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SUMARIO / SUMMARY / RESUMO

Editorial

The journal MLS Sport Research (MLSSR) was recently configured as a biannual publication with the aim of disseminating original research and review articles in both basic and applied and methodological areas that represent a contribution to progress in the field of Physical Activity and Sport Sciences. In this new issue (3) of the journal, corresponding to the first semester of the year 2023, 5 articles are presented that show the multidisciplinary vocation of the journal in the approach of diverse topics that add knowledge to the study of physical activity and sports, both from the perspective of health, sports performance or Physical Education. All this, through studies and literature reviews, cross-sectional studies, experiments or intervention programs. In this issue, very interesting review papers associated with the menstrual cycle and the development of strength or the association between physical exercise and breast cancer are described. In addition, an interesting teaching innovation experiment with a high value of ecological validity is presented, such as the use of Bike Desks to improve the physical activity levels of students, without harming their academic performance, under the paradigm of dual cognitive and motor interference tasks; or an isometric training intervention program for the prevention of injuries in soccer players. Finally, an interesting cross-sectional study provides insight into the psychosocial aspects that were compromised in university athletes during the Covid-19 pandemic. 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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THE INFLUENCE OF THE MENSTRUAL CYCLE ON STRENGTH TRAINING: A LITERATURE REVIEW

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Abstract. Introduction: To evaluate the existing scientific literature on the relationship between hormonal fluctuations and the ability to produce strength, and to establish which phase of the MC is the most appropriate to apply greater load in strength training. Method: A bibliographic search was carried out using the PubMed database. The articles included were those written in English or Spanish and related to strength production in eumenorrheic women. Results: In terms of grip strength, very different results were obtained, which may derive from the level of training of the participants, as well as from the method used to determine the phases since few of them coincided. If we observe those related to isometric strength, no significant differences were obtained throughout the menstrual cycle, although it would be necessary to look at the phases evaluated and the method used to evaluate these phases. Regarding lower limb strength, the results indicated better strength values in the follicular phase. Finally, the results related to maximum voluntary contraction indicated better values in the luteal and ovulation phases. Discussion and conclusion: In conclusion, the capacity to produce force is greater in different phases according to the strength test performed, the greatest uncertainty was in the grip strength where it is not clear which phase produces the greatest force since the results are very different. However, it seems that the capacity to generate isometric force does not vary throughout the menstrual cycle and the maximum force is related to the follicular phase where the estrogen peak occurs. As for maximal voluntary contraction, two different results are given that offer doubts as to which phase generates more of this type of force.

Keywords: Health, performance, female, sport, sex hormones, menstrual phase.

LA INFLUENCIA DEL CICLO MENSTRUAL EN EL ENTRENAMIENTO DE FUERZA: REVISIÓN BIBLIOGRÁFICA

Resumen. Introducción: Evaluar la literatura científica existente sobre la relación entre las fluctuaciones hormonales y la capacidad de producir fuerza, y establecer qué fase del CM es la más adecuada para aplicar mayor carga en entrenamiento de fuerza. Método: Se realizó una búsqueda bibliográfica a través de la base de datos PubMed. Los artículos incluidos fueron aquellos que estuvieran redactados en inglés o español y que estuvieran relacionados con la producción de fuerza en mujeres eumenorreicas. Resultados: En cuanto a la fuerza de prensión se obtuvieron resultados muy dispares que pueden derivar del nivel de entrenamiento de las participantes, así como del método utilizado para determinar las fases, ya que pocos coincidieron. Si observamos los estudios relacionados con la fuerza isométrica no se obtuvieron diferencias significativas a lo largo del ciclo menstrual, aunque habría que fijarse en las fases evaluadas y el método para evaluar dichas fases. En cuanto a la fuerza del miembro inferior los resultados indicaron mejores valores de fuerza en la fase folicular. Por último, los resultados relacionados con la contracción voluntaria máxima indicaron mejores valores en la fase lútea y de ovulación. Discusión y conclusión: En conclusión, la capacidad de producir fuerza es mayor en diferentes fases según la prueba de fuerza realizada, la mayor incertidumbre se dio en la fuerza de prensión donde no queda clara cuál es la fase en la que se produce mayor fuerza ya que los resultados son muy diferentes. Sin embargo, parece que la capacidad para generar fuerza isométrica no varía a lo largo del ciclo menstrual y la fuerza máxima está relacionada con la fase folicular donde se da el pico de estrógeno. En cuanto a la contracción voluntaria máxima se dan dos resultados diferentes que ofrecen dudas sobre en qué fase se genera más este tipo de fuerza.

