemotherapy or hormonal therapy, all with the aim of eradicating cancerous particles that have managed to spread from the breast tumor through the blood (Mutebi et al., 2020).

Breast cancer is a non-communicable disease in which there are certain common behavioral patterns. Changing these behavioral patterns over the years has been shown to reduce the chances of becoming ill by about 30% (Boffetta and Nyberg, 2003). These patterns include a series of recommendations regarding lifestyle habits such as prolonged breastfeeding, avoidance of alcohol consumption, non-exposure to tobacco smoke, prolonged use of hormones, excessive radiation exposures, and regular physical exercise (PE) (Wild et al., 2020).

It is in this last recommendation that this work is based. Over time, numerous studies have been conducted to try to obtain a training program with guidelines that are proven beneficial in the treatment of this disease (Leach et al., 2019). To date, the common conclusion of the studies carried out to date is that both aerobic exercise and strength exercise practiced regularly during the treatment period report clear benefits (Prado et al., 2004). Aerobic exercise is a safe and effective exercise modality that has a positive impact on such common symptoms of breast cancer as fatigue, loss of aerobic capacity, decreased strength and endurance, reduced increase in body mass index, weight and pain, thus improving patients' quality of life and quality of sleep (Batista-Martínez et al., 2019).

In these patients diagnosed with breast cancer, strength training, performed both with external loads and self-loads, improves health status, psychological parameters, pain symptoms, physical functionality, sexual functionality and enjoyment, fatigue, mood, emotional health, cognitive health, body composition and physical capacity. (Santos Durán et al., 2021). According to the ACS (2010) when talking about the benefits of PE during treatment for any type of cancer, it can be highlighted that it reduces the feeling of tiredness or fatigue, helps to reduce pressure and anxiety, improves physical ability to be independent, improves muscle strength, bone health and range of motion, and reduces the side effects of treatment.

Currently, there is not much scientific evidence on the benefits of the EF in women diagnosed with invasive breast cancer stages I to IIIA. Therefore, the aim of this review is to provide an updated overview on the effectiveness of treatments based on FE interventions in patients with invasive breast cancer between stages I to IIIA. Once the existing information has been studied, the aim is to arrive at some kind of conclusive result, which will make it possible to objectify the importance of the EF as part of a therapeutic intervention in the fight against breast cancer.

Method

The search for articles to prepare the paper was carried out during the first four months of the year 2022, between January and March, consulting the Google academic and Pubmed databases. For the selection of the articles to be reviewed, we have used searches with combined words and Boolean markers to filter the information and thus be able to reach the largest number of articles under study, the words used were "breast cancer" "physical exercise" "physical

activity" "breast cancer" "physical exercise" "physical activity" "aerobic training" and "strength training".

All articles on the subject to be reviewed were selected, regardless of language, year of publication and age of the sample. All the selected articles contain the variable invasive breast cancer and the variable physical exercise, regardless of which type was used in the study methodology.

We excluded all articles that were outside the scope of the study, those focused on more than one pathology, articles whose objective was not to study the improvement of the disease by means of PE, and those that did not provide clear results or detailed conclusions.

Results

The Prisma flowchart below shows graphically and schematically the selection criteria used to sift through the more than twenty-nine thousand articles found that deal with physical exercise and breast cancer, being finally seven the only ones that meet all the criteria and therefore those chosen for this review.

Figure 1

PRISMA flowchart for the identification of studies through systematic reviews

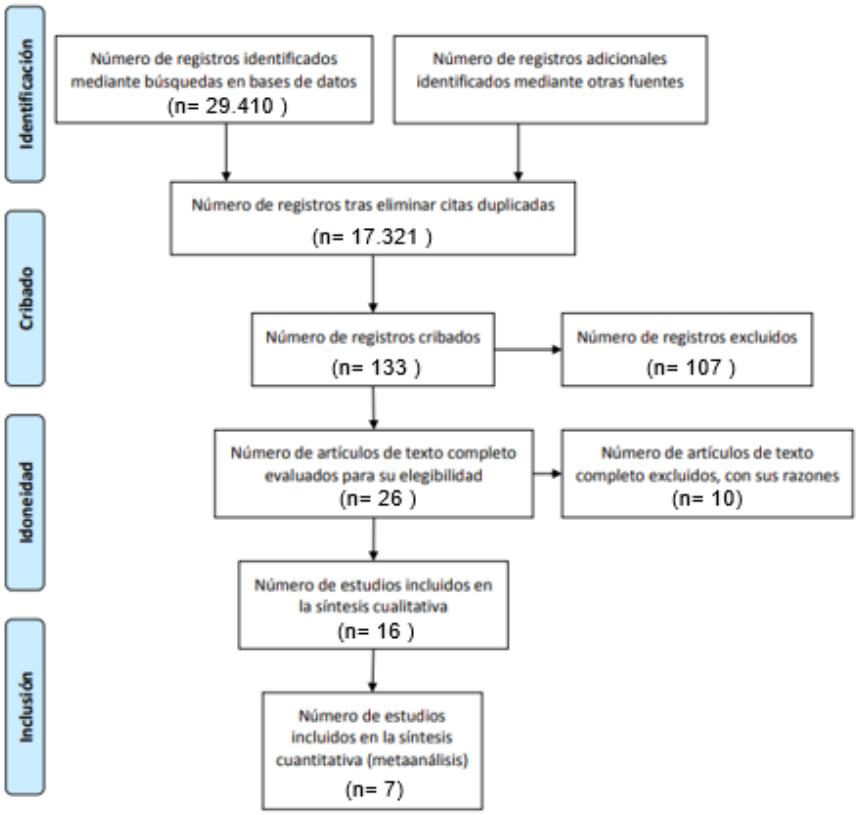

Table 1
*SEQ Illustration * ARABIC 2 Summary selected articles*

Title	Participants	Methodology	Intervention time	Method of evaluation	Results
Campbell et., al (2005)	22 women in stage I and II CM, receiving QT, RT or both	EA and EF. Intensity 60%-75% 1RM.	2 sessions of 20 minutes, per week for 12 weeks	Walking test for 12 minutes ACT-G ACT-B WLS FS PAQ	A structured group exercise program during adjuvant treatment is a safe, well-tolerated and effective way to provide psychological health benefits for women during early-stage breast cancer treatment.
Dieli-Conwright et al., (2018)	418 women with MC whose mean age was 53.5 years receiving QT and RT.	EA and EF	2/3 days a week for 16 weeks + 12 weeks non face-to-face training. G1: control group G2: days 1 and 3 aerobic exercise + strength (80') Day 2 aerobic exercise (50')	-Physical condition tests. -Biomarkers. -Quality of life questionnaires.	The patients' quality of life, depression and fatigue improved, and they were able to maintain their physical condition after 3 months. Significant increase in physical fitness and cardiorespiratory fitness
Ergun et al., (2013)	60 women with CM with mastectomy, and receiving QT, RT or both.	EA and EF. Intensity 60%-80% 1RM.	3 sessions per week of 45 minutes during 12 weeks	RayBio Human Cytokine Antibody array 3 -EORTC QLQ-C30 -BFI -BDI -ELISA kit.	Aerobic and strength exercises, alone or in combination, can be effective in improving quality of life and alleviating depression in breast cancer patients. It is important to schedule training sessions and to monitor patients. Changes in molecules related to angiogenesis and apoptosis are observed. More similar studies on exercise will be useful to raise awareness among both patients and health professionals.
Pereira-Rodríguez et al. (2020)	216 women in stage II disease and receive QT.	Supervised exercise included: high intensity cardiovascular and resistance training, relaxation training and body awareness. They were divided into 3 groups: **G1:** MICT **G2:** HIIT **G3:** control	3 days per week for 70' for 36 weeks. **G1:** 30' EA at 60%-80% FCmax and 20 min of EF at 40%.60% of 1 RM **G2:** the 30' of EA followed a 30-30	-Anthropometric measurements -Vital signs, cardiovascular function and stress test (6-minute walk). -Fatigue (FACT-Fatigue Scale)	Both HIIT and MICT training generate significant adaptations in the parameters evaluated. The first method is the most beneficial at the end of the intervention period. Both methods have been shown to be safe and

			protocol, i.e. 30 seconds at moderate intensity (60%-80% FCmax) and 30 seconds at high intensity (80%-90%) The EF phase was the same as G1.	-EORTC QLQ C-30.	beneficial for this type of patients affected by stage II breast cancer, also reducing fatigue levels, improving quality of life and increasing in parallel the indices of exercise tolerance, vo2 and MET.
Schmidt et al., (2015)	101 women over 18 years of age who have undergone mastectomy and are receiving QT.	EA and EF. Intensities 60%-80% 1 RM.	G1: 60-minute sessions 2 times a week. G2: 60-minute sessions twice a week. Both lasted 12 weeks	Fatigue is assessed with the Fatigue Assessment Questionnaire (FAQ) scale	The study demonstrates that practicing progressive and supervised strength exercises during chemotherapy treatment develops very important clinical benefits on fatigue and QoL. Starting to exercise coinciding with the first treatment sessions helps to prevent the spiral of deterioration that begins with loss of muscle strength, followed by a gradual decrease in physical activity and increased feelings of fatigue, all of which, even if the treatment is successfully completed, inevitably leads to health problems.
Travier et al., (2015)	204 women between 25 and 75 years of age with CM, without metastases and receiving QT.	EA and EF. **EA:** 25' per session **EF:** 2x10 reps at 65% 1RM, 1x10 reps at 75% 1RM, 1x20 reps at 45% 1RM.	**G1:** does not exercise. **G2:** 2 sessions per week for 18 weeks. 30' of unsupervised exercise 3 days a week was recommended	Multidimensional Fatigue Inventory (MFI) Fatigue Quality List (FQL) Dynamometries.	An 18-week supervised exercise program offered early in routine care during adjuvant breast cancer treatment showed positive effects on physical fatigue, submaximal cardiorespiratory fitness and muscle strength. At 36 weeks, these effects were no longer statistically significant. This could have been due to the high levels of physical activity of the participants in the control group during follow-up.
Winters-Stone et al., (2012)	106 women with stage I-IIIA CM, who are receiving QT, RT or both	EF. Intensity 60%-80% 1 RM.	2 sessions per week of 60 minutes during 1 year	1-RM measurement. SCFS.	Strength training along with impact-generating exercises are a

		PPB. Hand dynamometry.	good option for exercise adherence in addition to producing physical improvement. Elderly patients with CM can also participate in strength exercises to improve upper and lower body strength, reducing the risk of falls and future mobility problems.

Note. CM - Breast cancer PPB - Women's health questionnaire
QT - Chemotherapy MFI - Multidimensional Fatigue Inventory
RT - Radiotherapy Elisa Kit - antibody detection
AE - Aerobic Exercise SPAQ - Scottish Physical Activity Questionnaire
EF - Strength Training BDI - Beck Depression Inventory
SWLS - Satisfaction with Life Satisfaction Scale QoL - Quality of life
Fact-G - Functional assessment of general cancer treatment. EORTC QLQ-C30 - European Organization for Research and Treatment of Cancer.
Fact-B - Functional assessment of breast cancer treatment. MICT - Moderate Intensity Continuous Training
SCFS - Schwartz Cancer Fatigue Scale HIIT - High-Intensity Interval Training

Discussion and conclusions

The purpose of this research study is based on analyzing with tangible data whether the practice of PE in a guided and continued manner, whether aerobic or strength training, generates some type of benefit or help in minimizing the side effects produced by both the disease and the aggressive treatments that these patients have to face, such as tiredness or fatigue, weight loss, decreased cognitive function, loss of appetite or vomiting. This screening is framed for women who are diagnosed with invasive breast cancer and are between stages I to IIIA, and are receiving chemotherapy, radiotherapy or both at the same time, in any of the scheduled cycles.

In order to analyze the information in the most detailed and comprehensible way possible, a system has been used that consists of dividing this information into blocks, resulting in three clearly differentiated results: results referring to the benefits after strength training, aerobic training or combined training.

Regarding strength training, Schmidt et al., (2015) conclude that strength training in early stages of the disease can prevent muscle deterioration and alleviate the feeling of fatigue. In the study elaborated by Travier et al., (2015), the patients analyzed obtained improvements in the values of fatigue, submaximal cardiorespiratory capacity and muscle strength. These data are in agreement with those obtained by Battaglini et al. (2006), who examined the effects of a program with emphasis on individualized strength work in a group of women with breast cancer. In this study, the group of participants who underwent the intervention program significantly decreased their perception of fatigue and increased their muscle strength. Ergun et al., (2013) refers to the improvement in quality of life experienced by these patients when performing this type of training, as in a study by Soriano-Maldonado et al., (2019), which aimed to evaluate the effects on quality of life and muscle strength of a 12-week supervised strength exercise program with home aerobic exercise compared to home aerobic exercise alone. The increase in strength in both the lower and upper body automatically ensures that balance is not disturbed by the loss of muscle mass.

The improvements proposed by the aforementioned authors are all in line with each other. All the adaptations achieved took place in a time span of 12 weeks to one year. Ergun et al., (2013) themselves refer in their study to the fact that the action times were limited to 12 weeks, thus stating that the results cannot be considered conclusive in terms of the patients' life expectancy, but they can be considered conclusive in terms of improvement of body parameters. In the results obtained by Battaglini et al., (2006) and Soriano-Maldonado et al., (2019), and the results obtained in our review referring to improved quality of life, decreased fatigue and increased muscle strength, the durations of the interventions also ranged between those periods, respectively at 21 and 12 weeks.

To conclude this section, it should be emphasized that the intensities at which we worked in practically all the interventions ranged between 60%-80% of the 1RM, a range in which the stimulus received by the patient is optimal for obtaining improvements. If the intensity of the work is below 60%, it would be a stimulus with very little load, so we would not achieve significant adaptations. If, on the other hand, it were higher than 80%, it would be considered excessive, since we have to take into account that we are dealing with people with a complicated pathology (Pereira-Rodríguez et al., (2020a), Pereira-Rodríguez et al, (2020b), Winters-Stone et al., (2012), Schmidt et al., (2015), Campbell et., al (2005) and Ergun et al., (2013)) Travier et al., (2015) is the only one who deviates from this pattern, proposing to perform 4 series with the following structure: 2x10 repetitions at 65% 1RM, 1x10 repetitions at 75% 1RM and lastly 1x20 repetitions at 45% 1RM. In a review conducted by Lopez et al. (2020) that aimed to know the dose-response of strength exercise in breast cancer patients, after 10 articles analyzed, it was concluded that low-volume strength training could provide a conservative and appropriate approach in this type of patients, in addition to allowing a safer and more effective progression with the aim of producing the desired adaptations. The data obtained in this review are in agreement with those obtained in the present one, except for the one carried out by Traver et al. (2015).

In the results concerning aerobic training, Pereira-Rodriguez et al. (2020b) differ from conventional methods. The aim of the study is to analyze whether high-intensity interval training, known as HIIT, is really beneficial and can be safely practiced by breast cancer patients. The intensities at which we worked in this study were between 60%-80% of the FCmax for the MICT group, a range also proposed by other studies such as those published by Pereira-Rodriguez et al., (2020a), Winters-Stone et al., (2012). Schmidt et al., (2015), Campbell et., al (2005) and Ergun et al., (2013), and between 80%-90% of HRmax for those who trained HIIT. After 36 weeks of intervention, both the conventional and high-intensity interval training groups showed physical and biological improvements. If we look only at the women who trained HIIT, the improvements obtained were more significant. This study also included within the training session a part of strength exercises, which was identical for both the control group and the experimental group, so it can be concluded that the differences observed in the results were exclusively due to training with the HIIT method. In a study by Schmitt et al., (2016) the effects on quality of life and fatigue were compared in 2 groups of women with cancer. Each group of women underwent an exercise program, one based on combined strength and endurance exercise and the other with high intensity intervals. Both groups improved to a similar degree, however, they concluded that the HIIT strategy could be beneficial for this type of patient, since, in addition to reporting similar benefits, HIIT training took less time, which may be beneficial in this population.

Finally, it should be noted that most authors opt for combined training with sessions in which aerobic work and strength training are performed. Pereira-Rodríguez et al. (2020b) opted for a high intensity method for the aerobic work. Winters-Stone et al., (2012) opted for exercises that generate impact with the intention of improving balance and muscle strength, being the

improvement of these two aspects a contribution to reduce the risk of falls that usually suffer this type of patients throughout the disease. Pagola et al. (2020) analyzed the effects of a combined aerobic and strength exercise program for 24 weeks on psychological and physiological parameters in a group of women with breast cancer, compared to a control group without any type of physical exercise intervention. The results of this study concluded the importance of early inclusion of structured physical activity in cancer patients due to the improvements observed in the intervention group.

Dieli-Conwright et al., (2018) is the only one who after performing a sixteen-week intervention during chemotherapy treatment, proposed to the patients to continue for another twelve weeks performing physical exercise in an unsupervised manner and with the consequent lack of knowledge of the frequency of training that the patients performed during this period. The patients took advantage of the training and habits obtained during the first phase of the intervention to ingrain a training routine. Tests performed at the end of this period showed that the adaptations generated during the first phase did not diminish. However, these data are not in line with those obtained by Hwang et al. (2008), in which 40 women were randomized into 2 training groups: the first, which consisted of an exercise intervention at moderate intensity and supervised for 50 minutes 3 days per week. This intervention included shoulder-focused stretching exercises, aerobic exercise and strengthening exercise. The second, the control group, was composed of women who had to perform shoulder stretching exercises autonomously. The results showed that the control group showed decreased range of motion in all directions and a higher pain score. In contrast, the supervised exercise intervention group showed increased range of motion in all directions and lower pain scores. In addition, the structured exercise program was shown to produce better results. Although these improvements may be due to the fact that the supervised exercise group includes strength and endurance work in addition to flexibility, the results show that supervised, structured, multi-exercise physical exercise would produce greater benefits in these patients. Mutrie et al. (2207) also reported that the supervised exercise group showed improved physical and psychological functioning compared to the group performing unsupervised physical exercise at home, which is also similar to the study by Hwang et al., (2008) and contradicts our results. Therefore, supervised exercise guided by professionals may be more effective than home exercise.

The main limitation in preparing this study was the difficulty in selecting published articles that met all the eligibility criteria. For this reason, the final number of articles to be reviewed was only seven. Among those selected, although both the variability of the intervention periods and the variability of the evaluation tests used were heterogeneous, the conclusions were practically unanimous.

Once the review is completed, it can be concluded without a doubt that the practice of physical exercise in the modalities of aerobic or strength training on a continuous basis in women who have been diagnosed with some type of breast cancer and are undergoing treatment with chemotherapy or radiotherapy, is, from the clinical point of view, beneficial and totally safe, as long as it is performed in a supervised and personalized manner. It should be taken into account that on many occasions the physical activity to be performed must be adapted to the mood, sensations and particular needs of each of the patients, knowing that, depending on the moment of the cycle in which they are, these sensations will vary significantly.

It can also be concluded that, in women affected by this type of pathology, the habit of doing PE in a regular and controlled manner, apart from bringing psychological benefits, has other benefits such as: the reduction of the sensation of fatigue, the reinforcement of the muscles or the contribution to the daily physical activity does not decrease, with the objective of improving the quality of life.

Finally, it has also been shown that practicing aerobic exercise for twelve to sixteen weeks at a rate of two days a week, in sessions that do not exceed one hour in duration and in which exercise is performed on a treadmill or bicycle at intensities of between 60%-80% of the HRmax generates beneficial adaptations in women affected by invasive breast cancer who are between stages I to IIIA and who are receiving chemotherapy, radiotherapy or both. Similarly, practicing strength exercise independently or combined with aerobic exercise during the same period of time in which strengthening exercises are performed for both upper and lower body at intensities between 60%-80% of 1RM generates improvements in health status, psychological parameters, decreases pain symptoms, increases physical functionality, improves sexual functionality and enjoyment, decreases fatigue, improves mood, emotional health, cognitive health, body composition and physical capacity.

References

American Cancer Society | Information and Resources about for Cancer: Breast, Colon, Lung, Prostate, Skin. (n. d.). American Cancer Society. https://www.cancer.org/es/cancer/cancer-de-seno/acerca/tipos-de-cancer-de-seno/cancer-invasivo-del-seno.html.

Al-Quteimat, O. M., & Amer, A. A. (2020). The Impact of the COVID-19 Pandemic on Cancer Patients. *American Journal of Clinical Oncology*, *43*(6), 452-455. https://doi.org/10.1097/coc.0000000000000712

Aznar, F., Cortadellas, T., & Xercavins, J. (2005). Patología benigna de la mama II: Tumores benignos de mama. Fundamentos de Ginecología. *Sociedad Española de Ginecología y Obstetricia SEGO*, 483-92.

Battaglini, C. L., Bottaro, M., Dennehy, C. A., Barfoot, D., Shields, E. W., Kirk, D., & Hackney, A. C. (2006). The effects of resistance training on muscular strength and fatigue levels in breast cancer patients. *Revista Brasileira De Medicina Do Esporte*, *12*(3), 153-158.

Batista-Martínez, A., González, Y. G., & da Cuña Carrera, I. (2019). Programas de ejercicio aeróbico y sus beneficios en el cáncer de mama: Una revisión sistemática. *Cuestiones de fisioterapia: revista universitaria de información e investigación en Fisioterapia*, *48*(1), 40-55.

Boffetta, P., & Nyberg, F. (2003). Contribution of environmental factors to cancer risk. *British Medical Bulletin*, *68*(1), 71-94. https://doi.org/10.1093/bmp/ldg023

Campbell, A., Mutrie, N., White, F. A., McGuire, F., & Kearney, N. (2005). A pilot study of a supervised group exercise programme as a rehabilitation treatment for women with breast cancer receiving adjuvant treatment. *European Journal of Oncology Nursing*, *9*(1), 56-63. https://doi.org/10.1016/j.ejon.2004.03.007

Chaffer, C. L., & Weinberg, R. A. (2011). A Perspective on Cancer Cell Metastasis. Science, 331(6024), 1559-1564. https://doi.org/10.1126/science.1203543

Cheema, B. S., Kilbreath, S. L., Fahey, P., Delaney, G. P., & Atlantis, E. (2014). Safety and efficacy of progressive resistance training in breast cancer: a systematic review and meta-analysis. *Breast Cancer Research and Treatment*, *148*(2), 249-268. https://doi.org/10.1007/s10549-014-3162-9

Cummings, J. H., & Bingham, S. (1998). Fortnightly review: Diet and the prevention of cancer. *BMJ*, 317(7173), 1636-1640. https://doi.org/10.1136/bmj.317.7173.1636

Dieli-Conwright, C. M., Courneya, K. S., Demark-Wahnefried, W., Sami, N., Lee, K., Sweeney, F. C., Stewart, C. F., Buchanan, T. A., Spicer, D. V., Tripathy, D., Bernstein, L., & Mortimer, J. E. (2018). Aerobic and resistance exercise improves physical fitness, bone health, and quality of life in overweight and obese breast cancer survivors: a

randomized controlled trial. *Breast Cancer Research*, *20*(1). https://doi.org/10.1186/s13058-018-1051-6

Ergün, M., Eyigör, S., Karaca, B., Kisim, A., & Uslu, R. (2013). Effects of exercise on angiogenesis and apoptosis-related molecules, quality of life, fatigue and depression in breast cancer patients. *European Journal of Cancer Care*, *22*(5), 626-637. https://doi.org/10.1111/ecc.12068

Ginsburg, O., Yip, C. H., Brooks, A. D., Cabanes, A., Caleffi, M., Yataco, J. R., Gyawali, B., McCormack, V., De Anderson, M. M., Mehrotra, R., Mohar, A., Murillo, R., Pace, L. E., Paskett, E. D., Romanoff, A., Rositch, A. F., Scheel, J. R., Schneidman, M., Unger-Saldaña, K., Anderson, B. O. (2020). Breast cancer early detection: A phased approach to implementation. *Cancer*, *126*(S10), 2379-2393. https://doi.org/10.1002/cncr.32887

Home | Redecan. (n. d.). https://redecan.org/es

Hwang, J. H., Chang, H., Shim, Y. M., Park, W. S., Huh, S. J., & Yang, J. (2008). Effects of Supervised Exercise Therapy in Patients Receiving Radiotherapy for Breast Cancer. *Yonsei Medical Journal*, *49*(3), 443. https://doi.org/10.3349/ymj.2008.49.3.443

Klijn, J. G. M., Blamey, R. W., Boccardo, F., Tominaga, T., Duchateau, L., & Sylvester, R.(2001). Advanced breast cancer (II). *Journal of clinical oncology, 19*, 343-353.

Leach, H. J., Mama, S. K., & Harden, S. M. (2019). Group-based exercise interventions for increasing physical activity in cancer survivors: a systematic review of face-to-face randomized and non-randomized trials. *Supportive Care in Cancer, 27*(5), 1601-1612. https://doi.org/10.1007/s00520-019-04670-y

Lopez, P., Galvão, D. A., Taaffe, D. R., Newton, R. U., Souza, G., Trajano, G. S., & Pinto, R. S. (2021). Resistance training in breast cancer patients undergoing primary treatment: a systematic review and meta-regression of exercise dosage. *Breast Cancer*, *28*(1), 16-24. https://doi.org/10.1007/s12282-020-01147-3

Mutebi, M., Anderson, B. O., Duggan, C., Adebamowo, C., Agarwal, G., Ali, Z. & Eniu, A. (2020). Breast cancer treatment: A phased approach to implementation. *Cancer, 126*, 2365-2378. https://doi.org/10.1002/cncr.32910

Mutrie, N., Campbell, A. M., Whyte, F., McConnachie, A., Emslie, C., Lee, L., & Ritchie, D. (2007). Benefits of supervised group exercise programme for women being treated for early stage breast cancer: pragmatic randomised controlled trial. *Bmj*, *334*(7592), 517. https://doi.org/10.1136/bmj.39094.648553.ae

Pereira-Rodríguez, J. E., Mercado-Arrieta, M. A., Quintero-Gómez, J. C., Lopez-Flores, O., Díaz-Bravo, M., & Juárez-Vilchis, R. (2020a). Efectos y beneficios del entrenamiento de fuerza en pacientes con cáncer: revisión sistemática de la literatura. *Universidad Médica Pinareña, 16(*3), 1-15.

Pereira-Rodríguez, J. E., Peñaranda-Florez, D. G., Pereira-Rodríguez, R., Pereira-Rodríguez, P., Velásquez-Badillo, X., & Cañizares-Pérez, Y. A. (2020b). Fatiga asociada al cáncer de mama luego de un programa de entrenamiento. *Acta Médica Costarricense*, *62*(1), 18-25. https://doi.org/10.51481/amc.v62i1.1056

Ramirez, M. E. (2018). Cáncer de mama. *Revista Médica Sinergia, 2*(01), 8-12.

Santos-Durán, S. A., Luna-Dueñas, J. G., & García-González, D. E. (2021). Fuerza resistencia en la calidad de vida de mujeres con cáncer de seno: Una revisión de sistemática. *Oncol,* (Guayaquil), 164-175.

Schmidt, M. E., Wiskemann, J., Armbrust, P., Schneeweiss, A., Ulrich, C.M., & Steindorf, K. (2015). Effects of resistance exercise on fatigue and quality of life in breast cancer patients undergoing adjuvant chemotherapy: a randomized controlled

trial. *International journal of cancer*, *137*(2), 471-480. https://doi.org/10.1002/ijc.29383

Schmitt, J., Lindner, N., Reuss-Borst, M., Holmberg, H. C., & Sperlich, B. (2016). A 3-week multimodal intervention involving high-intensity interval training in female cancer survivors: a randomized controlled trial. *Physiological reports*, *4*(3), e12693. https://doi.org/10.14814/phy2.12693

Solidoro-Santisteban, A. (2006). Cancer in the 21st century. *Acta Médica Peruana, 23*(2), 112-118.

Soriano-Maldonado, A., Carrera-Ruiz, Á., Díez-Fernández, D. M., Esteban-Simón, A., Maldonado-Quesada, M., Moreno-Poza, N., & Casimiro-Andújar, A. J. (2019). Effects of a 12-week resistance and aerobic exercise program on muscular strength and quality of life in breast cancer survivors: Study protocol for the EFICAN randomized controlled trial. *Medicine, 98*(44). https://doi.org/10.1097/md.0000000000018419

The International Agency for Research on Cancer (IARC). (n. d.). *Global Cancer Observatory*. https://gco.iarc.fr/

Travier, N., Velthuis, M. J., Bisschop, C. N. S., Van Den Buijs, B. J. W., Monninkhof, E. M., Backx, F. J. G., Los, M., Erdkamp, F. L. G., Bloemendal, H. J., Rodenhuis, C., De Roos, M. A., Verhaar, M., Huinink, D. T. B., Van Der Wall, E., Peeters, P. H., & May, A. M. (2015). Effects of an 18-week exercise programme started early during breast cancer treatment: a randomised controlled trial. *BMC Medicine, 13*(1). https://doi.org/10.1186/s12916-015-0362-z

Walker, W. F., Bumgarner, J. R., Walton, J., Liu, J. E., Meléndez-Fernández, O. H., Nelson, R. J., & DeVries, A. C. (2020). Light Pollution and Cancer. International Journal of *Molecular Sciences, 21*(24), 9360. https://doi.org/10.3390/ijms21249360

Weinberg, R. A. (1996). How cancer arises. *Scientific American, 275*(3), 62-70. https://doi.org/10.1038/scientificamerican0996-62

Winters-Stone, K. M., Dobek, J., Bennett, J. A., Nail, L. M., Leo, M. C., & Schwartz, A. (2012). The effect of resistance training on muscle strength and physical function in older, postmenopausal breast cancer survivors: a randomized controlled trial. *Journal of Cancer Survivorship, 6*(2), 189-199. https://doi.org/10.1007/s11764-011-0210-x

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PLAYFUL BEHAVIOR AND SOCIAL INTERACTION OF CHILDREN FROM 5 YEARS OLD IN A REAL PHYSICAL EDUCATION TEACHING ENVIRONMENT

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Abstract. Movement through play favors the development of physical, cognitive and social skills of schoolchildren during the early childhood education stage. Aim: A pilot study was designed with the aim of analyzing play behavior and social interaction in 5-year-old boys and girls in a real teaching environment, determining the pedagogical characteristics of this learning environment. Method: 21 primary school children (12 girls and 9 boys) aged 5 years participated in this descriptive-cross-sectional study. The evaluation of children's behavior and cognitive functions was assessed using the ACFS includes the Behavior Observation Rating Scale (BORS), which evaluates seven attitudes of the child in relation to learning: self-regulation, persistence, frustration tolerance, flexibility, motivation, interactivity and responsivity. Playful behaviour was evaluated using the Penn Interactive Peer Play Scale (PIPPS). Results: item analysis on the PEPPS scale showed only significant differences by sex on the item: tattletale, tells secrets" ($p < 0.05$). Conclusions: The findings reflected that there were no significant differences when comparing by sex. Children's experiences in a specific sociocultural context. Therefore, it should be repeated in future studies with larger samples, to validate this observational methodology of children's behavior across different learning environments.

Key words: cognition, physical education, play, coordination, motor skills.

COMPORTAMIENTO LÚDICO Y LA INTERACCIÓN SOCIAL DE NIÑOS Y NIÑAS DE 5 AÑOS EN UN ENTORNO REAL DE ENSEÑANZA EN EDUACIÓN FÍSICA

Resumen. Durante la etapa de educación infantil, el movimiento a través del juego favorece al desarrollo de las capacidades físicas, cognitivas y sociales de los escolares. Objetivo: Se diseñó un estudio piloto con el objetivo de analizar el comportamiento lúdico y la interacción social en niños y niñas de 5 años en un entorno real de enseñanza, determinando las características pedagógicas de ese ambiente de aprendizaje. Método: 21 escolares de Educación Primaria (12 niñas y 9 niños) de 5 años participaron en el presente estudio de diseño descriptivo-transversal. La evaluación del comportamiento infantil y las funciones cognitivas se evaluó utilizando la escala de Observación del Comportamiento (BORS). El comportamiento lúdico se evaluó utilizando la escala de juego interactivo entre pares (PEPPS) para profesores en español. El comportamiento lúdico se evaluó mediante la escala Penn Interactive Peer Play Scale (PIPPS). Esta escala evalúa las relaciones lúdicas en el aula de preescolar y los puntos fuertes de juego de los niños pequeños. Resultados: el análisis por ítem en la escala PEPPS mostró

únicamente diferencias significativas por sexos en el ítem: chismorrea, rumorea, dice secretos ($p < 0.05$). Conclusiones: Los hallazgos reflejaron que no existió diferencias significativas al comparar por sexos. Las experiencias de los niños en un contexto sociocultural específico. Por tanto, debe repetirse en estudios futuros con muestras más amplias, con el fin de validar esta metodología observacional del comportamiento de los niños y niñas a lo largo de diferentes ambientes de aprendizaje.

Palabras clave: cognición, educación física, juego, coordinación, motricidad.

Introduction

Motor competence can be defined as the ability of each person to carry out different motor actions, such as coordination and motor skills, which are essential for the development of daily activities during life (Barnett et al., 2016).

Motor skills as purposeful movement or simply physical activity (PA) are primary needs of preschool children. Movement is the fundamental element of physical and cognitive development, exploration of the environment and social interaction. Thus, associating the movement capacity of each person according to age, state of health and quality of life, where the body and movement are two associated and indissoluble concepts from an educational perspective (Latorre-Román et al., 2017)

Vázquez (2001) points out that motor skills are a multifunctional concept with different forms and objectives that give rise to three analytical approaches: psychomotor, biomotor and expressive. Becoming the movement in a fundamental aspect for the morphofunctional development of people, through the discovery, development of body image and social interaction in the psychomotor field, in addition to analyzing the relationship between motor skills and cognitive development of people (Duncan et al., 2022).

The learning environment comprises the psychological, social, cultural and physical setting in which learning occurs and influences learner motivation and success (Rusticus et al., 2023). In this sense, Early Childhood Education is the primary environment for the development of motor skills through the playful practice of Physical Education and other multidisciplinary environments, being considered a fundamental axis in the integral and personal development of children.(Moreira et al., 2016). Thus, motor skills are the means through which children discover their own bodies by interacting with their environment (Alonso Álvarez & Pazos Couto, 2020). Therefore, motor competence in Early Childhood Education (EF), is very immersed in the game, since it increases active participation in motor actions, promotes the integral development and the formation of the personality in schoolchildren in a more playful way (Casolo & Albertazzi, 2013). Thus, the contribution in this case of Physical Education in Early Childhood Education is to contribute to the integral formation of students in all educational areas (cognitive, motor, affective and social). Several authors highlight significant links between motor skills and the development of cognitive functions in preschool children (Latorre-Román et al., 2019; Latorre-Román et al., 2020; Wassenberg et al., 2005).

In the early childhood years, children develop fundamental motor skills such as locomotor skills and object control skills (Stodden et al., 2008) that contribute to children's physical, cognitive and social development and are essential for an active lifestyle (Lubans et al, 2010). In recent years, there has been a growing interest in the analysis of the relationship between PA and cognitive development in children (Berrios Aguayo et al., 2019; Latorre-Román et al., 2016).

During the last decade, experiences have been developed in Early Childhood Education focused on a new organization of the physical space that aimed at staging methodological innovations that in turn entailed the restructuring of the educational projects of the centers and aimed at creating a more open, flexible and dynamic school (Riera Jaume et al., 2014). In this sense, the concept of educational environment is related to the interactions that take place in it and the ability of the children to project themselves into it (Cano y Lledó., 1997).

Thus, learning environments aimed at the stimulation and development of motor skills in an environment where play is the resource par excellence, will not only favor the motor component, but will also strengthen the affective, social and cognitive competencies necessary to creatively face the growing demands of the environment during the first years of life (Sevilla., 2010).

In the early childhood years, children develop fundamental motor skills such as locomotor skills and object control skills (Stodden et al., 2008) that contribute to children's physical, cognitive and social development and are essential for an active lifestyle (Lubans et al, 2010). In recent years, there has been a growing interest in the analysis of the relationship between PA and cognitive development in children (Berrios Aguayo et al., 2019; Latorre-Román et al., 2016).

Another more contemporary understanding of the learning environment points to it as a *learning landscape,* according to which the educational space should provide children with a variety of rich settings that encourage a wide range of activities (Hertzberger., 2008).

In short, learning environments organize the space, time and resources available to create a rich environment that allows for increased opportunities for experimentation, inquiry, play and interaction (Font Ribas., 2011). Consequently, preschoolers can record things in their long-term memory in learning environments that stimulate all the senses, allowing for the joint stimulation of motor, language, and social and emotional development (Yıldırım y Akamca., 2017). Consequently, the physical environment of early childhood facilities, e.g., size, density, type of plan, activity settings, etc., are related to children's cognitive and social development (Moore y Sugiyama. 2007). Therefore, based on the constructivist conception of learning in Physical Education, the creation of different learning environments by modifying their different constitutive dimensions (physical, functional, relational and temporal), represent an essential competence to develop in the future Early Childhood Education teacher in order to promote the integral development of children through the work of motor skills (Sutapa et al., 2021; Tapia-Fuselier & Ray, 2019).

Therefore, infant motor work should foster children's desire to move in an adapted and rich environment that enhances their motor competence as well as other learning skills. Undoubtedly, there is a need to create spaces that contribute to enhance their motor skills (Latorre et al., 2017). Thus, global work through games or different learning environments are the most interesting didactic resources for Physical Education in Early Childhood Education. Play is considered the most important tool for children to learn social norms and values; hence, preschools are generally the first place where children learn to get along with others.

Global work through games or different learning environments are the most interesting didactic resources for Physical Education in Early Childhood Education. Playing is a fun and exciting activity for children. Playing is a necessity, so we could say that playing is the world of children. Play offers children the opportunity to adapt to their peers and environment, and play influences children's motor development, thinking skills, and their ability to solve problems in daily life. Play-based learning environments should provide a safe and conducive space for learning. Play is a universally observed phenomenon in the early years of child development, and yet its potential roles in social development and emotional regulation are

often overlooked when considering mental health (Gibson et al., 2017). They should also provide opportunities for students to interact with each other and access resources that help them learn in different ways.

In this sense Riera (2014) puts forward a series of suggestions for the design and creation of learning environments with the objective of: 1) Promote the creation of connections between experiences and knowledge, 2) Seek to meet developmental needs, 3) Safety and autonomy for children, 4) Useful and innovative environments, 5) Stimulating and motivating, 6) Complex and dynamic*, 7)* Promote the construction of new knowledge and challenges in scenarios and sub-scenarios with different communicative, functional and semantic values.

In the different learning environments we will not only promote the motor development and health of students from 3 to 6 years of age, but we could also consider them as an extraordinary scenario in which to analyze children's play behavior, cognitive functions and social and emotional interaction among students

Based on the above arguments, and in the context of the Teaching Innovation Project entitled: "Good teaching practices and innovation in the selection of didactic material resources for motor development in Early Childhood Education (PIMED52_201921)" of the University of Jaén, the objective of this pilot study was to analyze the playful behavior and social interaction in 5-year-old children in a real teaching environment, determining the pedagogical characteristics of that learning environment.

Method

Design and participants

A total of 21 PD schoolchildren (12 girls and 9 boys) aged 5 years participated in the present descriptive-cross-sectional design study. The criteria for participation were a) To be enrolled in the educational center, b) Not to have any physical disability, c) To present the informed consent voluntarily signed by the representative. In addition, the present study took into account the principles of the Declaration of Helsinki (Helsinki, 2013) and the approval of the Bioethics Committee of the University of Jaén.

Instruments

Scales were used to assess child behavior and cognitive functions: Cognitive Functions Function Application (ACFS) (Lidz & Jepsen, 2003) and the scale: Behavioral Observation Rating (BORS) in Spanish (Aranov.,1999). The BORS scale captures the affective/motivational and metacognitive aspects of the child in seven dimensions. Each dimension consists of three items that are scored from 1 to 3. The scale assesses seven attitudes of the child in relation to learning: self-regulation, persistence, frustration tolerance, flexibility, motivation, interactivity and receptivity. The Spanish adaptation of the instrument has shown good reliability, with a Cronbach's alpha of 0.74 (Calero et al., 2009)

Play behavior was assessed using the interactive play scale (PIPPS) (Fantuzzo et al., 1995; Hampton et al., 1999) for school-age children for teachers in Spanish (Castro et al., 2002). This scale consists of 36 items that identify common gambling behaviors. The PIPPS scale explores children's social behaviors in peer play, including play interruptions and disconnections.

This tool was designed for use with preschool and kindergarten children and includes parallel versions for parents and teachers. Each of the 36 items is measured on a four-point scale, from "1 = never" to "4 = always". This tool has an acceptable internal consistency for

each dimension (Cronbach's alpha = 0.74-0.84) and the inter-rater reliability assessment revealed a significantly high correlation of 0.88 ($p < 0.001$) (Lee et al., 2020).

The three dimensions defined by this tool assess disruption (10 items), disengagement (9 items) and interaction (10 items) (Castro et al., 2002). Disruption reflects behaviors such as aggression and antisocial gambling behaviors. Disengagement reflects non-participation in play, evidenced by withdrawal, wandering, loitering, and being ignored by playmates. The third dimension, interaction, is characterized by sharing ideas, helping and encouraging other children to participate in play and leading (Lee et al., 2020). The scores of the items pertaining to disruption and disengagement are reversed, so that higher scores indicate fewer behavioral problems.

Procedure

Before starting the research, permission was requested from the educational center and informed consent was sent to the participants' representatives. The research was carried out at the educational center. The classroom was set up in an indoor room of approximately 70 square meters. The children were selected by previewing the video. The sample also took into account the participation of 2 children with specific educational support needs and also children of a race other than Caucasian.

Initially, a search for sessions designed for the Physical Education level in Early Childhood Education was carried out in different specialized websites. Once the session has been selected according to the established criteria 1) Specialized session in Early Childhood Education, 2) Thematic: Motor Skills Circuit, 3) Session time: 35 minutes. The circuit of the session to be worked was structured in two parts: a) Initial part: where the static warm-up was performed; b) Main part: a general dynamic coordination circuit was structured. The schoolchildren moved on Swedish benches while maintaining dynamic balance, then overcame several tires placed in single file on the ground. Afterwards, they performed a somersault with the help of the teacher, continued moving on hoops placed on the floor and finally finished the circuit by rolling on mats. Schoolchildren performed the circuit between four and five times. The session was recorded for later analysis.

The video was viewed repeatedly observing the individualized behavior of the selected children. We could qualify this environment as a semi-directed and closed environment. The technique we used to evaluate the students with the aforementioned instruments was systematic observation. This consists of an objective, intentional and systematic process used to obtain detailed information from children.

Data analysis

Data were analyzed using SPSS statistical software v.22.0 for Windows (SPSS Inc. Chicago). U.S.A. USA). The results are expressed as means and standard deviation (SD) for quantitative variables and as percentages (%) for qualitative variables. The significance level was set at $p<0.05$ and 95% CI. Descriptive data were reported in terms of means and standard deviations (SD) and percentages. Chi-square and Mann-Whitney U tests were used to analyze gender differences

Results

Table 1 shows the results by sex in the *Behaviour observation rating scale* in its different dimensions. There were no significant differences (p>0.05) when comparing by sex. In the total sample, high percentages are reached in rating 3, except for persistence.