Palabras clave: Salud, rendimiento, mujer, deporte, hormonas sexuales, fase menstrual.

Introduction

Over the past three decades, there has been an increase in the number of women participating in exercise, from physical activity to elite sport, attributable to the increasing development and investment in women's professional sport (McNulty et al., 2020). Specifically, the percentage of women competing in the Olympic Games has risen from 26% in Seoul in 1988 to 45% in Rio de Janeiro in 2016. In addition, Tokyo 2021 became the most gender-balanced Games in history, with equal numbers of medals available for men and women, predicting that women's participation in the Games will increase to 49% (McNulty et al., 2020). One of the physiological differences between the two sexes is the menstrual cycle (MC), the main aspect that influences women's sports practice. The influence of CM on the endocrine system and its relationship to physical performance in women has attracted increasing interest from athletes, coaches, physicians, and researchers and represents a developing line of research (Duaso et al., 2018).

The CM is a physiological period from the beginning of bleeding (day 0) until the day before the next bleeding (more or less 28 days), during this period there are physiological undulations of the 4 hormones: estrogen, progesterone, follicle stimulating and luteinizing hormones (Lago Fuentes, 2020). The menstrual cycle is usually divided into two phases, follicular and luteal, or into three, adding the ovulatory phase in between both (Duaso et al., 2018), although there are studies that divide it into up to seven phases. However, the classification of MC using only two phases does not sufficiently distinguish the multiple hormonal milieus that occur within these two phases. Therefore, CM is typically expressed in research using sub-phases, such as early follicular, late follicular, ovulatory, luteal, and premenstrual (Carmichael et al., 2021). The duration of the menstrual cycle throughout life ranges from puberty to menopause, interrupted only by pregnancy, lactation or particular pathologies. Its regularity is sensitive to factors,such as stress, emotional problems, surgical interventions, and disease (Zanin et al., 2011).

The early follicular phase begins with menstruation (bleeding phase) which usually takes 4 to 6 days to complete; in this phase, female sex hormone concentrations are relatively low and stable (Carmichael et al., 2021). The late follicular phase lasts until ovulation and the highest peak estrogen concentration coincides with low progesterone levels. Before ovulation, there is a decrease in estrogen concentration in order to promote ovulation (increase of luteinizing hormone to promote fertilization) (Lago Fuentes, 2020). Finally, the luteal phase begins a few hours after the oocyte has been expelled from the mature follicle. The corpus luteum secretes progesterone reaching its highest peak and a lower amount of estrogen (Zanin et al., 2011). Under the influence of both hormones, but especially progesterone, the endometrium begins its secretory phase, which is indispensable in preparing the uterus for implantation in case the oocyte is fertilized. If there is no implantation the corpus luteum degenerates in a few days as hormone concentrations decrease, this leads to triggering a new menstruation as the endometrium is detached from the uterus (Zanin et al., 2011).

Therefore, during these phases of CM there are two main hormones that vary in concentration throughout CM. The first is estrogen, a hormone with a putative anabolic function, i.e., it promotes muscle growth, whereas progesterone has been linked to catabolic pathways (Romero-Moraleda et al., 2019). Estrogen has an influence on type 1 collagen both in relation to decrease and degradation, increase of elastic content, decrease of fiber diameter and density. On the other hand, progesterone is connected with an increased number of fibroblasts and collagen synthesis. Many of these variables could be connected to the physical performance of female athletes in general, and to their levels of force production in particular (Duaso et al., 2018).

The influence of these hormones and CM phases on the ability to generate force is not entirely clear, with several studies showing contradictory results. Some studies showed greater strength during the follicular phase than during the luteal phase, while other studies reported greater strength during the luteal phase, while most studies could not find any alteration in muscle strength during CM (Sung et al., 2014). It is therefore clear that no agreement has been reached regarding the effects of CM on exercise performance; to date, there are no conclusive results regarding the effects of CM on force-generating capacity. Therefore, the objective of this work was to evaluate the existing scientific literature on the relationship between hormonal fluctuations and the ability to produce strength, and to establish which phase of the CM is the most appropriate to apply greater load in strength training

Method

Search strategy

The search for studies was performed in the PubMed database. The keywords used for the search were "menstrual cycle, strength, sex hormones, performance, menstrual phases and sport".