Table 1
Results of the BORS scale by sex (expressed in percentages)

Variables	Total (n=21) %	Children (n=9) %	Girls (n=12) %	p-value
SELF-REGULATION: Regulates attention and inhibits impulsivity.				
Regulates attention and controls impulsivity.	57.1	44.4	67.7	0.230
Requires mild adult intervention.	23.8	44.4	8.3	
Requires significant adult intervention.	19.0	11.2	25.0	
PERSISTENCE: completes the task or activity.				
Finish the task without trying to finish.	28.6	22.2	33.3	0.799
Complete the activity with encouragement.	66.7	77.8	58.3	
He withdraws and does not re-engage in the task.	4.8	0.0	8.3	
FRUSTRATION TOLERANCE: When frustrated, she recovers and continues.				
When she is upset, she calms down and redirects herself to the task	33.3	44.4	25.0	0.473*
When he is upset, he calms down and gets involved again.	4.8	11.1	0.0	
When you are upset, you can't calm down	4.8	0.0	8.3	
FLEXIBILITY: try alternative solutions or approaches.				
Easily change the focus or zoom in and out.	47.6	33.3	58.3	0.681
Alternative attempts, but the new attempt is similar	42.9	55.5	33.3	
Does not make any changes; gets stuck on the initial attempt or approach.	9.52	11.2	8.4	
MOTIVATION: shows an affective, positive response or interest in the activity.				
Shows an enthusiastic response to the activity.	71.4	77.8	66.7	1
Shows a neutral reaction, but proceeds without protesting	23.8	22.2	25.0	
Shows little or negative feedback; may indicate displeasure	4.8	0.0	8.3	
INTERACTIVITY: shows reciprocal social interactions.				
Participates in elaborate turn-taking conversations.	38.1	55.5	25.0	0.616*
Participates in turn-taking conversations with minimal responses.	28.6	22.2	33.3	
Participates in conversations without taking turns.	4.8	0.0	8.3	

RECEPTIVITY: shows openness to learning and teacher influence.				
He is a willing and receptive learner.	76.2	66.6	83.4	
Unconsciously willing and receptive.	19.0	33.4	8.3	0.269
Highly resistant to learning.	4.8	0.0	8.3	

Note. *The missing percentage is due to the fact that this behavior was not observed in some children.

Table 2 shows the analysis for each item of the PIPPS peer interactive play scale. The results showed significant differences only in the item "gossips, rumors, tells secrets" ($p < 0.05$). No differences were found in the rest of the variables ($p > 0.05$). Overall, scores on all items were low for either interaction, disruption or disengagement.

Table 2

Results of the PIPPS peer interactive play scale according to sex. (Data expressed in mean

and standard deviation)

Variables (Items)	Total (n=21) DT	Children (n=9) DT	Girls (n=12) DT	p-value
Help other children.	1.95 (0.86)	2 (1.12)	1.92 (0.67)	0.972
Helps resolve conflicts among peers.	1.14 (0.48)	1.11 (0.33)	1.17 (0.58)	0.972
Properly directs the action of others.	1.81 (0.87)	1.89 (0.93)	1.75 (0.87)	0.754
Encourage others to join the game.	1.52 (0.75)	1.78 (0.83)	1.33 (0.65)	0.247
Comfort others who are hurt or sad.	1(0)	1(0)	1 (0)	1
Verbalizes stories during play.	1.9 (0.89)	2 (1)	1.83 (0.84)	0.754
It is rejected by others.	1.24 (0.54)	1.11 (0.33)	1.33 (0.65)	0.602
Gossips, gossips, rumors, tells secrets	2 (0.84)	2.44 (0.73)	1.67 (0.78)	**0.049**
Take other people's things.	1.05 (0.22)	1.11 (0.33)	1 (0)	0.702
It is physically aggressive.	1.33 (0.58)	1.44 (0.73)	1.25 (0.45)	0.702
He disagrees without a fight.	1.19 (0.51)	1.22 (0.44)	1.17 (0.58)	0.651
Rejects the game ideas of others.	1.14 (0.36)	1.22(0.44)	1.08 (0.29)	0.602
It requires being in charge (being a leader).	1.24(0.54)	1.33 (0.71)	1.17 (0.39)	0.808
Starts fights and arguments.	1.29 (0.64)	1.22 (0.67)	1.33 (0.65)	0.651
You can go with the flow of the rest of your colleagues.	3.52 (0.6)	3.33 (0.5)	3.67 (0.65)	0.169
Shows creativity in inventing games and activities.	1.5 (0.71)	1.63 (0.92)	1.4 (0.52)	0.829
Interrupt the play of others.	1.71 (0.78)	2 (0.71)	1.5 (0.8)	0.148
Destroy other people's things.	1.05 (0.22)	1 (0)	1.08 (0.29)	0.754
Verbally offends others.	1.05 (0.22)	1.11 (0.33)	1(0)	0.702
Cries, complains, shows bad temper.	1.1 (0.44)	1 (0)	1.17 (0.58)	0.754
It moves out of the game group.	1.95 (0.67)	2.22 (0.67)	1. 75 (0.62)	0.169
Quit the game.	1.43 (0.68)	1.44 (0.73)	1.42 (0.67)	0.972
You need help to start playing.	1.67 (0.97)	1.78 (1.09)	1.58 (0.9)	0.808
He is confused in the game.	1.52 (0.75)	1.33 (0.71)	1.67 (0.78)	0.345
Needs direction from teachers.	1.95 (1.02)	2 (1.22)	1.92 (0.9)	0.917
Refuses to play when invited.	1 (0)	1 (0)	1 (0)	1.000
It is ignored by others.	1.29 (0.56)	1.22 (0.44)	1.33 (0.65)	0.862
He looks unhappy.	1.24 (0.62)	1 (0)	1.42 (0.79)	0.345
Wanders aimlessly.	1.57 (0.68)	1.78 (0.67)	1.42 (0.67)	0.247
He does not respect his turn.	1.29 (0.46)	1.33 (0.5)	1.25 (0.45)	0.754
Share toys or materials with other children.	1.19 (0.51)	1.33 (0.71)	1.08 (0.29)	0.602
Has difficulty switching from one activity to another.	1.52 (0.98)	1.44 (1.01)	1.58 (1)	0.702

Discussion and conclusions

The objective of this pilot study is to analyze the play behavior and social interaction of 5 to 6 year old children in a real learning environment, determining the pedagogical characteristics of that learning environment. The main finding of this study was that no significant gender differences were observed in both cognitive functioning and play behavior in this learning environment. In general terms, a closed and semi-directed environment based on a motor circuit, such as the one analyzed in this study, guarantees high scores in motivation, self-regulation, frustration tolerance and responsiveness, but not in interaction and flexibility. Due to its closed nature and individual participation, the results obtained in the PIPPS scale reflect moderate to low values of interactivity. Through the PIPPS scale, playful relationships in the preschool classroom and young children's play strengths can be observed, and the results can serve as a basis for any possible interventions aimed at promoting children's adaptive play skills

Regarding the effect of two different learning environments, one free and one directed on social skills and behavioral problems in children aged 3 to 6 years, in a recent study, no significant differences were found between the two groups in terms of social skills; however, the free play group reported more behavioral problems in two subscales of egocentrism and nervousness (Sahebi et al., 2018). In the same way, Mouratidou. (2016) they subjected preschool children to an eight-week Physical Education program based on physical activities and kinesthetic theatrical play, while the control group was involved in free play activities during the same period. The results revealed that the experimental group showed statistically lower aggression and unsafe social behaviors after the intervention compared to the control group. These findings indicate that appropriate Physical Education class design could support social development in early childhood. In this sense, structured physical education is important for the psychomotor development of preschool children, and impacts on children's interaction with the outside world (Teixeira Costa et al., 2015). In turn, children rated as more cognitively and socially competent engaged in higher levels of different play behaviors (e.g., associative-constructive and cooperative-dramatic), while children identified as less cognitively and socially competent engaged in lower levels of play behaviors (e.g., solitary-functional and spectator) (Farmer-Dougan & Kaszuba., 1999).

During the infancy period, peer interaction activities provide the context where children are socialized to share, take turns, cooperate, consider others' perspectives, and inhibit aggression, so it is essential that children acquire these social skills and be accepted by their peers (Fantuzzo et al., 1998). In particular, Physical Education classes with their informal atmosphere and content constitute an ideal environment in which social skills can be developed, thus, physical and motor play is identified as a form of social behavior, because through it children engage in various social situations such as cooperation, assistance, sharing, and problem solving in appropriate ways (Gregoriadis et al., 2013). Therefore and according to Teixeira Costa et al., (2015) the role of Early Childhood Education is fundamental for the development process of children, so at this stage, quality teaching practices should stimulate children, considering their individual characteristics and needs to help them acquire, during development, essential skills and abilities. Therefore, Physical Education, properly structured and describing the different learning environments, is an essential element in the professional competence to stimulate the motor, social, cognitive and affective development of preschool children.

In addition, it is important to point out that studies at the Early Childhood Education level regarding motor development by adapting the learning environments in the subject of Physical Education are limited, since this is not considered as the main axis of the integral development of children, and the motor contents are left as aspects of enjoyment through free movement in school children (Hernández Martínez et al., 2020).

The main limitation of this study is its pilot nature; moreover, the findings reflect only the experiences of children in a specific sociocultural context. Therefore, it should be repeated in future studies with larger samples in order to validate this observational methodology of children's behavior across different learning environments. In addition, one aspect that may have influenced this study is that the participation of outsiders to perform the observational analysis may have influenced the normal behavior of the participants. In this sense, contact, the creation of bonds of proximity and trust with schoolchildren is essential at an early age (Hernández Martínez et al., 2020).

By way of conclusion, the analysis of the different learning environments of Physical Education with preschool population through an observational methodology by teachers, and in this case by students of the Early Childhood Education Degree, through questionnaires of social interaction and cognitive functioning, may represent an innovative process in the specific training of professional competences when guaranteeing effective educational practices. In this sense, when operationally defined methods of play observation are used, observers can accurately record the level of play exhibited by each child, and these play behaviors reflect the child's current cognitive and social developmental functioning (Farmer-Dougan & Kaszuba., 1999). A learning environment is more than just a classroom: it is a space where learners feel safe and supported in their pursuit of knowledge, as well as inspired by their surroundings.

References

Alonso Álvarez, Y., & Pazos Couto, J. (2020). Importancia percibida de la motricidad en Educación Infantil en los centros educativos de Vigo (España). *Educação e Pesquisa*, *46*, e207294. https://doi.org/10.1590/s1678-4634202046207294

Aranov, Z. (1999). *Validity and Reliability of the ACFS Behavior Observation Rating Scale.*

Barnett, L. M., Lai, S. K., Veldman, S. L. C., Hardy, L. L., Cliff, D. P., Morgan, P. J., Zask, A., Lubans, D. R., Shultz, S. P., Ridgers, N. D., Rush, E., Brown, H. L., & Okely, A. D. (2016). Correlates of Gross Motor Competence in Children and Adolescents: A Systematic Review and Meta-Analysis. *Sports Medicine*, *46*(11), 1663–1688. https://doi.org/10.1007/s40279-016-0495-z

Berrios Aguayo, B., Pantoja Vallejo, A., & Latorre Román, P. Á. (2019). Acute effect of two different physical education classes on memory in children school-age. *Cognitive Development*, *50*. https://doi.org/10.1016/j.cogdev.2019.03.004

Calero, M. D., Robles, M. A., Márquez, J., & de la Osa, P. (2009). Evaluación de habilidades y potencial de aprendizaje para preescolares (EHPAP). *EOS*. https://www.researchgate.net/publication/258999122_EHPAP

Cano, M. I., & Lledó, Á. (1997). *Espacio, comunicación y aprendizaje*.

Casolo, F., & Albertazzi, S. (2013). ¿Cuál didáctica para la Motricidad Infantil? *Revista Motricidad y Persona: Serie de Estudios*, *13*, 31–38. https://dialnet.unirioja.es/servlet/articulo?codigo=4735580&info=resumen&idioma=ENG

Castro, M., Mendez, J. L., & Fantuzzo, J. (2002). A validation study of the Penn Interactive Peer Play Scale with urban Hispanic and African American preschool children. *School Psychology Quarterly*, *17*(2), 109.

Duncan, M., Foweather, L., Bardid, F., Barnett, A., Rudd, J., O'Brien, W., Foulkes, J., Roscoe, C., Issartel, J., Stratton, G., & Clark, C. T. (2022). Motor Competence Among Children in the United Kingdom and Ireland: An Expert Statement on Behalf of the International Motor Development Research Consortium. *Journal of Motor Learning and Development*, *10*(1), 7–26. https://doi.org/10.1123/JMLD.2021-0047

Fantuzzo, J., Manz, P. H., & McDermott, P. (1998). Preschool version of the social skills rating system: An empirical analysis of its use with low-income children. *Journal of School Psychology*, *36*(2), 199–214.

Fantuzzo, J., Sutton-Smith, B., Coolahan, K., Manz, P. H., Canning, S., & Debnam, D. (1995). Assessment of preschool play interaction behaviors in young low-income children: Penn Interactive Peer Play Scale. *Early Childhood Research Quarterly*, *10*(1), 105–120. https://doi.org/10.1016/0885-2006(95)90028-4

Farmer-Dougan, V., & Kaszuba, T. (1999). Reliability and Validity of Play-based Observations: relationship between the PLAY behaviour observation system and standardised measures of cognitive and social skills. *Educational Psychology*, *19*(4), 429–440.

Font Ribas, A. (2011). Aprendizaje basado en problemas. Presentación. *Red U. Revista de Docencia Universitaria, 2011, Vol. 9, Num. 1, p. 15-16*.

Gibson, J., Cornell, M., & Gill, T. (2017). A Systematic Review of Research into the Impact of Loose Parts Play on Children's Cognitive, Social and Emotional Development. *School Mental Health*, *9*(4), 295–309. https://doi.org/10.1007/S12310-017-9220-9/FIGURES/3

Gregoriadis, A., Grammatikopoulos, V., & Zachopoulou, E. (2013). Evaluating preschoolers' social skills: The impact of a physical education program from the parents' perspectives. *International Journal of Humanities and Social Science*, *3*(10), 40–51.

Hampton, V., Fantuzzo, J., & Manz, P. (1999). Assessing Interactive Play in Early Childhood: Penn Interactive Peer Play Scale. *NHSA Dialog*, *3*(1), 70–72. https://doi.org/10.1207/s19309325nhsa0301_8

Helsinki. (2013). World Medical Association declaration of Helsinki: Ethical principles for medical research involving human subjects. *JAMA - Journal of the American Medical Association*, *310*(20), 2191–2194. https://doi.org/10.1001/jama.2013.281053

Hernández Martínez, A., González Martí, I., Sánchez Matas, Y., & Carrión Olivares, S. (2020). Los ambientes de aprendizaje en Educación física y motivación en las primeras edades (Learning environments in Physical Education and motivation in early childhood). *Retos*, *38*(38), 761–767. https://doi.org/10.47197/retos.v38i38.77441

Hertzberger, H. (2008). *Space and learning: Lessons in architecture 3* (Vol. 3). 010 Publishers.

Latorre-Román, Llorisogallar, Salas-Sánchez, & García-Pinillos. (2019). Asociación entre función ejecutiva, madurez intelectual y condición física en niños preescolares. *Rev.Int.Med.Cienc.Act.Fís.Deporte*, *In press*.

Latorre-Román, P., Mora-López, D., & García-Pinillos, F. (2016). Intellectual maturity and physical fitness in preschool children. *Pediatrics International*, *58*(6). https://doi.org/10.1111/ped.12898

Latorre-Román, P., Moreno del Castillo, R., Lucena Zurita, M., Salas Sánchez, J., García-Pinillos, F., & Mora López, D. (2017). Physical fitness in preschool children: association with sex, age and weight status. *Child: Care, Health and Development*, *43*(2), 267–273. https://doi.org/10.1111/CCH.12404

Latorre-Román, P., Consuegra González, P., Martínez-Redondo, M., Cardona Linares, A., Salas-Sánchez, J., Lucena Zurita, M., Manjón Pozas, D., Pérez Jiménez, I., Aragón-Vela, J., García-Pinillos, Robles-Fuentes, A., & Párraga-Montilla, J. (2020). Complex Gait in Preschool Children in a Dual-Task Paradigm Is Related to Sex and Cognitive Functioning: A Cross-Sectional Study Providing an Innovative Test and Reference Values. *Mind, Brain, and Education*, mbe.12256. https://doi.org/10.1111/mbe.12256

Lee, R., Lane, S., Tang, A., Leung, C., Louie, L., Browne, G., & Chan, S. (2020). Effects of an Unstructured Free Play and Mindfulness Intervention on Wellbeing in Kindergarten Students. *International Journal of Environmental Research and Public Health 2020, Vol. 17, Page 5382*, *17*(15), 5382. https://doi.org/10.3390/IJERPH17155382

Lubans, D., Morgan, P., Cliff, D., Barnett, L., & Okely, A. (2010). Fundamental movement skills in children and adolescents: review of associated health benefits. *Sports Medicine (Auckland, N.Z.)*, *40*(12), 1019–1035. https://doi.org/10.2165/11536850-000000000-00000

Montilla, J. A. P., Román, P. A. L., del Castillo, R. J. M., & Pinillos, F. G. (2017). *Motricidad y salud en educacion infantil*. Ediciones Pirámide.

Moore, G. T., & Sugiyama, T. (2007). The children's physical environment rating scale (CP ERS): Reliability and validity for assessing the physical environment of early childhood educational facilities. *Children Youth and Environments*, *17*(4), 24–53.

Moreira, M., Almeida, G., & Marinho, S. (2016). Effects of an Educational Psychomotor Intervention program in preschool children. *Sportis. Scientific Journal of School Sport, Physical Education and Psychomotricity*, *2*(3), 326–342. https://doi.org/10.17979/sportis.2016.2.3.1563

Mouratidou, K. (2016). Physical education in early education: An intervention program for reducing aggressive and social insecure behavior. *Επιστημονική Επετηρίδα Παιδαγωγικού Τμήματος Νηπιαγωγών Πανεπιστημίου Ιωαννίνων*, *9*(1), 208–229.

Riera Jaume, M. A., Ferrer Ribot, M., & Ribas Mas, C. (2014). La organización del espacio por ambientes de aprendizaje en la Educación Infantil: significados, antecedentes y reflexiones. *RELAdEI. Revista Latinoamericana de Educación Infantil*, *3*(2), 19–39.

Rusticus, S., Pashootan, T., & Mah, A. (2023). What are the key elements of a positive learning environment? Perspectives from students and faculty. *Learning Environments Research*, *26*(1), 161–175. https://doi.org/10.1007/S10984-022-09410-4/METRICS

Sahebi, S., Arabi, M., & Velayati, V. (2018). The effect of gymnastic exercises and free play on social skills and behavioral problems of children aged 3 to 6 years. *Sport Psychology Studies*, *7*(25), 1–14.

Sevilla, Y. O. (2010). Diseño de espacios educativos significativos para el desarrollo de competencias en la infancia. *Revista CS*, 71–96.

Stodden, D. F., Goodway, J. D., Langendorfer, S. J., Roberton, M. a, Rudisill, M. E., Garcia, C., & Garcia, L. E. (2008). A Developmental Perspective on the Role of Motor Skill Competence in Physical Activity: An Emergent Relationship. *Quest*, *60*(2), 290–306. https://doi.org/10.1080/00336297.2008.10483582

Sutapa, P., Pratama, K., Rosly, M., Ali, S., & Karakauki, M. (2021). Improving Motor Skills in Early Childhood through Goal-Oriented Play Activity. *Children*, *8*(11). https://doi.org/10.3390/CHILDREN8110994

Tapia-Fuselier, J., & Ray, D. (2019). Culturally and linguistically responsive play therapy: Adapting child-centered play therapy for deaf children. *International Journal of Play Therapy*, *28*(2), 79–87. https://doi.org/10.1037/PLA0000091

Teixeira Costa, H., Abelairas-Gomez, C., Arufe-Giráldez, V., Pazos-Couto, J., & Barcala-Furelos, R. (2015). *Influence of a physical education plan on psychomotor development profiles of preschool children*.

Wassenberg, R., Feron, F. J. M., Kessels, A. G. H., Hendriksen, J. G. M., Kalff, A. C., Kroes, M., Hurks, P. P. M., Beeren, M., Jolles, J., & Vles, J. S. H. (2005). Relation between cognitive and motor performance in 5- to 6-year-old children: results from a large-scale cross-sectional study. *Child Development*, *76*(5), 1092–1103. https://doi.org/10.1111/j.1467-8624.2005.00899.x

Yıldırım, G., & Akamca, G. Ö. (2017). The effect of outdoor learning activities on the development of preschool children. *South African Journal of Education*, *37*(2).

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EXPERT AGREEMENT ON BOXING SPARRING PROGRAMMING USING A DELPHI TECHNIQUE

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Abstract. A large number of impacts are received to the head during sparring, the accumulation of which throughout a fighter´s career could cause brain injuries with important neuropsychiatric sequelae. Considering the above, this research was developed with the purpose of promoting an agreement among experts on the management and dosage of sparring rounds, in order to establish and promote a safer and more effective practice. A 4-round Delphi technique was used among a panel of 30 boxing expert coaches from Argentina, Mexico, Chile and Ecuador. The criterion of agreement was considered valid as long as a percentage ≥50% consensus was reached in the answers in round 2 and a mean >3 (Likert scale) in round 4. After the submission of Rounds 1 and 2, a consensus was obtained regarding the importance of its practice, the necessary protections, experience and weight/category of the partners, minimum/maximum weekly frequency and the criteria on which the dosage of the number of rounds is based. We also inquired about the number of minimum/maximum rounds, but in this case a consensus was reached only on their dosage in amateur boxing. Similarly, the minimum/maximum recommended intensity was sought, but no consensus could be reached for the minimum in professional boxing, although a consensus was reached for the maximum, and both in amateur boxing. After the submission of rounds 3 and 4, a final agreement was reached among 17 of the experts for all the items on which consensus had been previously reached.

Keywords: Sparring, round, box, boxer, injury, delphi.

ACUERDO DE EXPERTOS SOBRE LA PROGRAMACIÓN DEL SPARRING EN BOXEO UTILIZANDO UNA TÉCNICA DELPHI

Resumen. Durante el sparring se reciben una gran cantidad de impactos en la cabeza, cuya acumulación a lo largo de las carreras de los púgiles podría provocar lesiones cerebrales con importantes secuelas neuropsiquiátricas. Considerando lo antedicho, esta investigación se desarrolló para promover un acuerdo entre expertos sobre el manejo y la dosificación de los rounds de sparring, con el fin de establecer y promover una práctica más segura y eficaz. Se utilizó una técnica Delphi de 4 rounds, entre un panel de 30 entrenadores expertos en boxeo de Argentina, México, Chile y Ecuador. Se consideró como válido el criterio de acuerdo siempre y cuando se

alcanzara un porcentaje de consenso en las respuestas ≥50% en el round 2 y una media >3 (escala Likert) en el round 4. Luego del envío de los Rounds 1 y 2, se obtuvo un consenso en lo que respecta a la importancia de su práctica, las protecciones necesarias, experiencia y peso/categoría de los compañeros, frecuencia mínima/máxima semanal y los criterios con los que se fundamenta la dosificación del número de rounds. También se indagó sobre la cantidad de rounds mínimos/máximos, pero en este caso solo se alcanzó un consenso sobre su dosificación en boxeo amateur. Del mismo modo, se buscó conocer la intensidad mínima/máxima recomendada, no pudiéndose alcanzar un consenso para la mínima en boxeo profesional, aunque si para la máxima y ambas en boxeo amateur. Luego del envío de los rounds 3 y 4, se alcanzó un acuerdo final entre 17 de los expertos para todos los ítems sobre los que se había alcanzado consenso anteriormente.

Palabras clave: Sparring, round, boxeo, púgil, lesiones, Delphi.

Introduction

Boxing is a combat sport in which two opponents face each other for a regulated time, exchanging fist blows with the aim of knocking each other down, or accumulating points that allow them to win the fight (Rezzonico, 2022). The first rules of modern boxing were introduced by Jack Broughton in 1743, and then refined by Marcus Queensbury in 1867, at which time boxing came to be considered a "gentleman's sport" because of the mandatory use of gloves for fights, as well as the protective count after a fall (Förstl et al., 2010; Gambrell, 2007). From 1946 onwards, other protective measures were implemented, including the use of headgear, gloves with more padding and the option for the fight to be interrupted by the fighter, referee or ringside doctor (Förstl et al., 2010). Currently, boxers begin their careers participating at an amateur level, and after a while they may move on to the rental or professional field, facing differences in the number of rounds fought (more in professional boxing), use or not of headgear (no headgear is used in professional boxing), type of bandage (gauze and adhesive tape for professionals, rigid or semi-rigid fabric for amateurs) and glove size (smaller in professional boxing), as well as the number of competitions held per year (as the fighter's experience increases, the number of bouts per year decreases) (Hernández Rivas, 2020; Merlo, 2021).

From a physical aspect, boxing can be characterized as an acyclic activity where high and low intensity sequences alternate, with a ratio that can range from 1:1 to 1:2, and an average duration of the high intensity sequences from one to five seconds (Ľuboslav et al., 2020). This repetition of high intensity gestures interspersed with recovery periods; generate high stress on the aerobic pathway throughout the rounds (Davis et al., 2014; Lopes-Silva & Franchini, 2021). On the other hand, fist strikes can reach velocities at impact of up to 10 m/s, with forces proportional to the weight category that can exceed 5000 N (Förstl et al., 2010). The force applied in striking is linked to the use of the forces exerted by the lower body, upper body, core muscles, technique and experience of the athlete (Lenetsky et al., 2013; Lopez-Laval et al., 2020; McGill et al., 2010). It is for this same reason that it has been postulated that cardiorespiratory function, together with a broad technical-tactical development and increases in power-strength, are determining factors in the preparation of these athletes (Chaabène et al., 2015).

In this context, sparring appears as a training strategy in which boxers face each other in simulated bouts with the objective of promoting technical-tactical learning and the development of the physical capacities necessary for competition (Baum, 2022; Finlay et al., 2020; Follmer et al., 2020). However, such activity can induce considerable damage, inflammation, and risk of injury (Finlay et al., 2022). The most common sites of injury in boxing are the head, neck, face and hands, with brain injuries being one of the greatest risks (Gambrell,

2007) (Gambrell, 2007). Subconcussive impacts caused by blows to the head are an important issue to consider, as they do not manifest with observable clinical manifestations such as those caused during a concussion, but rather individuals are asymptomatic until a certain threshold of damage is reached (Jansen et al., 2021). Prolonged exposure to repeated trauma to the skull can result in chronic traumatic brain injury, also known as chronic traumatic encephalopathy or dementia pugilistica, characterized by structural, cognitive, and behavioral changes (Bailey et al., 2013; Di Virgilio et al., 2019). Although sparring is not usually carried out at the same intensity as combat, it is during this activity that a greater number of blows are accumulated (Baum, 2022).

The rotational forces of impacts to the fighters' heads and the repetition of these impacts throughout their careers are the main risks for long-term brain injury (Gambrell, 2007; Lota et al., 2022; Sethi et al., 2021). In order to reduce the danger of exposure to this practice, limiting the number of sparring rounds performed at medium and high intensity, devoting more time to teaching varied techniques, and reserving this practice for special days have been proposed as alternatives (Stiller et al., 2014), a prior clinical evaluation, education on the identification of a concussion, use of headgear, gloves of at least 16 Oz and mouthguards preferably performed by specialists (Sethi et al., 2021; Tjønndal et al., 2021).

At the moment sparring would be proposed as a common practice in combat sports, although there does not seem to be a unified criterion on how and how much coaches consider it necessary for the development of specific skills of boxers (Baum, 2022; Sethi et al., 2021; Stiller et al., 2014), this could generate discrepancies in the way of preparing them and unnecessary exposure to receive potentially injurious blows. For this reason and considering the demanding physical-technical demands of sport (Chaabène et al., 2015; Ľuboslav et al., 2020) as well as the high risk associated with repeated impacts received to the head during the fighters' races (Bailey et al., 2013; Di Virgilio et al., 2019; Lota et al., 2022; Sethi et al., 2021), the present work has been proposed with the aim of reaching an agreement on sparring programming in amateur and professional boxing among a group of specialist coaches.

Materials and Methods

In order to generate agreement on the described topic, a 4-round Delphi technique was used. It is based on the use of surveys of a group of experts, on whom the results are returned during successive rounds, allowing them to reconsider their opinions in the light of the group responses, to finally conclude whether or not there is agreement among them (Hasson et al., 2000) (Hasson et al., 2000). This methodology is especially used in cases where there is no information available on the subject, or the information is incomplete (Niederberger & Spranger, 2020) as is the case with sparring programming in boxing.

Due to the nature of the method used, this research presents a quali-quantitative character where the results were given by the unanimous opinion of the specialists and the level of consensus/agreement that existed among their answers, analyzing the data statistically through percentages and averages to establish whether or not there was a final agreement (Jones & Hunter, 1995) (Jones & Hunter, 1995).

Criteria for inclusion of the expert panel

The expert panel was composed of a non-probabilistic sample of boxing coaches. In all cases, these were coaches who had trained at least 10 amateur boxers and 5 professional boxers, in addition to having competed with them for a national, continental or world title.

Consensus and agreement criteria

For this study, a percentage ≥50% in the second round responses was used as consensus parameters (Sumsion, 1998) and, for the final agreement, a mean on a Likert-type scale >3 (Table 1) (Dawes, 2008) in the responses of round four. The Likert scale is a measurement instrument where the respondent must indicate his or her degree of agreement or disagreement on a statement/item (Matas, 2018).

Table 1

Likert scale used to assess the degree of agreement among specialists

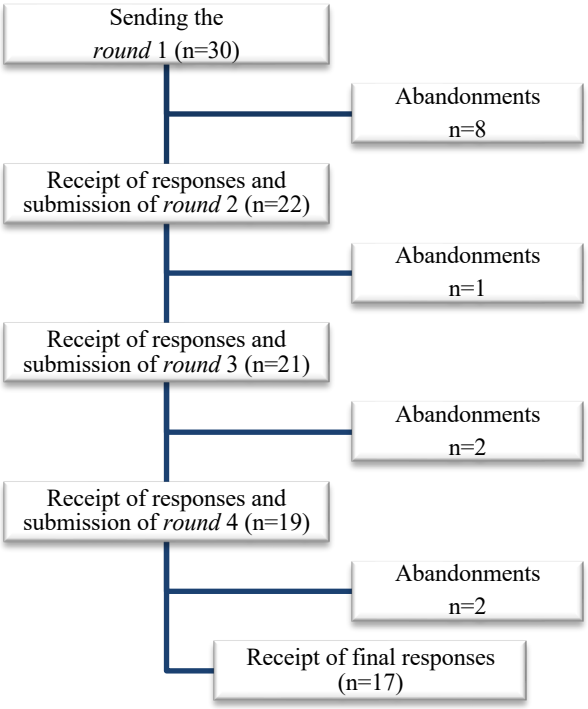
1	2	3	4	5
Strongly disagree	Disagree	Neither disagree nor agree	Agreed	Very much in agreement

Procedure

The 4 rounds that made up the technique (Figure 1) were arranged as follows: round 1) first, a questionnaire made up of 12 quali-quantitative questions with "multiple choice" and "to develop" format was sent through a Google form, to a total of 30 coaches from Argentina, Mexico, Chile and Ecuador, who were previously consulted if they met the inclusion criteria and presented interest in participating in the research; round 2) a total of 22 responses were received and, after their analysis, a new questionnaire was sent with the objective of reaching the initial consensus, this time totally under the "multiple choice" modality and presenting the percentages of the first round in each of the questions; round 3) a total of 21 responses were received and, after processing the data, new questionnaires were sent out, this time including the Likert scale parameters (Table 1) in order to begin to seek the agreement of the specialists; round 4) a total of 19 responses were obtained from the previous round and, once again, group opinions were presented, this time using the mean of the results as a reference, and then the questionnaires were resent in order to seek final agreement. Seventeen responses were received from the round 4 questionnaire, with which the results of the research were formed.

Figure 1

Progression of the Rounds of the Delphi technique used



Questionnaire

The first questionnaire sent out in round 1 was divided into two parts or sections. The first (Table 2), consisting of 3 questions, was aimed at obtaining demographic data from the coaches, while the second (Table 3), consisting of 9 questions, was oriented to information on sparring programming for amateur and professional boxers. In agreement with some of the variables described in the literature (Jordan et al., 1996; Sethi et al., 2021) (Jordan et al., 1996; Sethi et al., 2021) the questionnaire took into account the following topics: protections used, characteristics of sparring partners, weekly frequency, number of rounds and intensity developed.

Although the surveys were anonymous, the following legend was added at the end of each questionnaire: "By submitting the data in this form, you agree that the data will be used for research: Expert agreement on boxing sparring programming using a Delphi technique".

Table 2

Initial questionnaire - Demographic data

1	How many years have you been a boxing trainer?	1	2	3	4	5	6	7	8	9	>10
2	How many boxers have you trained?	<5			5-10			10-15			>15
3	How many of these boxers have you prepared to challenge for a title?	0			<3			3-6			>6

Table 3

Initial questionnaire - Sparring scheduling

4	Why do you think it is important to perform sparring sessions in boxing? Mention 3 or more reasons						
5	What are the protections you require your athletes to wear during sparring? Select for amateur boxing and then for professional boxing	Head	Gloves <14Oz	Gloves >14Oz	Bandaging of the hands	Groin protector (male)	Breastplate (women)
6	Which sparring partner would you select taking into account the level of experience of your athlete? Select for amateur boxing and then for professional boxing	< Experience level		= Experience level		> Level of experience	
7	Which sparring partner would you select taking into account the weight/category of your athlete? Select for amateur boxing and then for professional boxing	2 or more categories below	Up to 1 category below	Same category		Up to 1 category above	Up to 2 categories above
8	How many times a week do you think a boxer should spar? Select a minimum and a maximum for amateur and professional boxing	1	2	3	4	5	6	7
9	How many rounds of sparring do you think a boxer should do in one session? Select a minimum and a maximum for amateur and professional boxing	1 a 2	3 a 4	5 a 6	7 a 8	9 a 10	11 a 12	≥13
10	What is the intensity at which you consider sparring should be carried out? Select a minimum and a maximum for amateur and professional boxing	Low or no contact		Moderate		High, but not as high as the competition	High, equal to the competition
11	What are the criteria on which you base the dosage of the number of sparring rounds of an amateur boxer? Mention 3 or more criteria						
12	What are the criteria on which you base the dosage of the number of sparring rounds of a professional boxer? Mention 3 or more criteria						

For round 2, the "demographic data" section (Table 2) was eliminated and questions 4, 11 and 12 (Table 3) were modified and adopted a "multiple choice" format (Table 4) according to the answers obtained in the previous round.

Table 4

Modifications to the initial questionnaire

4	Why do you think it is important to perform sparring sessions in boxing? Select one or more criteria.	Technical-tactical preparation	Improved physical performance	Preparation of the combat strategy	Athlete evaluation	Mental preparation of the athlete
5	What are the criteria on which you base the dosage of the number of sparring rounds of an amateur boxer? Select one or more criteria.	Individual requirements of the athlete (physical condition, technical/tactical level, experience)	Timing of the competitive calendar/ Periodization	Characteristics of opponents (weight/category, height, styles, experience)	Competition characteristics (number of rounds, opponent's characteristics, level of competition)	Fixed programming with own criteria (same work scheme that is repeated and previously standardized by self-determination)
6	What are the criteria on which you base the dosage of the number of sparring rounds of a professional boxer? Select one or more criteria.	Characteristics of the competition (number of rounds, characteristics of the opponents, weight category, combat strategy)	Timing of the competitive calendar/ Periodization	Athlete characteristics (physical condition, technical/tactical level, experience, weight/category)	Fixed programming with own criteria (same work scheme that is repeated and previously standardized by self-determination)	Characteristics/level of sparring to be worked with

In *rounds* 3 and 4, only those options in which ≥50% agreement was obtained in the answers of the previous *round* were included, and a "multiple choice" format was used, presenting the Likert scale of Table 1.

Results

Rounds 1 and 2

After sending *round* 1 to a total of 30 coaches, who had been previously consulted about the possibility of being included in the research, a total of 22 responses were received (8 dropouts), and after sending *round* 2, 21 responses (1 dropout) (Figure 1).

Regarding demographic data (n=22), 90.9% of the coaches reported having >10 years of experience in the field of boxer preparation, while 9.1% selected 8 years. In addition, all the group of experts confirmed having experience in *amateur* and professional boxing (Table 5), as well as having prepared some of them for a title fight (Table 6).

Table 5

Number of boxers trained

N° of boxers	Amateur	%	Professional	%
>15	18	81.8	5	22.7
10 a 15	3	13.6	5	22.7
5 a 10	1	4.6	8	36.4
<5	0	0.0	4	18.2

Table 6

Number of boxers with whom a title has been contested

N° of boxers	Amateur	%	Professional	%
>6	17	77.3	4	18.2
3 a 6	3	13.6	9	40.9
<3	2	9.1	7	31.8
0	0	0.0	2	9.1

Questions 4, 11 and 12 in Table 3, in which coaches were required to complete by developing in round 1, were analyzed to extract key points from each response. In this way, the items that were then sent in the questionnaire for round 2 were assembled, this being entirely made up of "multiple choice" type questions.

Table 7 shows the results of round 2, which is representative of the initial consensus with which the expert agreement was later sought. Some of the items do not appear among the responses because they were eliminated after the return of round 1, as they were not selected by any of the coaches.

Table 7

Round 2 results

Ask	Item	%	
		Amateur	Professional
Why do you think it is important to perform sparring sessions in boxing?	Technical-tactical preparation	90.5	
	Preparation of the combat strategy	71.4	
	Athlete evaluation	57.1	
	Mental preparation of the athlete	23.8	
	Improved physical performance	14.3	
What are the protections you require your athletes to wear during sparring?	Head	95.2	95.2
	Gloves <14oz	23.8	4.8
	Gloves ≥14oz	76.2	90.5
	Hand bandage	71.4	71.4
	Groin protector	38.1	52.4
	Breastplate (women)	47.6	52.4
Which sparring partner would you select taking into account the level of experience of your athlete?	= experience	100	85.7
	> experience	76.2	81
	< experience	14.3	19.1
Which sparring partner would you select taking into account the weight/category of your athlete?	Same category	95.2	90.5
	Up to 1 category above	61.9	76.2
	Up to 1 category below	57.1	61.9
How many times a week do you think a boxer should spar?	Minimum 1	52.4	61.9
	Minimum 2	47.6	33.3
	Minimum 3	0	4.8

	Maximum 1	61.9	71.4
	Maximum 2	33.3	23.8
	Maximum 3	4.8	4.8
How many rounds of sparring do you think a boxer should do in one session?	Minimum 1 to 2	23.8	0
	Minimum 3 to 4	66.7	23.8
	Minimum 5 to 6	9.5	33.3
	Minimum 7 to 8	0	14.3
	Minimum 10 to 11	0	14.3
	Minimum >13	0	4.8
	Maximum 3 to 4	52.4	0
	Maximum 5 to 6	42.9	0
	Maximum 7 to 8	4.8	23.8
	Maximum 9 to 10	0	33.3
	Maximum 10 to 11	0	14.3
	Maximum 11 to 12	0	14.3
	Maximum >13	0	4.8
What is the intensity at which you consider sparring should be carried out?	Minimal Low or no contact	4.8	0
	Minimal Moderate	38.1	19.1
	Minimal High, but not as high as competition	33.3	61.9
	Minimal High, equal to the competition	23.8	19.1
	Maximum Moderate	9.5	0
	Maximum Alta, but not like the competition	33.3	28.6
	Maximum High, equal to the competition	57.1	71.4
What are the criteria on which you base the dosage of the number of sparring rounds of an amateur boxer?	Individual athlete requirements	76.2	
	Characteristics of the competition	71.4	
	Timing of the competitive calendar	61.9	
	Characteristics of the rivals	42.7	
	Fixed programming with own criteria	14.3	
What are the criteria on which you base the dosage of the number of sparring rounds of a professional boxer?	Characteristics of the competition	90.5	
	Timing of the competitive calendar	66.7	
	Athlete characteristics	61.9	
	Characteristics/level of *sparring*	52.4	
	Fixed programming with own criteria	19.1	

For all questions, agreement was obtained in both amateur and professional boxing, except for: minimum and maximum number of rounds that a professional boxer should perform in a session and minimum intensity at which sparring should be carried out in amateur boxing.

Rounds 3 and 4

For the preparation of the round 3 questionnaire, all those options in which a percentage ≥50% was reached in the round 2 responses were used. This third questionnaire was sent to a total of 21 coaches and responses were received from 19 of them (2 dropped out). Finally, round 4 was sent to 19 experts who had confirmed the submission of the 3 previous forms, concluding with a total of 17 final responses (2 dropouts).

Table 8 shows the results of round 4, which is representative of the final agreement of 17 of the 30 experts with whom the research began. Some of the items are not included among the responses because they did not reach the necessary consensus in round 2.

Table 8

Results of round 4

Ask	Item	Media	
		Amateur	Professional
Why do you think it is important to perform sparring sessions in boxing?	Technical-tactical preparation	4.8	
	Preparation of the combat strategy	4.7	
	Athlete evaluation	4.5	
What are the protections you require your athletes to wear during sparring?	Head	4.8	4.9
	Gloves ≥14oz	4.6	4.7
	Hand bandage	4.9	4.8
	Groin protector		4.7
	Breastplate (women)		4.4
Which sparring partner would you select taking into account the level of experience of your athlete?	= experience	4.7	4.7
	> experience	4.4	4.6
Which sparring partner would you select taking into account the weight/category of your athlete?	Same category	4.8	4.7
	Up to 1 category above	4.3	4.3
	Up to 1 category below	3.9	4
How many times a week do you think a boxer should spar?	Minimum 1	4.3	
	Minimum 2		4.3
	Maximum 2	4.2	
	Maximum 3		4.2
How many rounds of sparring do you think a boxer should do in one session?	Minimum 3 to 4	4.4	
	Maximum 3 to 4	4.2	
What is the intensity at which you consider sparring should be carried out?	Minimal High, but not as high as competition		3.8
	Maximum High, equal to the competition	4.4	4.8
What are the criteria on which you base the dosage of the number of sparring rounds of an amateur boxer?	Individual athlete requirements	4.4	
	Characteristics of the competition	4.6	
	Timing of the competitive calendar	4.3	

What are the criteria on which you base the dosage of the number of sparring rounds of a professional boxer?	Characteristics of the competition	4.7
	Timing of the competitive calendar	4.4
	Athlete characteristics	4.7
	Characteristics/level of sparring	4.5

For all the questions on which consensus was reached in round 2, there was also a high rate of agreement among the experts consulted. The only values below a mean of 4, a value representing complete agreement, were found for the selection of sparring weight/category in amateur boxing (down to 1 below) and for the minimum intensity at which sparring should be carried out in professional boxing (high, but not like competition).

Discussion

In the present study, we inquired about the programming of sparring in amateur and professional boxing: importance of its practice, necessary protections, experience and weight/category of partners, minimum/maximum weekly frequency, minimum/maximum number of rounds per session, recommended minimum/maximum intensity and criteria for the dosage of the number of rounds.

In the first instance and after the analysis of the results of round 1, the following criteria were distinguished as important for the practice of sparring in amateur and professional boxing: technical-tactical preparation, preparation of the combat strategy, evaluation of the athlete, mental preparation of the athlete and improvement of physical performance. Although some authors have mentioned the importance of sparring in order to develop the physical capabilities of athletes (Baum, 2022; Finlay et al., 2020; Follmer et al., 2020) and although this concept appeared among the responses of the coaches, a sufficient percentage of consensus was not reached in the first rounds for it to be considered in the final agreement. Similar findings are presented with regard to the criterion of mental preparation of the athlete.

Regarding protections, the highest percentages of consensus were obtained in both amateur and professional boxing for: 1) head, 2) gloves ≥14oz and 3) hand bandage. However, for professional boxing a consensus percentage was also reached for: 4) groin protector and 5) breastplate (women). At the end of round 4, agreement was reached for all 5 items. Some of these protections have also been mentioned as important in the literature (Förstl et al., 2010; Sethi et al., 2021; Tjønndal et al., 2021) in order to reduce the risk caused by exposure to impacts. According to the results on the use of headgear during sparring, where a consensus percentage of 95.2% was reached for both amateur and professional boxing and an agreement of 4.8 for amateur boxing and 4.9 in the case of professionals, we could infer that boxers should not carry out this practice without such protection.