Inclusion and exclusion criteria

In this work, studies related to the production of strength in women were included; those that focused only on men were excluded; studies with women with a menstrual cycle were included, therefore, those involving preadolescent, menopausal, premenopausal or postmenopausal women were excluded; and studies with women with a natural menstrual cycle were included, therefore, those involving women using contraceptive treatments were excluded.

Types of studies collected

Experimental studies were collected for this work.

Languages

The search for studies was conducted in English and studies in English and Spanish were accepted.

Search period

A search for studies from 1996 onwards was carried out.

Type of participants

We searched for studies involving women with a menstrual cycle, who were eumenorrheic and who were not using any type of contraceptive treatment.

Results

Figure 1 shows the literature search and the selection of studies included in the review

Figure 1

PRISMA flowchart of this revision

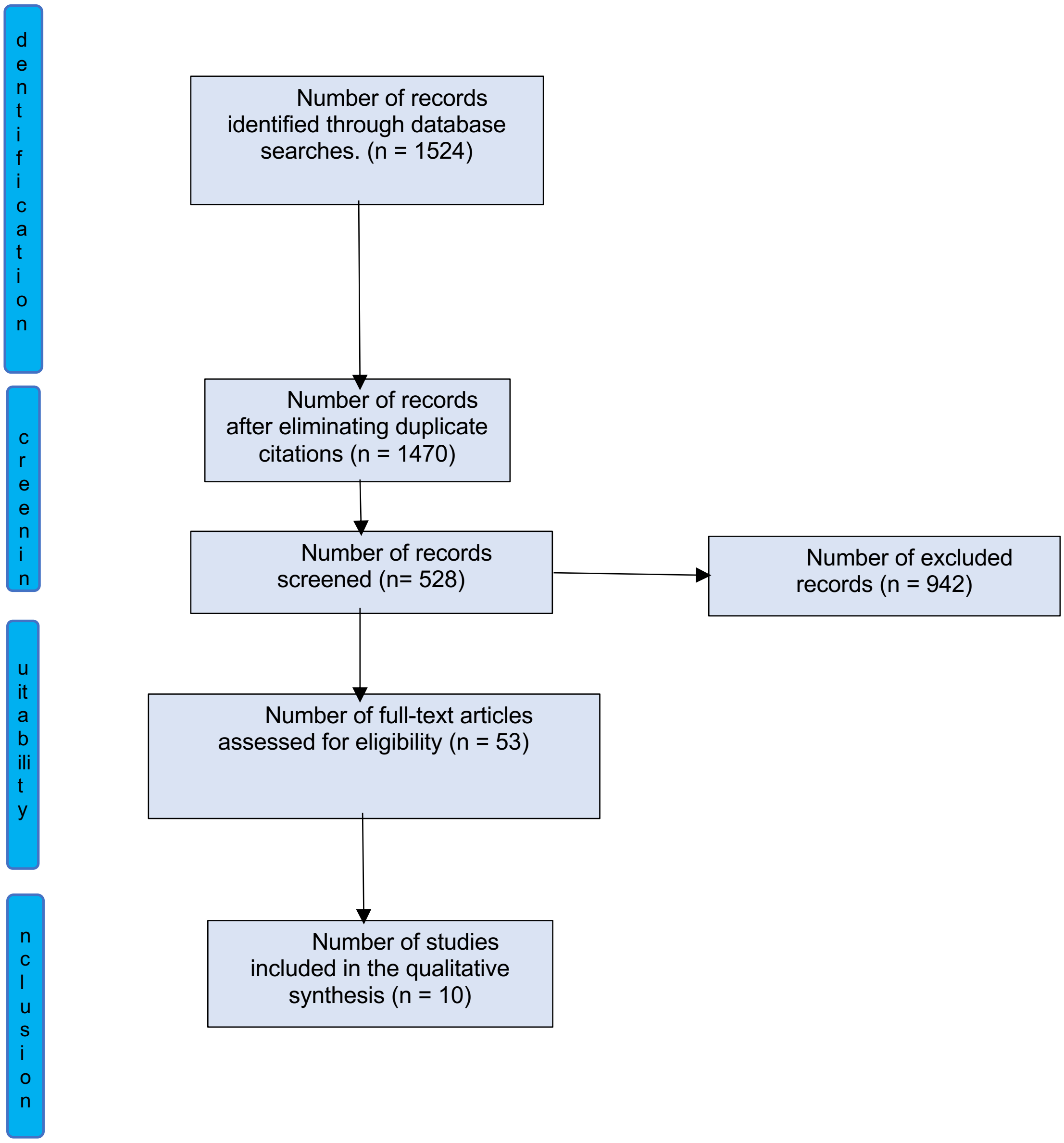

Table 1 shows the results obtained from the different studies analyzed, describing the most relevant aspects:

Table 1

Summary of the results obtained from the analyzed studies

Author and Date	Target	Participants	Method	Phase of the menstrual cycle	Evaluation of the phases	Results
(Dasa et al., 2021)	To investigate the effect of menstrual cycles on strength performance in highly trained female team athletes throughout the menstrual cycle and to examine whether eumenorrheic participants with natural hormonal fluctuations showed improved FF versus FL performance	Eumenorrean women in sports such as soccer, handball and volleyball competing at the national level. (n=8)	Maximal voluntary isometric isometric grip strength of the dominant hand was measured using a digital pinch/grip analyzer and the pneumatic leg press.	FF FL	By serum hormone levels through non-fasting venous blood samples prior to testing at each visit.	There were no statistically significant changes for the two different phases of the menstrual cycle, in terms of physical performance. As for the isometric pressure strength test the highest values were in the LF. In the leg press test, the values were practically similar throughout the menstrual cycle, with the FF being the one that registered the best value.