Although it has been postulated about limiting sparring to medium and high intensity (Stiller et al., 2014), it is noteworthy that coaches agreed on a minimum for professional boxers "high, but not like competition" and maximum "high, same as competition". For amateur boxing there was no initial consensus on the minimum intensity, but there was consensus on the maximum intensity, which should be "high, equal to competition". This could indicate the possibility that coaches may agree to vary the minimum intensity of sparring in amateur boxing according to various criteria.

Because experts would select sparring partners of greater experience and up to 1 weight category higher, it should be noted that this could generate an increase in the forces produced in the strikes (Förstl et al., 2010; Lenetsky et al., 2013; Lopez-Laval et al.) with a subsequent higher sparring intensity.

The high intensities proposed by boxing coaches seem to be in agreement with some works carried out in other sports, where mention is made of their importance in the preparation of athletes in order to tolerate the demands of competition and thus achieve success in them (Gabbett, 2022; Gabbett & Gahan, 2016).

The volume or number of sparring rounds is an important issue to address when seeking to reduce the danger of blows received to the head (Stiller et al., 2014), a context in which the weekly frequency and number of rounds per session appear. The experts consulted in this work agreed on a weekly minimum and maximum for amateur and professional boxing, but regarding the amount per session, an agreement was only reached for amateur boxing. Thus, a concrete programming proposal was obtained for amateur boxers and, on the other hand, there does not seem to be a fixed number of sparring rounds per session for professionals, but it will depend on the characteristics of the competition, the athlete, his partner and the time of the competitive calendar.

The analysis of the results allowed us to distinguish the following criteria for the dosage of the number of sparring rounds in amateur and professional boxing: individual requirements or characteristics of the athlete, characteristics of the competition and time of the competitive calendar. Accordingly, the volume of sparring would be given by an interaction between the needs of the athlete and the demands of the competition.

Considering that prolonged exposure to impacts, shaped by the volume of training and number of years within the sport, can affect different cognitive functions and increase the risk of chronic traumatic brain injury (Bailey et al., 2013; Cunningham et al., 2020; Di Virgilio et al., 2019; Jordan et al., 1996; Stiller et al., 2014), sparring programming should be done with caution and always coordinated in an interdisciplinary manner by the coach, physical trainer and health care team.

During the data collection process of this research, one limitation was the difficulty in maintaining the adherence of the experts consulted, losing contact with 13 of the 30 with whom the work began, who abandoned the return of the results in different instances or rounds.

Conclusions

Through the implementation of a 4-round Delphi technique, an agreement was reached among 17 expert trainers from Argentina, Mexico, Chile and Ecuador, on some of the characteristics of sparring programming in amateur and professional boxing.

Firstly, it was determined that the importance of sparring sessions in boxing lies in the technical-tactical preparation and combat strategy, as well as in the possibility of evaluating the athletes.

As far as amateur boxing is concerned, the experts agreed that the necessary protections for sparring are headgear, ≥14oz gloves and hand bandage. Sparring partners must be of equal or greater experience, as well as of equal weight category, and up to 1 more above or below. The practice of this activity should be carried out a minimum of once a week and a maximum of 2 times a week, ranging from 3 to 4 rounds in each one, and with a maximum intensity "high, equal to competition". Finally, the criteria on which the dosage of the number of rounds in these athletes is based are individual requirements of the athlete, characteristics of the competition and time of the competitive calendar.

In professional boxing work, it is emphasized that the necessary protections for sparring are headgear, ≥14oz gloves, hand bandage, groin protector and, in the case of female boxers, breastplate. Sparring partners must be of equal or greater experience, equal weight category and up to 1 more above or below. The practice of this activity should be carried out a minimum of 2 times a week and a maximum of 3 times a week, with a minimum intensity "high, but not like competition" and a maximum "high, equal to competition". Finally, the criteria on which the

dosage of the number of rounds in these boxers is based are characteristics of the competition, moment of the competitive calendar, characteristics of the athlete, and characteristics or level of the sparring partner.

References

Bailey, D. M., Jones, D. W., Sinnott, A., Brugniaux, J. V., New, K. J., Hodson, D., Marley, C. J., Smirl, J. D., Ogoh, S., & Ainslie, P. N. (2013). Impaired cerebral haemodynamic function associated with chronic traumatic brain injury in professional boxers. *Clinical Science, 124*(3), 177–189. https://doi.org/10.1042/CS20120259

Baum, A. (n.d.). Safety in Combat Sports: Is Boxing Safer? *Integrated Studies*, *393*.https://digitalcommons.murraystate.edu/bis437/393

Chaabène, H., Tabben, M., Mkaouer, B., Franchini, E., Negra, Y., Hammami, M., Amara, S., Chaabène, R. B., & Hachana, Y. (2015). Amateur boxing: physical and physiological attributes. *Sports Medicine (Auckland, N.Z.)*, *45*(3), 337-352. https://doi.org/10.1007/S40279-014-0274-7

Cunningham, J., Broglio, S. P., O'Grady, M., & Wilson, F. (2020). History of Sport-Related Concussion and Long-Term Clinical Cognitive Health Outcomes in Retired Athletes: A Systematic Review. *Journal of athletic training, 55*(2), 132-158. https://doi.org/10.4085/1062-6050-297-18. https://doi.org/10.4085/1062-6050-297-18

Davis, P., Leithäuser, R. M., & Beneke, R. (2014). The energetics of semicontact 3 x 2-min amateur boxing. *International Journal of Sports Physiology and Performance*, *9*(2), 233-239. https://doi.org/10.1123/IJSPP.2013-0006. https://doi.org/10.1123/IJSPP.2013-0006

Dawes, J. (2008). Do data characteristics change according to the number of scale points used? An experiment using 5-point, 7-point and 10-point scales. *International Journal of Market Research*, *50*(1), 61–77. https://doi.org/10.1177/147078530805000106/ASSET/147078530805000106.FP.PNG_V03

Di Virgilio, T. G., Ietswaart, M., Wilson, L., Donaldson, D. I., & Hunter, A. M. (2019). Understanding the Consequences of Repetitive Subconcussive Head Impacts in Sport: Brain Changes and Dampened Motor Control Are Seen After Boxing Practice. *Frontiers in Human Neuroscience*, *13. https://doi.*org/10.3389/FNHUM.2019.00294/FULL

Finlay, M. J., Greig, M., McCarthy, J., & Page, R. M. (2020). Physical Response to Pad- and Bag-Based Boxing-Specific Training Modalities. *Journal of Strength and Conditioning Research*, *34*(4), 1052-1061. https://doi.org/10.1519/JSC.0000000000002928

Finlay, M. J., Greig, M., Page, R. M., & Bridge, C. A. (2022). Acute physiological, endocrine, biochemical and performance responses associated with amateur boxing: A systematic review with meta-analysis. *European Journal of Sport Science*. https://doi.org/10.1080/17461391.2022.2063072

Follmer, B., Varga, A. A., & Zehr, E. P. (2020). Understanding concussion knowledge and behavior among mixed martial arts, boxing, kickboxing, and Muay Thai athletes and coaches. *The Physician and Sportsmedicine*, *48*(4), 417-423. https://doi.org/10.1080/00913847.2020.1729668. https://doi.org/10.1080/00913847.2020.1729668

Förstl, H., Haass, C., Hemmer, B., Meyer, B., & Halle, M. (2010). Boxing-Acute Complications and Late Sequelae: From Concussion to Dementia. *Deutsches Ärzteblatt International*, *107*(47), 835. https://doi.org/10.3238/ARZTEBL.2010.0835

Gabbett T. J. (2022). The "Worst-Case Scenario": Recovery Between Repeated High-Intensity Efforts in Rugby League Match-Play. *Sports health*, *19417381221139437.* Advance online publication. https://doi.org/10.1177/19417381221139437

Gabbett, T. J., & Gahan, C. W. (2016). Repeated High-Intensity Effort Activity in Relation to Tries Scored and Conceded during Rugby League Match-Play. *International journal of sports physiology and performance, 11*(4), 530-534. https://doi.org/10.1123/ijspp.2015-0266

Gambrell, R. C. (2007). Boxing: medical care in and out of the ring. *Current Sports Medicine Reports*, *6*(5), 317-321. https://doi.org/10.1007/S11932-007-0069-9

Hasson, F., Keeney, S., & McKenna, H. (2000). Research guidelines for the Delphi survey technique. *Journal of Advanced Nursing*, *32*(4), 1008–1015. https://doi.org/10.1046/J.1365-2648.2000.T01-1-01567.X

Hernández Rivas, R. (2020). *Boxeo Olímpico. Una exploración sobre los aportes científicos para una práctica saludable* (Autoedición, Ed.).

Jansen, A. E., McGrath, M., Samorezov, S., Johnston, J., Bartsch, A., & Alberts, J. (2021). Characterizing Head Impact Exposure in Men and Women During Boxing and Mixed Martial Arts. *Orthopaedic Journal of Sports Medicine*, *9*(12). https://doi.org/10.1177/23259671211059815/ASSET/IMAGES/LARGE/10.1177_23259671211059815-FIG2.JPEG

Jones, J., & Hunter, D. (1995). Consensus methods for medical and health services research. *BMJ (Clinical Research Ed.)*, *311*(7001), 376. https://doi.org/10.1136/BMJ.311.7001.376. https://doi.org/10.1136/BMJ.311.7001.376

Jordan, B. D., Matser, E. J. T., Zimmerman, R. D., & Zazula, T. (1996). Sparring and cognitive function in professional boxers. *The Physician and Sportsmedicine*, *24*(5), 87-98. https://doi.org/10.3810/PSM.1996.05.1358. https://doi.org/10.3810/PSM.1996.05.1358

Lenetsky, S., Harris, N., & Brughelli, M. (2013). Assessment and Contributors of Punching Forces in Combat Sports Athletes: Implications for Strength and Conditioning. *Strength and Conditioning Journal*, *35*(2), 1–7. https://doi.org/10.1519/SSC.0B013E31828B6C12

Lopes-Silva, J. P., & Franchini, E. (2021). Developing anaerobic power and capacity for combat sports athletes. *Revista de Artes Marciales Asiáticas*, *16*(1s), 60–85. https://doi.org/10.18002/RAMA.V16I1S.7001

Lopez-Laval, I., Sitko, S., Muniz-Pardos, B., Cirer-Sastre, R., & Calleja-Gonzalez, J. (2020). Relationship Between Bench Press Strength and Punch Performance in Male Professional Boxers. *Journal of Strength and Conditioning Research*, *34*(2), 308-312. https://doi.org/10.1519/JSC.0000000000003362. https://doi.org/10.1519/JSC.0000000000003362

Lota, K. S., Malliaropoulos, N., Blach, W., Kamitani, T., Ikumi, A., Korakakis, V., & Maffulli, N. (2022). Rotational head acceleration and traumatic brain injury in combat sports: a systematic review. *British Medical Bulletin*, *141*(1), 33-46. https://doi.org/10.1093/BMB/LDAC002

Ľuboslav, Š., Andrej, H., Peter, K., & Jaroslav, B. (2020). Development of specific training load in boxing. *Journal of Physical Education and Sport*, *20*(5), 2580-2585. https://doi.org/10.7752/JPES.2020.05352

Matas, A. (2018). Design of the Likert-type scale format: A state of the art. *Revista Electronica de Investigacion Educativa*, *20*(1), 38-47. https://doi.org/10.24320/REDIE.2018.20.1.1347

McGill, S. M., Chaimberg, J. D., Frost, D. M., & Fenwick, C. M. J. (2010). Evidence of a double peak in muscle activation to enhance strike speed and force: an example with elite mixed martial arts fighters. *Journal of Strength and Conditioning Research*, *24*(2), 348–357. https://doi.org/10.1519/JSC.0B013E3181CC23D5

Merlo, R. (2021). *Analytical Boxing. Del video a la lona* (Self-publishing, Ed.).

Niederberger, M., & Spranger, J. (2020). Delphi Technique in Health Sciences: A Map. *Frontiers in Public Health*, *8*, 457. https://doi.org/10.3389/FPUBH.2020.00457/BIBTEX

Rezzonico, G. (2022). *Entrenamiento de la Fuerza en el Boxeo: construyendo el knockout*. Autoedición.

Sethi, N. K., Lenihan, M. L., Khabie, V., Chang, R. G., Aceto, T., & Beaufort, A. (2021). Safe Sparring Protocol: Reducing Head Impact Exposures During Training in Combat Sports. *Journal of Combat Sports Medicine*, *3*(2), 20–24. https://ringsidearp.org/wp-content/uploads/2021/06/ARP-Vol3-Iss2.pdf

Stiller, J. W., Yu, S. S., Brenner, L. A., Langenberg, P., Scrofani, P., Pannella, P., Hsu, E. B., Roberts, D. W., Monsell, R. M. T., Binks, S. W., Guzman, A., & Postolache, T. T. (2014). Sparring and Neurological Function in Professional Boxers. *Frontiers in Public Health*, *2*(JUL). https://doi.org/10.3389/FPUBH.2014.00069

Sumsion, T. (1998). The Delphi Technique: An Adaptive Research Tool. *British Journal of Occupational Therapy*, *61*(4), 153–156. https://journals.sagepub.com/doi/10.1177/030802269806100403

Tjønndal, A., Haudenhuyse, R., de Geus, B., & Buyse, L. (2021). Concussions, cuts and cracked bones : A systematic literature review on protective headgear and head injury prevention in Olympic boxing. *13*, *22*(3), 447-459. https://doi.org/10.1080/17461391.2021.1872711

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DERMATOGLYPHIC CHARACTERISTICS IN CEDAR CAMPECHE INTERNAL ATHLETES IN THE ACADEMIC YEAR 2021-2022

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Abstract. Introduction: In sports, dermatoglyphics are being used as a marker of biological individuality to select athletes with outstanding performances. Objective: Determine dermatoglyphic characteristics as an indicator in the selection of CEDAR Campeche athletes, taking into account their sporting genetic potential and general genetic predisposition required for the sport they practice. Methods: it is a basic type of research, with a descriptive, field and bibliographic scope, with a non-experimental cross-sectional design and a quantitative approach. As a method for the inclusion and exclusion of the sample, a survey will be used to separate them and take an intentional sample within the population to perform the dermatoglyphic analysis and determine the potential and sporting genetic predisposition. Results: the population analyzed has a high level of sporting genetic potential in the physical characteristics of coordination and resistance, both in men and women of the 3 sports, while the physical characteristics to be enhanced include strength, speed and agility, on the other hand, the general genetic predisposition in CEDAR Campeche athletes in the 2021-2022 academic year, remains with a general genetic predisposition at a high level with 64%, medium with 28% and only 8% of the athletes analyzed, they do not have a general genetic predisposition to be in high performance. Conclusions: With these data we deduce that the CEDAR Campeche talent recruitment programs have good effectiveness and complementing it with dermatoglyphic analysis, the percentage of general genetic predisposition would increase.

Keywords: Athletes, sports talent, dermatoglyphics.

CARACTERÍSTICAS DERMATOGLÍFICAS EN ATLETAS INTERNOS DEL CEDAR CAMPECHE EN EL CURSO 2021-2022

Resumen. Introducción: En el deporte se está utilizando la dermatoglífia como marcador de individualidad biológica para seleccionar deportistas con rendimientos sobresalientes. Objetivo: Determinar las características dermatoglíficas como indicador en la selección de atletas del CEDAR Campeche, teniendo en cuenta su potencial genético deportivo y predisposición genética general requeridas para el deporte que practica. Métodos: es una investigación de tipo básico, con alcance descriptivo, de campo y bibliográfica, con diseño no experimental transversal y enfoque cuantitativo. Como método en la inclusión y exclusión de la muestra se utilizará una encuesta, para separarlos y tomar una muestra intencionada dentro de la población para realizar el análisis dermatoglífico y determinar las potencialidades y predisposición genética deportiva. Resultados: la población analizada, cuenta con un potencial genético deportivo en nivel alto en las características físicas de coordinación y resistencia, tanto en hombres como en mujeres de los 3 deportes, mientras que en las características físicas a potenciar se encuentran la fuerza, velocidad y agilidad, por otra parte, la predisposición genética general en atletas del CEDAR Campeche en el curso 2021-2022, se mantiene con una predisposición genética general en un nivel

alto con 64%, medio con un 28% y solo un 8% de los deportistas analizados, no cuentan con una predisposición genética general para estar en el alto rendimiento. Conclusiones: Con estos datos deducimos que los programas de captación de talentos del CEDAR Campeche tienen una buena efectividad y complementándola con el análisis dermatoglifico, aumentaría el porcentaje de predisposición genética general.

Keywords: Athletes, sports talent, dermatoglyphics.

Introduction

Fingerprint dermatoglyphics is recognized as an effective scientific tool for the diagnosis of physical potentialities related to physical performance. It can be very useful in sports detection, selection and orientation, as well as a starting point for health-related physical training. Likewise, its capacity as a predictor of prevention of some diseases is valued, but its use in the health sciences to date is very limited; therefore, it is thought that its potential as a diagnostic and prognostic tool in this field is wasted. Its potential is appreciated in the field of sports science, where its use is more widespread, especially in other parts of the world. Therefore, in Mexico there is virgin ground, both for research and for its practical application, as a consulting service to public and private sports institutions, which can be of help for decision making when selecting sports talent.

From studies conducted, it was determined that dermatoglyphic and somatotypic profiling establishes a quantitative and qualitative analysis of the fingerprints (third phalanx) and is understood as a genetic marker, which yields a series of variables associated with the physical abilities of a subject (Fernández y Ferreira, 2011). In Brazil, this tool has been widely developed in sports such as volleyball, basketball, karate, boxing, gymnastics, handball, triathlon, field soccer, fencing and swimming (Colmenares et al., 2016). However, from the review found, it was identified that in Colombia, authors such as (Avella y Medellin , 2013); (Colmenares et al., 2016) have implemented this tool in sports such as swimming, athletics, gymnastics, basketball and cycling, which leads to evidence that there has been very limited research in this regard, in contrast to the wide range of sports practiced in the country.

In this way, it is clearly evident the need to deepen in other sports disciplines that have a great relevance at national level, such as wrestling, judo and athletics, since they are considered as sports that have given more recognition to the Campeche delegation in regional, national and international events (CONADE, 2018). For this reason, dermatoglyphics is an opportunity to obtain genetic data at low cost and easy accessibility to strengthen the sports processes in the state of Campeche.

In the call issued by INDECAM on the state program "Sports Talent Recruitment" convenes for the 2021-2022 cycle within the sports processes in their sports talent and national reserve programs", are given under the categories of initiation (7-10 years), base (11-13 years) and development towards high performance (14 years and older).

Cancio and Calderin (2010)agree that specific motor skills can begin to be developed at transition ages, stimulating flexibility, strength and endurance. In addition, work is done so that the child can develop body control and analytical movements, as well as the incorporation of techniques and gestures specific to each sport.

In these ages of sports transition, the identification of the capacities and potentialities is sought by means of physical condition tests, which can be complemented from the wide orientative benefits that dermatoglyphics has, since as it adds (Colmenares et al., 2016) dermatoglyphics is considered as an alternative tool to make the most of the genetic predisposition of the individual, and thus, develop an athlete in a more complete way in terms of the requirements of their sports practice.

Therefore, it was identified that dermatoglyphics can be a complementary method for the orientation processes in the sports offered by CEDAR Campeche, therefore, it is intended to determine whether dermatoglyphics is a valid tool to guide athletes to the sports offered at CEDAR Campeche.

Dermatoglyphics is a science that has been studied for many years worldwide, however, in our country its knowledge is practically null, unlike other Latin American countries such as Brazil and Argentina that already work with this technique as a support in the search for sports talent.

According to Cordeiro et al. (2014), in these two countries "from 2003 to 2012, 26 studies on dermatoglyphia were found registered as an aid to talent selection, this compendium was made from four scientific databases (Scielo, Dialnet, Latindex and LILAC)" (p. 31-43).

Method

This research was defined as basic with an openness to an applied proposal as long as the conditions for it exist.

For this study, a descriptive scope was used, making known the objective of this research based on the collection of information on the variables independently. By means of dermatoglyphic analysis through the protocol (Cummins y Midlo, 1942).

The modality used in this research work was a field and bibliographic research. We worked as an on-site investigation, taking fingerprints at the scene of the crime, in this case CEDAR Campeche. The inquiry facilitates and empowers this type of investigation.

It is considered bibliographic because it is an absolutely new research in the state and the country, which will allow physical education and sports scholars to have accurate data to apply this science already established in other countries as essential to evaluate conditional and coordinative capacities.

The knowledge provided by this study was decisive for those who are interested in dealing with relatively new information and those who also wish to update their knowledge and broaden their scope of action in the workplace.

According to the guidelines commented by (Hernandez, 2011) this research will be guided by the application of a non-experimental-transversal design, since it seeks to examine, describe and differentiate aspects related to dermatoglyphia and sports genetic potential and general genetic predisposition, and where data will be taken at a single moment from the entire sample and there will be no intervention to modify or alter in any way the development of the athlete, which could affect their performance. Finally, the impact of the measurements obtained will be analyzed and the results will be reported.

For this research, a quantitative approach will be used for the results obtained in a broad way, measuring the variables obtained in a given context and analyzing them by means of a statistical method to obtain a specific point of view (Hernandez, 2011).

Procedure

According to Supo (2014) "there are 5 data collection techniques and you can use one or more of them in your research work." (p.1) In this work a survey will be used to determine if the young people are athletes between 11 and 19 years old belonging to CEDAR Campeche within the internal modality and also to determine the sport specialty to which they belong, to separate them and take only a purposive sample in the population. In addition to determine the sports genetic characteristics, a dermatoglyphic test was performed in search of the sports

genetic potential to associate with the enhanced physical abilities and the general genetic predisposition to determine the level of predisposition towards high performance, and to be able to deduce if it is a possible sports talent.

The data obtained will go through the following steps for the purpose of tabulation and data processing.

Collection of information

Data will be collected at CEDAR Campeche from inmate athletes between the ages of 11 and 19 years old.

The Cummins and Middlo method was used to collect data for the aforementioned test (Fernandes, 2010, pág. 23).

In the verification of dermatoglyphic fingerprint characteristics in internal athletes of CEDAR Campeche in the course 2021-2022 (ages between 11 and 19 years) was used the method of fingerprinting (Cummins y Midlo, 1963) the collection of fingerprints of the 10 fingers was done through a biometric fingerprint scanner brand Dermalog model ZF2, making the capture of a single uniform rolled fingerprint with Certificates: CE, FBI-PIV, FBI-EBTS/F, FCC Part 15 Subpart B Class B, through the Dermalog VC3Version:4.9.0.1821 software, to transfer it to the Excel spreadsheet designed for this process.

After the collection of fingerprints, the following procedure was carried out for their formulation:

A registration table was structured with the different nomenclatures of morphology, ¨A¨; arches, ¨L¨; loops; ¨W¨, whorls.

The number of designs on the fingers of the hands, right and left. Complexity in the designs of the ten fingers of the hands (D10), calculated by the equation:

$$\mathbf{D10= \sum L + 2\sum W}$$

Where:

Arcs (A)	0 points, therefore, they do not appear in the equation.
Loops (L)	1 point.
Whorls (W)	2 points.

Number of lines

Each ridge that crosses or touches the imaginary line drawn from the delta to the core is counted, not including the delta or core count. Based on the number of lines of all the fingers of the hands, SQTL is calculated, which is the sum of the number of lines of the fingers of the two hands.

Percentage of the types of digital formulas:

AL	Presence of arches and loops in any combination.
ALW	Presence of arches, loops and whorls in any combination.
10L	Presence of loops.
LW	Presence of loops and whorls with the condition that the number of loops is greater than or equal to five.
WL	Presence of whorls and loops provided that the number of whorls is greater than five.

"The shape of the designs constitutes a qualitative characteristic, while the number of lines (QL), the sum total of the number of lines (SQTL) and the number of skin ridges within the design represent the quantitative characteristics." It is found that each design marks a tendency in certain physical quality, this is established as a guideline to obtain a source of

information of the genetic potential of the athletes, and it is explained which is the condition that demonstrates each design:

Table 1

Types of designs and physical conditions (Morales, 2014)

Class	Digital prints		Somatic-Functional	
	D10	**SQTL**	**Minimum**	**Maximum**
I	5,5	26,5	Height Absolute strength Resistance Coordination	Relative strength
II	9,0	47,7	Coordination	Overall strength
III	11,6	126,4	Relative strength	Height Absolute strength
IV	13,1	134,2	Height Absolute strength	Resistance Coordination
V	17,5	162.8	Relative strength	Coordination

Note. Classification of the set of dermatoglyphic indices and somatic-functional index among highly qualified athletes. Taken from (Abramova, 1995) Modified. By (Morales, 2014).

For data tabulation, having already clarified that this is a quantitative study, a statistical process will be carried out with the support of experts and statistical programs that facilitate the work.

All the data will be tabulated initially by joining all the data, and then disaggregating each one into the different sports and genders.

Processing of the information obtained from the application of the tests.

To process the information, the Microsoft Excel program will be used to calculate percentages.

Processing of information using statistical graphs.

Selection of the statistical program.

The program will be used: Microsoft Office Excel.

The aforementioned program will be used because of its ease of use and accessibility to make statistical calculations and graphs to show the diagnosis in both variables.

Data processing.

The statistical method used was descriptive statistics, since it was necessary to use values of mode, mean, median and range.

Validity of the instrument.

Validity says, "Whether an instrument, a procedure, a sampling, a design, are appropriate to help us obtain valid conclusions" (Martínez, 2013, pág. 5).

In dermatoglyphics, the method used is the only recommended method when the aim is to understand the genetically determinant physical capabilities of a person.

Therefore, the instruments are of very high reliability, measuring exactly the capacity to be measured.

Reliability "is a measure to determine the stability of the instrument", stability is understood as the fact that when a test is repeated it yields similar results. (Martínez, 2013, pág. 28).

Results

From the findings, when establishing the predominance of the dermatoglyphic profile in each of the disciplines to which the athletes of CEDAR Campeche belong in the 2021-2022 course, it is characterized by presenting a predominance of the figures loops and whorls in the three sports analyzed, there is a high number of crests in both hands and in general, with a level of potentialities for physical condition of IV, V level and a general genetic predisposition for high performance sports results, the digital formula that is most presented is W>L.

From the evidence collected, it can be deduced that the population analyzed, has a sports genetic potential enhanced in the physical characteristics of coordination and endurance, both in men and women in the 3 sports, while in the physical characteristics to be enhanced are strength, speed and agility, on the other hand, the general genetic predisposition in athletes of CEDAR Campeche in the course 2021-2022, the general genetic predisposition is maintained at a high level with 64%, medium with 28% and only 8% of the analyzed athletes do not have a general genetic predisposition to be in high performance, with these data it can be deduced that the talent recruitment programs of CEDAR Campeche, have a good effectiveness and complementing it with the dermatoglyphic analysis, would increase the percentage of general genetic predisposition.

The following are the relevant results represented in tables and graphs.

Table 2

CEDAR Campeche population classified by sport and gender.

Population of CEDAR Campeche			
Sports	**Quantity**	**Sex**	
		M	F
Judo	8	2	6
Fight	11	11	0
Athletics	6	5	1
Total	25	18	7
Media	8.3	6.0	2.3
Desv. Est.	2.5	4.6	3.2
%	100%	72%	28%

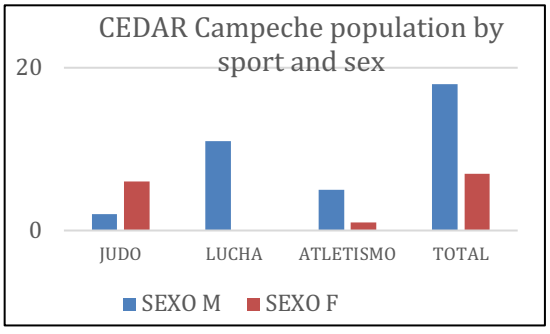


Table 3
Dermatoglyphic profile in CEDAR Campeche athletes in the 2021-2022 school year

Sports	Sex	% W	% L	% A
Fight	Male	54.5%	42.7%	2.7%
	Female	0.0%	0.0%	0.0%
	General	54.5%	42.7%	2.7%
Judo	Male	28.3%	63.3%	8.3%
	Female	33.3%	60.0%	6.7%
	General	28.3%	63.3%	8.3%
Athletics	Male	66.0%	34.0%	0.0%
	Female	20.0%	80.0%	0.0%
	General	58.3%	41.7%	0.0%
General	Male	57.2%	40.6%	2.2%
	Female	31.4%	62.9%	5.7%
	General	50.0%	46.8%	3.2%

Note. %W=percentage of Verticilio, %L=percentage of loops, %a Percentage of arches.

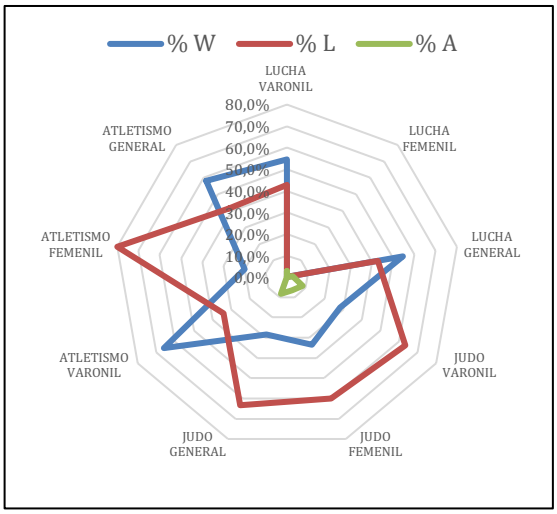


Table 4

Digital formulas in CEDAR Campeche athletes in the 2021-2022 academic year, by sport and gender

Sports	Male			Female			General		
	Form.	Qty.	%	Form.	Qty.	%	Form.	Qty.	%
Fight	W>L	7	64%	W>L	0	0%	W>L	7	64%
	LWA	1	9%	LWA	0	0%	LWA	1	9%
	L>A	1	9%	L>A	0	0%	L>A	1	9%
	L>W	2	18%	L>W	0	0%	L>W	2	18%
	Totals	11	100%	Totals	0	0%	Totals	11	100
Athletics	10W	2	40%	10W	0	0%	10W	2	33%
	L>W	1	20%	L>W	1	100%	L>W	2	33%
	W>L	1	20%	W>L	0	0%	W>L	1	17%
	L=W	1	20%	L=W	0	0%	L=W	1	17%
	Totals	5	100%	Totals	1	100%	Totals	6	100
Judo	W>L	2	33%	W>L	1	50%	W>L	3	38%
	L>W	1	17%	L>W	0	0%	L>W	1	13%
	10L	1	17%	10L	0	0%	10L	1	13%
	LAW	1	17%	LAW	1	50%	LAW	2	25%
	L>A	1	17%	L>A	0	0%	L>A	1	13%
	Totals	6	100%	Totals	2	100%	Totals	8	100

Note. W=Wing, L=Pins, A=Arches, Form. = formula, Qty. =Quantity.

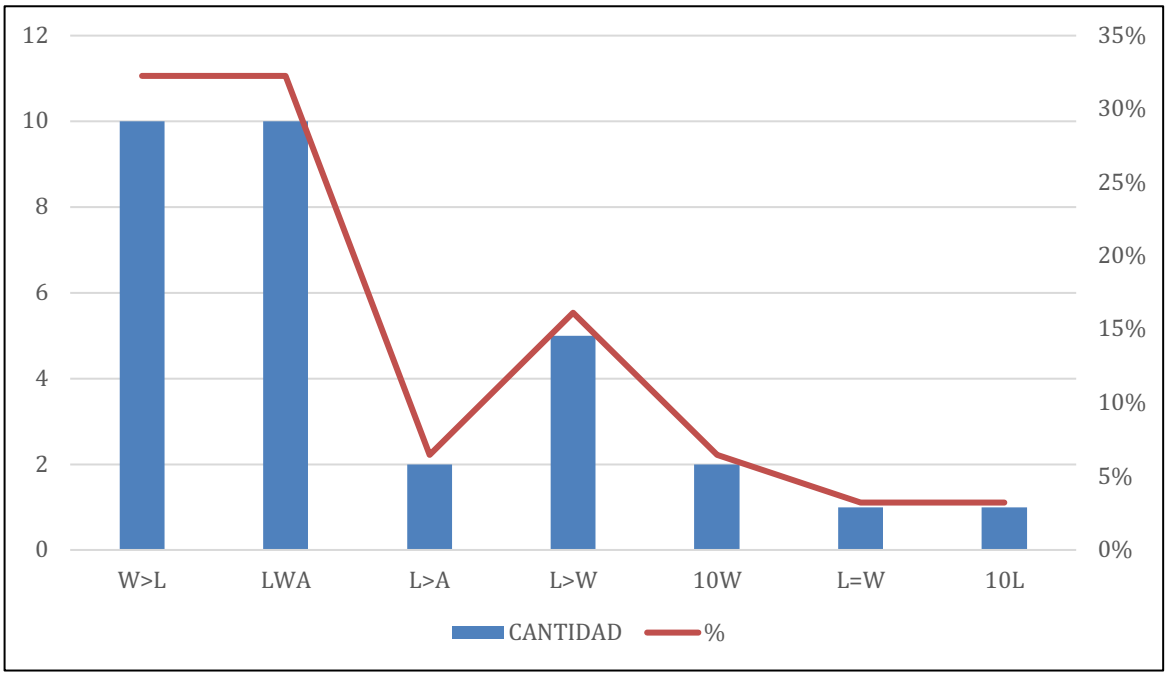


Table 5

Mean values and their derivatives for D10 values by sport and gender

Sports	D10		
	Sex		Total
	V	F	
Judo	14.5 ± 3.5	12.7 ± 3.2	13.1 ± 3.1
Fight	15.2 ± 3.19	0 ± 0	15.2 ± 3.19
Athletics	16.6 ± 3.78	12.0 ± 0	15.8 ± 3.9
General	15.5 ± 3.4	12.6 ± 4	14.6 ± 3.7

Note. Male Sex=M, Female Sex=F, D10=Delta Index.

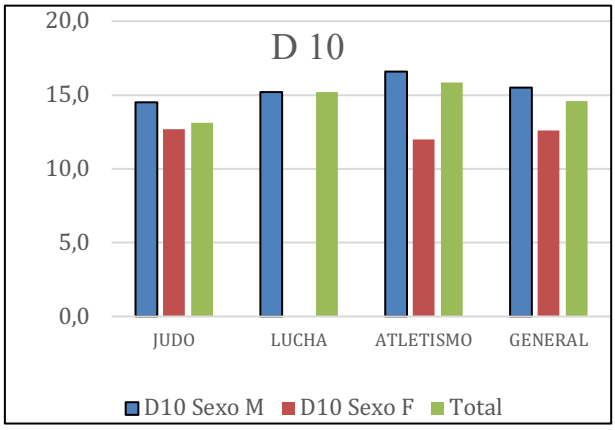


Table 6

lQTS values by sport and gender

Sports	SQTL		
	Sex		Total
	V	M	
Judo	130.00 ±82.02	137.83±39.32	135.88±45.59
Fight	134.77±30.29	00.00±0.00	134.77±30.29
Athletics	165.20±41.33	144.00±0.00	161.67±37.97
General	138.71±35.97	142.69±39.32	141.58±37.71

Note. Male Sex=M, Female Sex=F, SQTL= Total lines on both hands.

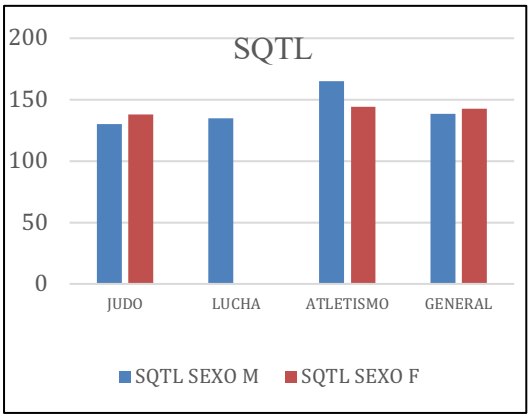

SQTL
200
150
100
50
0
JUDO
LUCHA
ATLETISMO
GENERAL
SQTL SEXO M
SQTL SEXO F

Table 7
Sports Genetic Potential

Sports Genetic Potential		Judo		Fight		Athletics		General					
		Total		Total		Total		Female		Male		Total	
Powered	**Potential**	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Coordination, Endurance and Agility	Speed and Strength	1	13%	1	9%	2	33%	2	29%	2	11%	4	16%
Coordination and Endurance	Strength, Speed and Agility	4	50%	5	45%	3	50%	3	43%	9	50%	12	48%
Speed, Strength and Explosive Force	Coordination, Agility and Endurance	2	25%	0	0%	0	0%	1	14%	1	6%	2	8%
Speed and Explosive Force	Coordination, Endurance, Agility	1	13%	5	45%	1	17%	1	14%	6	33%	7	28%
Totals		8	100 %	11	100%	6	100 %	7	100%	18	100%	25	100 %
Media		2.00		2.75		1.50		1.75		4.50		6.25	
Standard Deviation		1.41		2.63		1.29		0.96		3.70		4.35	

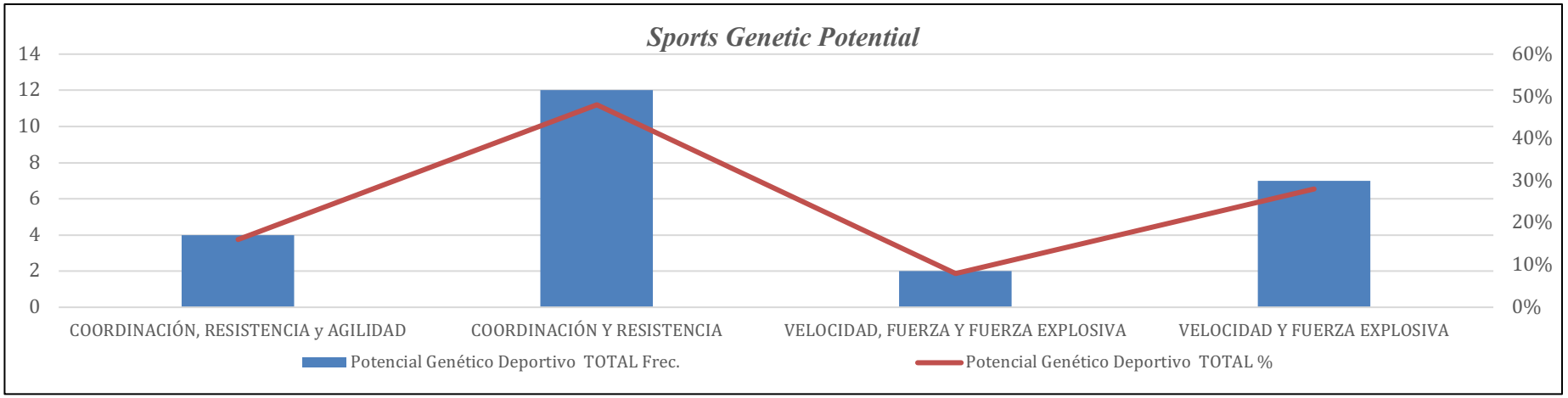
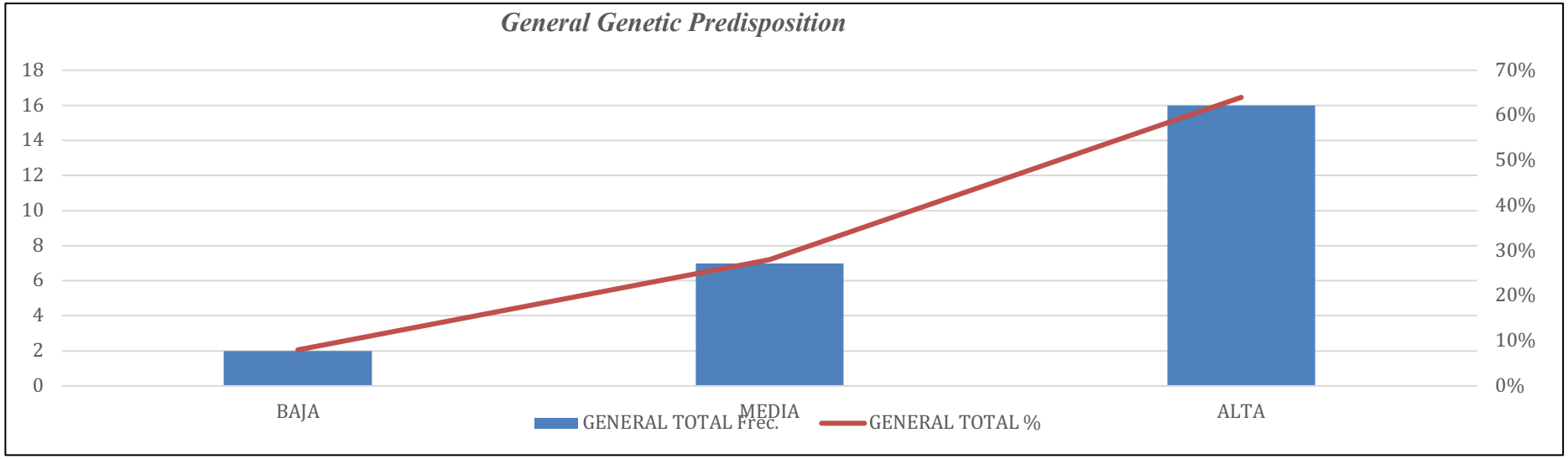


Table 8

General Genetic Predisposition in CEDAR Campeche athletes in the 2021-2022 academic year.

General Genetic Predisposition	Female						Male						General					
	Judo		Fight		Athletics		Judo		Fight		Athletics		Female		Maculino		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
High	4	67%	0	0	1	100%	1	50%	6	55%	4	80%	5	71%	11	61%	16	64%
Media	1	17%	0	0	0	0%	0	0%	5	45%	1	20%	1	14%	6	33%	7	28%
Download	1	17%	0	0	0	0%	1	50%	0	0%	0	0%	1	14%	1	6%	2	8%
Totals	6	100 %	0	0	1	100%	2	100%	11	100%	5	100 %	7	100 %	18	100 %	25	100 %



Conclusions and recommendations

From this research it is concluded that CEDAR Campeche should begin to adopt processes and methods of search and selection of sports talent, to guide athletes in their physical abilities and achieve better performance in the training processes, seeking high sports performance, although the results show a general genetic predisposition in a high level with 64%, medium with 28% and only 8% of the analyzed athletes do not have a general genetic predisposition to be in high performance, the ideal would be to reduce the medium levels and reduce the low levels to 0% to increase to 80% the high level of predisposition to high performance. After this analysis it can be deduced that the talent recruitment programs of CEDAR Campeche, have a good effectiveness applying their established protocols, but clearly it can be seen that there is an error bias, that complementing this talent recruitment protocol with dermatoglyphic analysis would eliminate and increase the percentage of high level of general genetic predisposition and with them there would be a greater probability of having consolidated athletes in high performance in competitions at national and international level.

With the results obtained from taking the fingerprints and the whole process carried out, each of the athletes should be guided in their genetic potential evidenced through the dermatoglyphia, for this, specific instructions should be given to coaches and promoters of the proper use and interpretation of this tool to make a more individualized planning and thus comply with one of the principles of sports training.

This information, obtained through Dermatoglyphics, are invaluable and offer a tool for training planning and application in the development of basic physical qualities proposed for the sport in the training process in students with the genetic potential found.

Dermatoglyphics can be a useful tool for the identification and selection of sporting talent and for the evaluation of the sporting potential of athletes. However, more research is needed to confirm the efficacy of this technique and its applicability in different sports disciplines.