(Iwanska et al., 2021)	To investigate the effect of the menstrual cycle on strength in physically active women.	Physically active and eumenorrheic women (n=24)	Muscle strength was assessed as ankle flexor muscle pairs in CVM were measured under isometric conditions using the specially designed measuring stand. Two measurements were performed, one at a 90º angle and the other at a 60º angle for all the joints of the lower limb.	Follicular Phase. Luteal phase.	Blood samples were taken from the antecubital vein to determine sex steroid concentrations.	Higher values were documented in both phases for the 90° angle at the ankle joint. Muscle torque in the stretched muscle ($\alpha = 60°$) was 11 % lower on average. MVC was higher in the luteal phase for both angles.
(Janse de Jonge et al., 2001)	To study the influence of the different phases of the menstrual cycle on the contractile characteristics of skeletal muscle.	Eumenorrheic women (n = 15)	An adjustable chair with a steel frame and straight back was used to measure the isometric strength of the quadriceps. The grip strength of the dominant hand was measured using a force transducer placed inside an adjustable frame.	Menstruation phase. Late follicular phase. Luteal phase.	Fasting blood samples were taken from an antecubital vein to measure serum concentrations of estrogen, progesterone, FSH and LH using kits.	There were no significant differences between the phases of the menstrual cycle for any of the variables. No significant changes over menstrual cycle phases were shown for quadriceps isometric strength. For grip strength, no significant changes were also shown throughout the menstrual cycle.
(Kuehne et al., 2021)	To examine changes in muscle strength across menstrual cycles in women.	Eumenorrheic women regularly participated in resistance training	For upper body isometric strength testing, individuals sat on a preacher curl bench with the elbow flexed at 90° and were asked to flex the arm as hard as possible against an immovable object. Isometric force was measured with a load cell.	Menstrual phase. Ovulation phase. Luteal phase.	The Flo app and use of home ovulation kits were used to validate the ovulation phase.	The phase of the menstrual cycle does not seem to influence isometric strength. Isometric strength levels were very similar throughout the 3 menstrual phases.