A possible area for improvement in this topic would be to conduct further research to evaluate the effectiveness of dermatoglyphic analysis in the selection of sports talent in different contexts and populations. In addition, the incorporation of other biological and psychological markers could be considered to improve the accuracy of sports talent selection.

Another possible area for improvement would be the implementation of more individualized training programs adapted to the biological and psychological characteristics of each athlete, using the information obtained through dermatoglyphic analysis and other markers. This could help maximize each athlete's potential and improve their athletic performance.

References

Avella, R. E. & Medellin , J. P. (2013). Perfil dermatoglífico y somatotípico de atletas de la selección Colombia de atletismo (velocidad) participante en los juegos panamericanos de Guadalajara, 2011. *Revista U.D.C.A Actualidad & Divulgación Científica, 16*(1), 17-25.

Cancio S., R. E. & Calderin A., O. (2010). Consideraciones para la iniciación deportiva. *Efdeportes - Revista Digital*, *141*. http://www.efdeportes.com/efd141/consideraciones-para-la-iniciacion-deportiva.htm.

Colmenares, G. A., Montoya, P. Á., & Villalba, A. E. (2016). Técnica de dermatoglifos, una herramienta del entrenador, educador físico y profesional de la actividad física, para detectar talentos. *Ímpetus, 11*(1), 81-92 http://revistaimpetus.unillanos.edu.co/impetus/index.php/lmp1/article/view/191

CONADE. (Julio de 2018). *olimpiadanacional2018*. olimpiadanacional2018: https://olimpiadanacional2018.conade.gob.mx/Medallero_PN.aspx

Cordeiro, W., Gomes, L., Tadeo, M., Bruno, W., & Carvalheiro, F. (2014). A importância da dermatoglifia na detecção de talentos no esporte. *Revista Interdisciplinar, 3*(1), 31-43. http://dx.doi.org/10.24302/sma.v3i1.532.

Cummins, H., & Midlo, C. (1963). Finger prints, palms and soles. An introduction to dermatoglyphics. *Dover Publications*, *319.*

Cummins, H., & Midlo, C. H. (1942). *Palmar and plantar dermatoglyphics in primates.* Winstar Institute of Anatomy and Biology.

Fernandes, J. (2010). *La impresión digital (dermatoglifos) y la detección de talentos deportivos.* Center of excellence in physical evaluation.

Fernández, F. J., & Ferreira, P. B. (2011). *Atletas talentosos: um processo de seleção e desenvolvimento.* https://docplayer.com.br/41540938-Atletas-talentosos-um-processo-de-selecao-e-desenvolvimento-resumo.html

Hernandez, S. R. (2011). *Metodologia de la Investigación.* Mc Graw Hill Education.

Martínez, A. (2013). *Validación.* de:http://www.arnaldomartinez.net/enfermeria/validez_y_confiabilidad.pdf. http://www.arnaldomartinez.net/enfermeria/validez_y_confiabilidad.pdf

Morales, S. (29 de ENERO de 2014). Genética deportiva. Atlantic International University. http://www.aiu.edu/applications/DocumentLibraryManager/upload/1-1282014-182728-10487564.pdf

Supo, J. (2014). *La recolección de datos.* https://seminariosdeinvestigacion.com/la-recoleccion-de-datos/

ANNEXES

Annex 1
Survey

INITIAL SURVEY
Dermatoglyphic Characteristics in Continuing and New Athletes of CEDAR Campeche in the 2021-2020 academic year

Survey conducted for athletes of CEDAR Campeche

Athlete's Name: _____

The purpose of this survey is to separate the students considered by the researcher as internal athletes of CEDAR Campeche from those who are not, to determine the athletes who are between the ages of 11 to 19 years old. To determine the sport discipline to which he belongs and to know the status in which he is within the sports school, the results were not tabulated.

Question 1. In what modality are you enrolled in CEDAR Campeche?
1. Internal
2. semi-internal
3. External

Question 2. What is your chronological age range?
1. Under 11 years old
2. From 11-13 years old
3. From 14-16 years old
4. From 17- 19 years old
5. More than 19 years old

Question 3. What is your sport specialty within CEDAR Campeche?
1. Fight
2. Judo
3. Weightlifting
4. Athletics
5. Archery

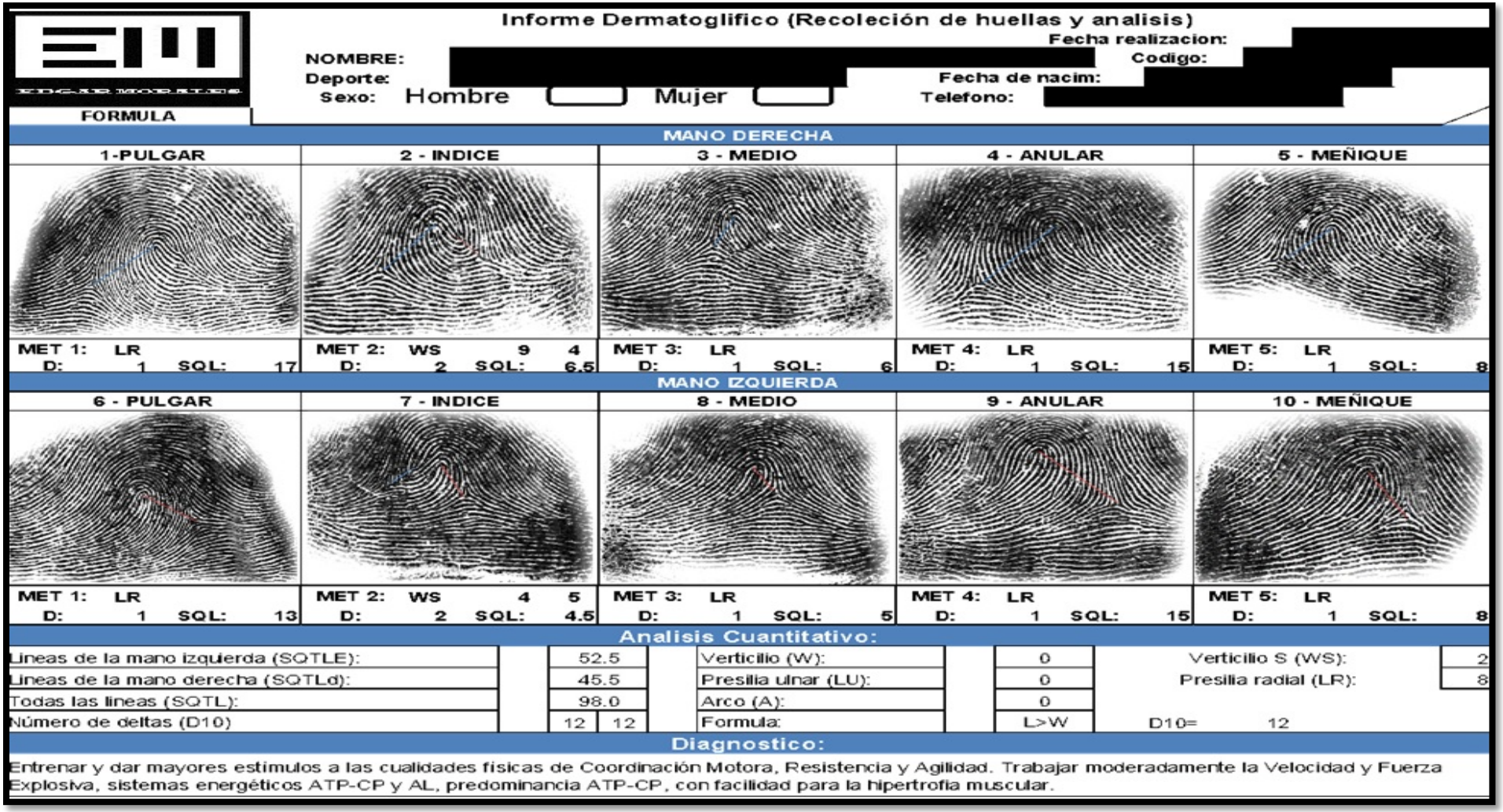
Question 4. What is your status within CEDAR Campeche?
1. New Entry
2. Continue

to

Source: Own elaboration

Annex 2

Template for fingerprint collection and dermatoglyphic analysis



Informe Dermatoglifico (Recoleción de huellas y analisis)

NOMBRE: [redacted] Fecha realizacion: [redacted]
Deporte: Codigo: [redacted]
Sexo: Hombre ☐ Mujer ☐ Fecha de nacim: [redacted]
Telefono: [redacted]

FORMULA

MANO DERECHA

1-PULGAR	2 - INDICE	3 - MEDIO	4 - ANULAR	5 - MEÑIQUE
MET 1: LR D: 1 SQL: 17	MET 2: WS 9 4 D: 2 SQL: 6.5	MET 3: LR D: 1 SQL: 6	MET 4: LR D: 1 SQL: 15	MET 5: LR D: 1 SQL: 8

MANO IZQUIERDA

6 - PULGAR	7 - INDICE	8 - MEDIO	9 - ANULAR	10 - MEÑIQUE
MET 1: LR D: 1 SQL: 13	MET 2: WS 4 5 D: 2 SQL: 4.5	MET 3: LR D: 1 SQL: 5	MET 4: LR D: 1 SQL: 15	MET 5: LR D: 1 SQL: 8

Analisis Cuantitativo:

Lineas de la mano izquierda (SQTLE):	52.5	Verticilio (W):	0	Verticilio S (WS):	2
Lineas de la mano derecha (SQTLd):	45.5	Presilia ulnar (LU):	0	Presilia radial (LR):	8
Todas las lineas (SQTL):	98.0	Arco (A):	0		
Número de deltas (D10)	12 12	Formula:	L>W	D10=	12

Diagnostico:

Entrenar y dar mayores estímulos a las cualidades físicas de Coordinación Motora, Resistencia y Agilidad. Trabajar moderadamente la Velocidad y Fuerza Explosiva, sistemas energéticos ATP-CP y AL, predominancia ATP-CP, con facilidad para la hipertrofia muscular.

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REPEAT JUMP ABILITY: PROPOSAL OF A NOVEL TEST TO ASSESS MAXIMAL POWER, MEAN POWER AND FATIGUE INDEX

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Abstract. The capacity to generate and maintain high power levels is relevant in both athletes and active people. A new test, *Repeat Jump Ability* (RJA), was proposed and analyzed to assess maximal power, mean power and fatigue index (FI) in active adults who do not practice competitive sport. Twenty-four volunteers (12 females, 12 males; age: 30.0 ± 7.2 years; mass: 71.5 ± 11.0 kg; height: 171.2 ± 10.4 cm) performed the Wingate, Repeat Sprint Ability (RSA), 30s countermovement jumps (T30s) and RJA tests. For each one, the IF was calculated; additionally, for the Wingate, T30s and RJA tests, the maximum and mean power was determined, while the maximum and mean velocity was determined for the RSA. The RJA results for each variable were correlated with the corresponding obtained for the other tests. An almost perfect correlation was observed for mean power between RJA and Wingate ($r = 0.91$) and between RJA and T30s ($r = 0.93$), and a very high correlation for mean performance between RJA and RSA ($r = 0.73$). For maximum performance, the correlation was very high between RJA and Wingate and between RJA and T30s ($r = 0.87$ and $r = 0.73$, respectively), and high between RJA and RSA ($r = 0.61$). For IF, the correlation was low ($r < 0.30$) in all cases. The RJA could provide a valid and accessible alternative for estimating maximum and mean power in active adults; its convenience would be an advantage over the other tests.

Keywords: Maximum power, mean power, fatigue index, vertical jumps, countermovement jumps.

REPEAT JUMP ABILITY: PROPUESTA DE UN NUEVO TEST PARA EVALUAR POTENCIA MÁXIMA, POTENCIA MEDIA E ÍNDICE DE FATIGA

Resumen. La capacidad para generar y mantener altos valores de potencia resulta relevante tanto en deportistas como en personas activas. Se propuso y analizó un nuevo test, *Repeat Jump Ability* (RJA), para evaluar potencia máxima, potencia media e índice de fatiga (IF) en adultos activos no deportistas. Veinticuatro voluntarios (12 mujeres, 12 varones; edad: 30,0 ± 7,2 años; masa: 71,5 ± 11,0 kg; altura: 171,2 ± 10,4 cm) realizaron los test de Wingate, Repeat Sprint Ability (RSA), 30s de saltos con contramovimiento (T30s) y RJA. Para cada uno se calculó el IF; adicionalmente para los test Wingate, T30s y RJA se determinó la potencia máxima y media, y para el RSA, la velocidad máxima y media. Los resultados del RJA para cada variable fueron correlacionados con los correspondientes de los demás test. Se observó una correlación casi perfecta para la potencia media entre RJA y Wingate (r = 0,91) y entre RJA y T30s (r = 0,93), y una correlación muy alta para el rendimiento medio entre RJA y RSA (r = 0,73). Para el rendimiento máximo, la correlación fue muy alta entre RJA y Wingate y entre RJA y T30s (r = 0,87 y r = 0,73, respectivamente), y alta entre RJA y RSA (r = 0,61). Para el IF, la correlación fue baja (r < 0,30) en todos los casos. El RJA podría constituir una alternativa válida y accesible para estimar la potencia máxima y media en adultos activos; su practicidad supondría una ventaja frente a los demás test.

Palabras clave: Potencia máxima, potencia media, índice de fatiga, saltos verticales, saltos con contramovimiento.

Introduction

Muscular power, in its various manifestations, as well as resistance to fatigue during high intensity efforts, are relevant factors for the analysis of the physical fitness profile, both in athletes and in active non-athletes (Jiménez et al., 2011; López and Fernández, 2022; Martínez, 2002). In the case of athletes, the evaluation of the ability to generate and maintain high power values provides information about their metabolic and neuromuscular characteristics, which is of value for the planning of specialized training and the implementation of optimal strategies in competition. On the other hand, in non-athletic individuals, it has been argued that the ability to generate power represents an important element of muscle fitness, which, in turn, is a crucial component of health-related fitness (Khawaja et al., 2019; Runge et al., 2004; Straight et al., 2015). This is particularly relevant in the elderly, where this ability can play a crucial role in preventing falls and promoting active and healthy aging.

In the field of sports performance, a variety of validated tests are available and frequently used by coaches to evaluate different indicators related to power capacity and fatigue resistance in trained athletes. However, given its characteristics (in terms of physical demand or equipment needed for its evaluation), its use is usually not appropriate for subjects with lower physical condition or fitness objectives.

Recently, our research group conducted a pilot study, in which the authors proposed a new test called Repeat Jump Ability (RJA), to estimate power and muscle fatigue variables (Basín et al., 2019). This study compared, in adult female volleyball players, the maximum power, average power and fatigue index estimated by means of the RJA vs. the Wingate test and the Repeat Sprint Ability (RSA), Campanna Sassi's protocol. The latter consists of performing six 40m sprints, with 20m round-trips, alternating 20s pauses between each sprint (Rampinini et al., 2007). Both tests have been validated and are widely used in sport. Regarding peak power, a very high positive correlation was observed between the RSA test and RJA (r = 0.79) and a moderate positive correlation between the Wingate test and RJA (r = 0.46). Regarding mean power, a very high positive correlation was observed between the RSA test and RJA (r = 0.86) and a high positive correlation between the Wingate test and RJA (r = 0.52).

Regarding the fatigue index, the correlation was low positive between the RSA test and RJA (r = 0.24) and moderate positive between the Wingate test and RJA (r = 0.39).

According to the authors of this study, the RJA would present advantages over the other two tests in terms of practicality and economy, requiring only one device to evaluate jump height, a reduced space and a single evaluator. In addition, the fact of requiring brief and intermittent efforts instead of a continuous effort (as in the case of the Wingate test), could provide information on differential physiological parameters, at the same time that it would be more accessible to people with lower physical condition.

However, and in spite of the possible advantages of the RJA test, the limitations of the aforementioned work (among them, a reduced sample of subjects, n = 10, and the lack of comparison with other jump tests), make that more studies in this sense are necessary. In addition, it is relevant to know if the results found by these authors are replicated in a sample of active subjects, but not athletes, and of both sexes.

For this purpose, the present work sought to determine the correlation between the maximum power, average power and fatigue index recorded by the RJA test, in comparison with those recorded by the Wingate test, RSA and the 30s countermovement jump test (T30s). The results of the present investigation could be a valuable contribution to the sports and fitness field. In this sense, they would provide important information when considering the use of the RJA as an alternative to estimate power variables and fatigability indicators in non-athletes. These data are valuable for coaches and professionals related to Physical Education and fitness, as they allow them to design more effective training programs to improve the performance of the analyzed variables.

Method

Methodological design

The study was carried out using a descriptive and cross-sectional design, employing a quantitative approach methodology. It was performed in full compliance with the principles of the Declaration of Helsinki and received the approval of the Ethics Committee of the Higher Institute of Physical Education of the University of the Republic (Resolution Nº13/2022).

Participants

Convenience sampling was performed, whereby 24 non-athletic active adult volunteers (12 females, 12 males; age = 30.0 ± 7.2 years; mass = 71.5 ± 11.0 kg; height = 171.2 ± 10.4 cm) were selected. Each of them was familiarized with the objectives of the study, where the formalities of the study were explained to them, and they were given an informed consent form, which they read and signed.

The inclusion criteria were: (i) to present a current physical fitness card or health card at the time of the evaluations; (ii) not to have had or have been suffering from any type of injury that could impair performance in some of the evaluations; iii) not to have made any intense physical effort unrelated to the study, at least 48 hours prior to the start of the evaluations and during the time the evaluations were carried out; iv) not to be a smoker or to have quit smoking in the last six months; v) not to consume any drug, stimulant or other substance that could affect the results; and vi) not to practice sports in a federated manner.

Procedures

The study was carried out in four instances, on four consecutive days, always in the morning and under similar conditions of temperature and humidity. The volunteers were previously informed about the objectives of the study and the protocols of the different tests to be carried out. The following instances were dedicated to carry out the corresponding evaluations, as described below.

First instance: First, the height and body mass of each participant were determined. For the former, a SECA 213 portable stadiometer (SECA, Germany), accurate to 1 mm, was used. Regarding the latter, an electronic balance Gama SCG-430 (GA.MA., Italy), with an accuracy of 100g, was used. In all cases, the protocols described by the International Society for the Advancement of Cineanthropometry (ISAK) were followed (Sirvent and Alvero, 2017).

Once these measurements were completed, the subjects performed the RJA test. Before starting, standardized warm-up exercises were performed, which included joint mobility of upper and lower limbs and brief stretching (less than 6s) in static position, with a total duration of 15min. This warm-up was repeated in all other instances under the same conditions. This was followed by a test series of five continuous jumps with countermovement, similar to those subsequently used in the RJA. This allowed for appropriate corrections to be made in terms of movement execution, as well as allowing the subjects to familiarize themselves with the gestures and equipment used.

Subsequently, a complete pause of 5 minutes was given and the test was performed using a contact mat (Projump Wireless, Evaluación Deportiva, Uruguay). Following the methodology described by Basín et al. (2019), the protocol implemented consisted of the execution of six blocks of five vertical jumps with countermovement, keeping the hands on the waist. These jumps were performed continuously and with maximum effort, making sure that the evaluee reached the maximum possible height in each jump and that the contact time with the surface after each fall was minimal. A passive recovery pause of 20 seconds was established between each block. Both the number of blocks and the duration of the pause were established similarly to the Repeat Sprint Ability (RSA) test. Similarly, for the RJA, the number of jumps in each block was set so that its average duration (approximately 8s) was similar to that of each sprint in the RSA test.

From the power value of each individual jump (data provided by the equipment software), the following parameters were calculated: the power of each block (obtained from the average of the five jumps), and particularly that of the block where the highest performance was observed (Pmax); the average power developed in the 6 blocks of jumps (Pmed); and the power of the block with the lowest performance (Pmin) for the calculation of the fatigue index (FI) or percentage of decrease, using the formula: IF (%) = (Pmax - Pmin) /Pmax x 100.

Second instance: the subjects performed the T30s test. The carpet used was the same as that described for the RJA test. To perform the test the subject stood on the carpet in an upright position with hands on the waist and eyes straight ahead. The subjects had to perform 30s of maximum vertical jumps. They were instructed to keep their trunk and lower limbs in an upright position and their hands on their waists during the flight phase. In the fall phase, they were asked to make the first contact with the mat with their feet in plantar flexion, cushioning the impact of the fall (Gutiérrez-Dávila et al., 2015). To calculate the maximum and minimum power, the total duration was divided into six intervals of 5s, and through the power value of each individual jump (data provided by the equipment software), the power of the jumps completed in each of them was averaged. The interval in which the highest power (Pmax) was obtained, usually the first or second, and in which the lowest power (Pmin) was obtained, usually the last, were considered. The average power (Pmed) was calculated from the average

power of all jumps completed in the 30s. Analogously to what was done for the YOY, the FI or percentage decrease was calculated using the formula: IF (%) = (Pmax - Pmin) /Pmax x 100.

Third stage: in this stage, the RSA test was performed, according to Campanna Sassi's protocol (Rampinini et al., 2007). This test was held at the Darwin Piñeyrúa athletics track in the city of Montevideo, which has a tartan surface. To determine the distances established by the test protocol, tapes positioned on the track separated by a distance of 20m were used. A manual stopwatch (Casio, HS-80TW-1D) was used to measure the sprint times.

From the recorded values, the speed of each sprint was calculated in m/s, and the following parameters were obtained: maximum speed (vMax), minimum speed (vMin) and average speed (mean) of the six sprint (vMed). As in the case of the previous tests, the IF was calculated using the formula: IF (%) = (vMax - vMin) / vMax x 100.

Fourth instance: the subjects performed the Wingate test. Prior to the start of the session, the operation of the device was explained, the purpose of the measurements and indications on how to execute the pedaling were given. A Cyclus 2 cycloergometer (RBM elektronik-automation GmbH, Leipzig, Germany) was used, associated with the corresponding software (Wingate Anaerobic Test Software, Lode BV). In each case, the height of the seat was individualized according to the length of the subject's lower limbs, so that the upper part of the seat coincided with the maximum height of the iliac crest. Additionally, the device resistance was adjusted to 7.5% of body weight, according to the protocol described by Sands et al. (2004).