		(n=14).				
(Miyazaki et al., 2022)	To determine the effect of the menstrual cycle on hamstring strength.	Healthy young women (n=16)	Isometric muscle strength was measured in prone position with 90º knee flexion using an isokinetic dynamometer. Maximal muscle strength was defined as the exercise of force at maximum effort for 3 seconds.	Follicular phase. Ovulation phase. Luteal phase.	The follicular phase (3 days after the end of menstruation), the luteal phase (6 to 8 days before the next scheduled onset of menstruation) and the ovulation phase (2 to 3 days after the ovulation test was positive) were determined according to menstruation	Isometric muscle strength showed no significant difference between the follicular and ovulatory phases. However, there was a significant increase in the luteal phase compared to the ovulatory phase
(Pallavi et al., 2017)	To evaluate variations in muscle strength during various phases of the menstrual cycle in young adults.	Untrained or poorly trained eumenorrheic students. (n=100)	To assess muscle strength, the Mosso Ergograph and Hand Dynamometer was chosen as the testing tool.	Menstrual phase. Follicular phase. Luteal phase.	No evaluation of hormone levels was performed to confirm the phases.	Manual grip strength was significantly higher in the follicular phase and relatively reduced in the menstrual and luteal phases of the menstrual cycle. The menstrual phase has the lowest strength compared to the other two phases.
(Romero-Moraleda et al., 2019)	To investigate fluctuations in muscle performance in the half squat exercise on the Smith machine during three different phases of the menstrual cycle.	Triathletes, eumenorrheic and strength-trained women (n=13)	Half squat on the Smith machine at maximum speed with loads representing 20, 40, 60 and 80% of their 1RM.	FFTemprana FFTardía FLM.	We used: a) period tracking application; b) measurement of tympanic temperature and changes in body mass and c) evaluation of peak urinary luteinizing hormone.	**Maximum strength:** At 20 and 40% of 1 MR, there were no significant differences. At 60% of 1RM, it was possibly greater in the FFTemprana compared to the FLM. At 80% of 1RM, it was possibly greater in the FFTardía compared to the FFTemprana and FLM.
(Sarwar et al., 1996)	To investigate the effect of different phases of the menstrual cycle on skeletal muscle strength and contractile properties.	Young, healthy and relatively sedentary women. (n=10)	Quadriceps MVC was measured using a conventional strength test chair. Grip strength was measured using a Jamar hydraulic hand-held dynamometer, with the arm at the side of the body and the elbow extended.	Early follicular phase. Middle follicular phase. Ovulation phase. Mid luteal phase. Late luteal phase.	They were estimated from the first day of bleeding and the ovulation phase was predicted as 14 days before menstruation. Early follicular phase (between days 1-7), mid follicular (between days 7-12), ovulation (between days 12- 18), mid luteal (between days 18-21) and late luteal (between days 21-32).	There was a significant increase of about 11% in quadriceps and hand grip strength at mid-cycle compared to the follicular and luteal phases. Quadriceps strength peaked during the ovulation phase. There were significant differences in MVC between the ovulatory phase and all other phases of the cycle, with the greatest difference being between the ovulatory and late luteal phases. Grip strength was also significantly higher in the ovulation phase compared to all other phases.
(Shalfawi et al., 2021)	To examine changes in strength in eumenorrheic young female college students during the menstruation phase and at	Eumenorrheic university students, their activity level was limited to physical	Participants tested on bench press one repetition maximum (1RM), leg press 1RM, push-ups to failure, leg press with 60% of 1RM to failure.	Early follicular phase. Late follicular phase. Ovulation phase.	It was based on the classical model of the menstrual cycle, the early follicular phase (day 2), late follicular phase (day 8), ovulation phase (day 14) and mid-luteal phase (day 21).	The results of the present study showed no significant differences in maximal strength or endurance strength tests for both lower and upper body. The highest values were observed in the late follicular phase.

	different testing occasions within a menstrual cycle.	education classes and recreational activities. (n=12)		Mid luteal phase.		
(Weidauer et al., 2020)	To determine changes in neuromuscular performance throughout the menstrual cycle.	Physically active university students (n=22)	Grip strength on the dominant side was measured using the Grip-D digital grip strength dynamometer.	Early follicular phase. Ovulatory phase. Mid luteal phase.	Blood was drawn from a vein in the antecubital region to measure plasma estradiol and progesterone. In addition, they took an ovulation test at home every day starting on day 7, which indicated when the LH surge occurred before ovulation.	Grasping force was greater in the ovulatory and mid-luteal phase than in the early follicular phase.

Note: FF: Follicular phase**,** FL: Luteal phase, CVM: Maximum voluntary contraction, HFE: Follicle stimulating hormone, FSH: Luteinizing hormone, FFTemprana: Early follicular phase, FFTardia: Late follicular phase, LMP: Mid luteal phase

Discussion and conclusions

The results obtained in the different studies on the influence of the menstrual cycle on grip strength are very contradictory. It seems that the phase of the menstrual cycle in which the production of gripping force is greatest is not fully defined. Following a study carried out with sportswomen, they have shown better strength values during the luteal phase (Dasa et al., 2021)which clashes with the results of a study with untrained students where better strength values have been obtained in the follicular phase (Pallavi et al., 2017). This generates a great deal of doubt since the predominant hormone in each is different, but it must be taken into account that the phases evaluated are few and far between, an aspect that may influence the results. In addition, it may be that the physical preparation of the participants may influence the results, since we are talking about athletes and students. On the other hand, two authors (Sarwar et al., 1996) y (Weidauer et al., 2020) who with their studies agree that the best values of clamp force occur in the ovulation phase where the predominant hormone is luteinizing hormone, but if we observe the method of evaluation of this phase is different from each other and it may be that the method used by (Sarwar et al., 1996) is not entirely effective since it predicts the ovulation phase 14 days before menstruation without any type of test that can confirm the phase. On the other hand, (Weidauer et al., 2020) to confirm the ovulation phase has asked the participants to take an ovulation test at home every day from the seventh day until positive, a more efficient method that allows confirmation and testing at that phase. Finally, (Janse De Jonge et al., 2001) in his study found no significant differences throughout the menstrual cycle, although he left some phases to be evaluated, such as ovulation, and observing the previous results, he may have found some difference. Therefore, there are many differences between these studies since the level of training of the participants is very diverse, as well as the methods of evaluation of the phases and the number of phases evaluated, all of which makes the results very confusing and not entirely reliable.

In this case there is a coincidence among the three studies (Janse De Jonge et al., 2001; Kuehne et al., 2021; Miyazaki & Maeda, 2022), all have recorded that there are no significant changes in isometric strength throughout the menstrual cycle, these data agree with those obtained by (Arazi et al., 2019), who have also found no differences in isometric strength throughout the menstrual cycle. The phases evaluated I think are few and far between, (Janse De Jonge et al., 2001) I believe they use an adequate method to evaluate the phases as they measure estrogen, progesterone, FSH and LH through blood samples, thus being able to confirm the phase of the cycle. On the other hand, (Kuehne et al., 2021 and Miyazaki & Maeda, 2022) did evaluate the ovulation phase although the method for determining the phases may not be very effective since the first uses an app and ovulation kits, with the participants having a great responsibility when recording the phases and the second establishes the phases based on menstruation, something that may not be very accurate and reliable.

Two studies have evaluated lower limb strength. (Romero-Moraleda et al., 2019) have performed a half squat study with different percentages of 1RM observing only differences with percentages of 60 and 80% in which the best values were obtained in the early and late follicular phase respectively, coinciding the late follicular phase with the highest estrogen peak, thus supporting the hypothesis put forward by (Smith et al., 1999) suggesting that higher strength values can be observed because estrogen is higher in the late follicular phase. In addition, to determine the phases of the cycle, they have used three types of measurements as recommended by (Bambaeichi et al., 2004 and Tenan et al., 2016) that allow to effectively control and determine the phases. Results that have a slight coincidence with (Shalfawi & el Kailani, 2021) which has performed 1RM leg press and which has evaluated a large number of phases that have allowed them to achieve more accurate results, although they have used a method that is not very valid since it is based on the classical model of the menstrual cycle and does not perform any type of test to validate and determine the phase of the cycle. The results did not show major differences between the phases, but the best values were recorded in the late follicular phase.

As limitations, few studies related to strength and the menstrual cycle have been found. In addition, in most of them the methods of evaluation of the menstrual phase are different and different strength tests are performed.