Prior to the test, the subjects performed three submaximal efforts of 15s to adapt to the pedaling gesture, interspersed by passive pauses of 1min. This was followed by a passive rest of at least one minute prior to the start of the test. When the subject expressed readiness, an auditory signal was given, after which he/she had to pedal as fast as possible for 30s, maintaining his/her maximum effort during that period. The participant was asked to try to reach the maximum acceleration in the shortest possible time.

To calculate the maximum and minimum power, the total duration (30s) was divided into 6 intervals of 5s, and through the value obtained in each millisecond (data provided by the equipment software), the power of each of them was averaged. The highest power interval (Pmax), usually the first, and the lowest power interval (Pmin), almost always the last, were considered. The mean power (Pmed) was calculated from the average power in the 30s. Analogously to what was done for the other tests, the IF was calculated using the formula: IF (%) = (Pmax - Pmin) /Pmax x 100.

Statistical analysis

Data are presented as mean ± SD. The normal distribution of the data was verified by means of the Kolmogorov-Smirnov test, and the homogeneity of variances by means of the Levene test.

Pearson's correlation coefficient (r) was used to examine the relationships between the indicators of maximum power, mean power and fatigue index for each of the tests. Prior to the application of this statistic, normality was verified using the Shapiro-Wilk test. In addition, the assumptions of linearity and absence of outliers required by the same were corroborated.

The strength of correlation was interpreted according to Hopkins et al. (2009), which establish as poor association values (positive or negative) equal to or less than 0.10; low association values between 0.11 and 0.30; moderate association values between 0.31 and 0.50; high association values between 0.51 and 0.70; very high association values between 0.71 and 0.90; and almost perfect association values equal to or greater than 0.91.

In all cases, a significance level of $p < 0.05$ was established. Statistical calculations were performed with the free software JASP (Version 0.16.4; JASP Team, 2022, University of Amsterdam).

Results

The 24 subjects that initially made up the sample participated satisfactorily in the four planned instances. Consequently, for the purposes of this study, data from the entire sample were considered.

Table 1 shows the results obtained from the Wingate, T30s, and RJA tests, in relation to the variables of average power, maximum power and fatigue index. In addition, the RSA test results for average speed, maximum speed and IF are shown.

Table 1
Results obtained from the Wingate, T30s, RJA and RSA tests.

	YAN (mean ± SD)	T30s (mean ± SD)	RSA (mean ± SD)	Wingate (mean ± SD)
Maximum yield	648,0 ± 282,3 (w)	676,3 ± 379,8 (w)	5.0 ± 0.4 (m/s)	615,6 ± 154,4 (w)
Average yield	610,4 ± 239,7 (w)	555,4 ± 329,6 (w)	4.7 ± 0.4 (m/s)	529,9 ± 129,1 (w)
Fatigue index (%)	21,0 ± 15,1	27,181 ± 15,1	7,6 ± 6,8	22,0 ± 5,7

Abbreviations: SD: standard deviation; Wingate: Wingate test; T30s: 30s jumps with countermovement; RSA: Repeat Sprint Ability test; RJA: Repeat Jump Ability test.

Table 2 shows the correlation values between the RJA test and the other tests analyzed.

Table 2
Pearson correlation values (r) between Wingate, T30s, RJA and RSA test results

	Maximum yield	Average yield	Fatigue index
RJA (w) vs Wingate (w)	0,87	0,91	0,26
RJA (w) vs T30s (w)	0,73	0,93	0,30
RJA (w) vs RSA (m/s)	0,61	0,73	0,19

Abbreviations: Wingate: Wingate test; T30s: 30s jump test with countermovement; RSA: Repeat Sprint Ability test; RJA: Repeat Jump Ability test.

Regarding the relationship between the RJA and Wingate tests, the correlation coefficient for mean power was r = 0.91, interpreted as an almost perfect correlation. In addition, for maximum power, a correlation of r = 0.87 was obtained, which was rated as very high. Finally, the correlation observed in relation to the FI was r = 0.26, interpreted as low.

Regarding the correlation between the RJA test and the T30s test for mean power, an r = 0.93 was obtained, interpreted as an almost perfect correlation. The maximum power between both tests presented an r = 0.73, considered a very high correlation, and as for the IF, an r = 0.30 was obtained, considered a low correlation.

Finally, for the correlation between the RJA and RSA tests, we considered the variables of average, maximum and IF performance. A very high correlation was obtained for average yield (r = 0.73), a high correlation for maximum yield (r = 0.61), and a low correlation for FI (r = 0.19).

Discussion

Muscle power and fatigue are variables of great importance, both in the field of competitive sport and for those who practice sport for recreational and *fitness* purposes. Regarding fatigue, this refers to a decrease in the maximum contraction capacity of skeletal muscle due to sustained effort, influenced by both central and peripheral factors, leading to a decrease in performance (Rosas et al., 2020). As far as muscle power is concerned, it acquires particular relevance in the field of performance sport (García-Manso and Valverde, 2015); although it has also been shown to have a significant impact on health as it is an integral element of the so-called *muscle fitness*. This aspect has been observed both in children and adolescents (Ortega et al., 2008; Steene-Johannessen et al., 2013), as well as in adult subjects (Khawaja et al., 2019), and becomes particularly relevant in elderly people (Runge et al., 2004; Straight et al., 2015).

The present study analyzed the correlation between indicator variables of maximum power, average power and FI obtained from a new test proposal (RJA) and their equivalent indicators in the Wingate, RSA and T30s tests, the latter being frequently used in the field of sport. A high to very high correlation was found for maximum power, a very high to near perfect correlation for average power, and a low correlation for IF. This last finding suggests that the

neuro-physiological mechanisms that lead to fatigue in the RJA could be different from those that generate it in the other tests; which could in part be explained by the type of movement involved in the different tests (running, pedaling, jumping) with the concomitant difference in the muscle mass and biomechanics involved, and/or the effect of the pause periods (continuous vs. intermittent effort).

Correlation between RJA and Wingate tests

The Wingate anaerobic test is a supramaximal test developed in the 1970s. It has since been positioned worldwide as a valid and reliable test for the assessment of both power and muscular endurance and fatigue (Özkan et al., 2010). However, its execution requires extreme physical and even mental effort, which has led in recent years to a reduction in its use, even in highly trained athletes (Muriel et al., 2012).

In the work of Basín et al. (2019), the main antecedent of the present work, the authors found a moderate correlation between this test and the RJA in terms of IF and maximum power ($r = 0.39$ and $r = 0.46$, respectively), and a high correlation in terms of average power ($r = 0.52$). This does not agree with what was found in the present study (almost perfect correlation for medium power, very high for maximum power and low for IF).

It is important to mention that a Computrainer Pro model cycloergometer (Racermate Inc., Seattle, USA) was used in the aforementioned study, which does not allow adjusting the load according to the body weight of each participant. For that reason, the authors had to use the same resistance for all subjects. It should be noted that the Wingate test protocol establishes that the load should be adjusted according to the body weight of the person being tested (Inbar et al., 1996), something that was taken into consideration in the present study. We believe that this difference, at least in part, may explain the disparities in the results, the latter having provided a more accurate approximation to the objectives set.

Additionally, unlike the previously cited study, in which the authors examined a relatively small sample of federated volleyball players, this study included a sample composed of a larger number of participants. This provided a broader database for further analysis. It should also be noted that the participants in the present study, although physically active, did not play sports competitively, which may partly explain the weaker correlation found in relation to FI. Unlike the sample used in the aforementioned study, carried out with trained athletes, the participants in the present study could have had a lower tolerance to effort in a test with the characteristics of the Wingate test, which requires maximum and sustained effort.

In previous research, the correlation between the power estimated by means of the Wingate test and that estimated by means of a jump test had already been analyzed. In this context, a positive and significant correlation ($r = 0.446$, $p < 0.0001$) was found between peak power measured with the Wingate test and that measured with a bipodal horizontal jump test (Standing Broad Jump Test) in elite weightlifters, wrestlers and fencers (Krishnan et al., 2017). Likewise, a positive and significant correlation ($p < 0.05$) was observed between the flight time in the countermovement jump (CMJ) and the mean and maximum power obtained in the Wingate test in young adult cyclists with a high level of training (Muriel et al., 2012).

In another study conducted in adolescent and adult female volleyball players (Nikolaidis et al., 2016), the researchers analyzed the correlation between the maximum and mean power estimated through different jumping tests (squat jump, CMJ, Abalakov, Bosco 30-second jump test) and that estimated through the Wingate test. A positive and significant correlation ($p < 0.05$) was observed between the mean power estimated by the Bosco 30-second jump test and the Wingate test. A positive and significant correlation ($p < 0.05$) was also found between the

mean and peak power estimated by the Wingate test and that estimated in each of the other jump tests mentioned.

It is relevant to highlight that, in all the mentioned cases, the correlation was higher in adult female athletes compared to juvenile female athletes. In particular, in this study it was found that the correlation between the Bosco 30-second jump test and the Wingate for mean power in adult female players ($r = 0.56$) was very similar to the correlation observed between the RJA test and the Wingate for the same variable in the work of Basín et al. (2019) ($r = 0.52$), who examined a sample of the same population. However, this correlation was lower than that found in the present study in non-athletic adults ($r = 0.91$), as mentioned above.

Another study (Sands et al., 2004) compared the performance in the Wingate test vs. consecutive jumps during 60s (according to Bosco's protocol) in adult athletes of both sexes. The authors found that the correlation in terms of performance in both tests was significantly higher ($p < 0.05$) in male athletes, but not in their female peers. A difference observed with respect to the present study is that in the latter, the analysis did not include a group differentiation according to biological sex. Another difference is determined by the sample, which, in the aforementioned study, corresponds to university track and field athletes. This could explain the choice of the tests used by these authors, since both tests are usually used in trained athletes.

In the present study, the jumping test used (RJA) presents characteristics that make it less demanding than the one used by Sands et al. (2004). Compared to the latter, the former would be more suitable for healthy non-athletes, due to its intermediate pauses and shorter duration of effort between rests. On the other hand, in the Bosco test, the jumps to be performed by the subjects are continuous during the 60s that the test lasts, and approximate knee flexion at 90° is required in the descent phase. In the RJA test, six blocks of five jumps with countermovement are performed, with passive pauses between the blocks and no strict requirement to reach the aforementioned flexion. Even with these differences, significant correlations can be observed in both studies in terms of average and maximum performance.

In sum, the findings of the present work, as well as the antecedents mentioned *ut supra*, would indicate that there is a high correlation between the power, both maximum and average, estimated by means of jumping tests (including the RJA) and the Wingate test, both for athletes and for active non-athletes.

Correlation between the RJA and RSA tests

With respect to these two variables, the results of the present study are similar to those reported by Balsalobre-Fernandez et al. (2015), who related the ability to repeat sprinting using the RAST (*Running-based Anaerobic Sprint Test*) and vertical jumps using the peak performance value in a CMJ. In both the RAST test (consisting of six 35m sprints executed at the maximum possible speed, with 10s of rest between each sprint) and the RSA, interval sprint efforts are performed. The main differences between the two are related to the route, the pause between each sprint and the blocks to be performed. According to the authors, the CMJ test was performed with a countermovement to 90° knee flexion, jumping as high as possible, repeated three times. On the other hand, and as mentioned, in the RJA test, six blocks of five jumps are performed with countermovement, without necessarily reaching this degree of flexion.

In this study, the authors observed a moderate positive correlation in the power produced in the RAST test and the CMJ test ($r = 0.419$, $p < 0.001$), indicating that performance in the latter would be associated with power production in the RAST. Additionally, the authors observed that subjects with lower FI on the RAST had lower loss of performance on the CMJ test.

As for the correlations reported in that study between average and maximum performance, they coincide with those found in the present study between the RSA and RJA tests. It is relevant to note that the protocol used in the RAST test is consistent with that of the RSA (Campanna Sassi protocol).

Correlation between RJA and T30s tests

Regarding this correlation, it is important to note that no precedents were found in the scientific literature reviewed on this subject, suggesting that this aspect may be a novel contribution of the present work. It is interesting to note that the most robust correlation between the two tests was observed for mean power. This implies that the YOR could be considered as a valid alternative to evaluate this parameter.

It should be noted that T30s requires continuous effort, which can potentially demand a greater use of the anaerobic glycolysis energy system. This implies that the individual performing this test must possess a certain level of physical fitness. In contrast, the characteristics of the RJA, which include passive intermediate pauses, would imply a greater involvement of the phosphocreatine system and the oxidative system. As previously mentioned, this may make the RJA more applicable for people with lower fitness levels.

Practical feasibility of the RJA

The characteristics of the RJA make it a versatile test that can be used in a wide variety of settings, regardless of spatial or sociocultural conditions. Its implementation is simple, since it does not require the presence of specialized technical personnel, nor a large space or expensive materials. Only a device is needed to measure the height of the jump, such as a contact mat, for example. If this tool is not available, there are applications available for cell phones and other mobile devices that provide a valid measure, making the test even more accessible. In addition, these materials are easy to transport and the time required to complete the test generally does not exceed 20 minutes, including the warm-up phase.

RJA and the description of the fitness profile

One of the objectives of the study was to contribute to the description of the physical fitness profile of the participants, through the evaluation of capacities that reflect maximum power, average power and Fatigue Index (FI), as well as the analysis of correlations with other tests. This information is valuable for defining the physical condition of each individual, regardless of whether they are athletes or not, and for designing personalized training programs.

It is recognized that muscle power plays an important role not only in the context of sports performance, but also in the field of health-related fitness, as pointed out by Balsalobre-Fernandez et al. (2012) and Izquierdo et al. (2015), among other authors. Therefore, power assessment and training are relevant for both athletes and people who exercise with the aim of maintaining and improving their physical condition and health.

In sum, we think that the RJA could have the potential to become a useful tool to contribute to the description and evaluation of the fitness profile of individuals.

Limitations and future possibilities for intervention

The present work had limitations. Among them, we mention the limited previous experience of the subjects who participated in the study with regard to the different tests performed. Additionally, in reference to the RSA test, it would have been desirable to use photoelectric cells or similar devices for data collection, thus improving the accuracy in determining the speed of each sprint.

As a suggestion for future research, we propose to carry out similar studies, but considering different populations, such as boys, girls and adolescents, as well as exploring differences between biological sexes and comparing athletes from different disciplines. This would provide a more complete and specific understanding of the behavior of the variables analyzed in various groups and contexts.

In addition, it would be interesting to incorporate other analyses, such as the determination of blood lactate, the non-invasive measurement of muscle oxygenation through oximetry, and the evaluation of muscle fatigue through techniques such as tensiomyography and/or electromyography, among others. These complementary methods could provide additional insight and enrich the understanding of the results obtained.

Given the intermittent nature of the RJA, we hypothesized that, compared to continuous tests such as the Wingate test or the T30s, a lower contribution of anaerobic glycolysis metabolism would be observed in the RJA, in favor of a greater participation of phosphocreatine metabolism and oxidative metabolism. Studies incorporating these measurements could help to clarify this hypothesis.

Conclusions

The results of this study suggest that the RJA could be a practical and accessible tool for estimating peak and mean power in active adults of both sexes. This could represent a valuable contribution to the *fitness* field. Further studies are needed to confirm these findings.

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References

Balsalobre-Fernández, C., Del Campo-Vecino, J., Tejero-González, C. M, and Alonso-Curiel, D. (2012). Relación entre potencia máxima, fuerza máxima, salto vertical y sprint de 30 metros en atletas cuatrocentistas de alto rendimiento. *Apunts. Educación Física y Deportes*, *108*(2), 63-69. https://dx.doi.org/10.5672/apunts.2014-0983.es.(2012/2).108.07

Balsalobre-Fernández, C., Nevado-Garrosa, F., Del Campo-Vecino, J., and Ganancias-Gómez, P. (2015). Repetición de sprints y salto vertical en jugadores jóvenes de baloncesto y fútbol de élite. *Apunts. Educación Física y Deportes*, *120*(2), 52-57. https://core.ac.uk/download/pdf/39140641.pdf

Basín, M., Fernandez, E. and Magallanes, C. (2019). *Repeat Jump Ability Test: Estudio piloto para la valoración de la capacidad de salto* [Degree Thesis, Instituto Superior de Educación Física, Universidad de la República]. Repositorio Colibrí. https://www.colibri.udelar.edu.uy/jspui/bitstream/20.500.12008/29775/1/T 764-.pdf

García-Manso and Valverde. (2015). *Potencia muscular y rendimiento deportivo*. Editorial Kinesis.

Gutiérrez-Dávila, M., Giles, M., González, C., Gallardo, D. and Rojas, F. (2015). Efecto de la intensidad del contramovimiento sobre el rendimiento del salto vertical. *Lecturas: Educación Física y Deportes, 119*(1), 87-96. https://dx.doi.org/10.5672/apunts.2014-0983.es.(2015/1).119.06

Hopkins, W. G., Marshall, S. W., Batterham, A. M., and Hanin, J. (2009). Progressive statistics for studies in sports medicine and exercise science. *Medicine and Science in Sports and Exercise, 41*, 3-13. https://dx.doi.org/10.1249/MSS.0b013e31818cb278.

Inbar, O., Bar-Or, O. and Skinner J. S. (1996). *The Wingate Anaerobic Test*. Human Kinetics.

Izquierdo, M., Redondo, J. C., Oliveira da Silva, L., Lopez, L. M., Marcolin, É., & Sedano, S. (2015). Efectos de dos tipos de entrenamiento complejo en fuerza máxima y potencia en jugadores jóvenes de deportes colectivos. *Revista Brasileira de Prescrição e Fisiologia do Exercício*, *9*(53), 290-302. http://www.rbpfex.com.br/index.php/rbpfex/article/view/803/702

Jiménez, P., Cuadrado-Peñafiel, V. and González-Badillo, J. J. (2011). Análisis de variables medidas en salto vertical relacionadas con el rendimiento deportivo y su aplicación al entrenamiento. *Cultura, Ciencia y Deporte*, *6*(17), 113-119. https://www.redalyc.org/articulo.oa?id=163022532005

Khawaja, A., Sabbagh, P., Prioux, J., Zunquin, G., Baquet, G., Maalouf, G., and El Hage, R. (2019). Does Muscular Power Predict Bone Mineral Density in Young Adults? Journal of Clinical Densitometry, *22*(3), 311-320. https://doi.org/10.1016/j.jocd.2019.01.005

Krishnan, A., Sharma, D., Bhatt, M., Dixit, A., and Pradeep, P. (2017). Comparison between Standing Broad Jump test and Wingate test for assessing lower limb anaerobic power in elite sportsmen. *Medical Journal Armed Forces India*, *73*(2), 140,145. https://doi.org/10.1016/j.mjafi.2016.11.003

López, J. and Fernández, A. (2022). *Fisiología del ejercicio*. (4th Ed.). Médica Panamericana.

Martínez, E. (2002). *Pruebas de aptitud física*. Editorial Paidotribo

Muriel, X., Cámara Tobalina, J., Fernández López, J. R., & Pallarés, J. G. (2012). Validez del test de salto para la valoración del rendimiento anaeróbico y la asimetría en el ciclismo de alto nivel. *Sport TK*, *1*(1), 39-46.

Nikolaidis, P. T., Afonso, J., Clemente-Suarez, V. J., Alvarado, J. R. P., Driss, T., Knechtle, B., and Torres-Luque, G. (2016). Vertical jumping tests versus Wingate anaerobic test in female volleyball players: The role of age. *Sports*, *4*(1), 1-7. https://doi.org/10.3390/sports4010009

Ortega, F. B., Ruiz, J. R., Castillo, M. J., & Sjostrom, M. (2008). Physical fitness in childhood and adolescence: A powerful marker of health. *International Journal of Obesity, 32*, 1-11. https://doi.org/10.1519/JSC.0000000000000864

Özkan, A., Köklü, Y., & Ersöz, G. (2010). Wingate anaerobic power test. *Journal of Human Sciences*, *7*(1), 207-224.

Rampinini, E., Bishop, D., Marcora, S. M., Ferrari Bravo, D., Sassi, R., and Impellizzeri, F. M. (2007). Validity of simple field tests as indicators of matchrelated physical performance in top-level professional soccer players. *International Journal of Sports Medicine*, *28*(3), 228-235.

Rosas, H., Alcaraz-Caracheo, L. A., & Jimenez, A. (2020). Métodos para determinar el índice de fatiga muscular a través de semg: revisión de la literatura. *Pistas Educativas*, *42*(137), 526-540.

Runge, M., Rittweger, J., Russo, C. R., Schiessl, H. and Felsenberg, D. (2004). Is muscle power output a key factor in the age-related decline in physical performance? A comparison of muscle cross section, chair-rising test and jumping power. *Clinical Physiology and Functional Imaging, 24*(6), 335-340. https://doi.org/10.1111/j.1475-097X.2004.00567.x

Sands, W. A., McNeal, J. R., Ochi, M. T., Urbanek, T. L., Jemni, N. and Stone, M. H. (2004). Comparison of the Wingate and Bosco anaerobic tests. *The Journal of Strength and Conditioning Research*, *18*(4), 810-815. https://doi.org/10.1519/13923.1

Sirvent, J., & Alvero, J. (2017). *La cineantropometría y sus aplicaciones*. Univiersitat d' Alicant.

Steene-Johannessen, J., Kolle, E., Andersen, L. B., & Anderssen, S. A. (2013). Adiposity, aerobic fitness, muscle fitness, and markers of inflammation in children. *Medicine and Science in Sports and Exercise, 45,* 714-721. https://doi.org/10.1249/MSS.0b013e318279707a

Straight, C. R., Lindheimer, J. B., Brady, A. O., Dishman, R. K., & Evans, E. M. (2015). Effects of Resistance Training on Lower-Extremity Muscle Power in Middle-Aged and Older Adults: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. *Sports Medicine, 46*(3), 353-364. https://doi.org/10.1007/s40279-015-0418-4

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