Regarding the main objective of this study, we can conclude that the ability to produce force is greater in different phases depending on the strength test performed, the greatest uncertainty is in the grip strength where it is not clear which phase produces the greatest force since the results are very different. However, it appears that the ability to generate isometric force does not vary throughout the menstrual cycle and maximal force is related to the follicular phase where the estrogen peak occurs. As for the maximum voluntary contraction, two different results are given, which raise doubts as to which phase generates more of this type of force. I believe that the level of training of the participants and the method of determining the phases greatly influences the results, an aspect that should be standardized for future studies related to the menstrual cycle.

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EVALUATION OF THE EFFECTS OF PHYSICAL EXERCISE IN PATIENTS WITH BREAST CANCER: A SYSTEMATIC REVIEW

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Abstract. The main aim of this review was to evaluate the effectiveness of a physical exercise (PE) program in breast cancer (BC) patients and its effects on their life's quality, perceived fatigue, depression and physical condition A systematic search, based on PRISMA guidelines, was performed using three databases: Medline, Pubmed and Google Scholar. Inclusion criteria were; adults (>18 years), BC patients during adjuvant therapy, PE interventions with the capability of influencing quality of life, fatigue and physical fitness.In addition, the exclusion criteria were; performing the PE intervention after the disease, articles published before 2010, as well as any written in languages that were not English, Spanish and/or French. The results five articles were included for review and all studies showed improvements in quality of life, physical fitness and/or body composition, as well as perceived fatigue and depression. It can be concluded that the complementary incorporation of systematized PE programs during adjuvant therapy for women with BC offers both improvements in quality of life and physical fitness and decreased fatigue and depression, whatever the type of training program (resistance, strength or the both of them combined).

Keywords: Breast cancer, physical exercise, physical condition, quality of life and fatigue.

EVALUACIÓN DE LOS EFECTOS DEL EJERCICIO FÍSICO EN PACIENTES CON CÁNCER DE MAMA: UNA REVISIÓN SISTEMÁTICA

Resumen. El objetivo principal de esta revisión fue evaluar la eficacia de un programa de ejercicio físico (EF) en pacientes con cáncer de mama (CM) y sus efectos sobre la calidad de vida, la fatiga percibida, la depresión y la condición física. Se realizó una búsqueda sistemática, basada en las directrices PRISMA, utilizando tres bases de datos diferentes: Medline, Pubmed y Google Académico. Los criterios de inclusión fueron; adultos (>18 años), pacientes con CM durante la terapia adyuvante, intervenciones de EF con el efecto de influir en la calidad de vida, la fatiga y la condición física. Así mismo, los criterios de exclusión fueron; realizar la intervención de EF después de la enfermedad, artículos publicados antes del 2010 o en idiomas que no fueran inglés, castellano y/o francés.Los resultados incluyeron cinco artículos para la revisión y todos los estudios mostraron mejoras en la calidad de vida, la condición física y/o en la composición corporal, además de en la percepción de fatiga percibida y de la depresión.Se puede llegar a la conclusión de que las incorporaciones complementarias de programas de EF sistematizado durante la terapia adyuvante a mujeres con CM ofrece tanto mejoras en la calidad de vida, como en la condición física y una disminución de la fatiga y la depresión, sea cual sea el tipo de programa de entrenamiento (resistencia, fuerza o combinación de ambas)

Palabras clave: cáncer de mama, ejercicio físico, condición física, calidad de vida y fatiga

Introduction

CM is the most diagnosed in women worldwide (Ferlay et al.,2015), likewise, the risk of being diagnosed with CM is 1:8 (Kootstra et al., 2010), causing survivors a multitude of side effects (Diaby et al.,2015), including cardiac toxicity (Martin et al., 2013), vomiting (Adamsen et al.,2009) and fatigue (Heim et al., 2007), this being one of the most frequent.

Fatigue is the most common side effect in people with CM, with 70-100% of patients experiencing long-term feelings of fatigue (Lipsett et al., 2017). Cancer-related fatigue typically causes a vicious cycle, because reduced physical activity levels caused by the presence of fatigue exaggerate the feeling of tiredness (Gebruers et al., 2019).

During adjuvant treatments is where the greatest consequences are observed at the cardiovascular level, this affects the effects at the cardiac level and its consequences on aerobic capacity (Roca-Alonso et al.,2012). Due to fatigue, PA practice is abandoned, resulting in a loss of muscle and bone mass (Demark-Wahnefried et al, 2001). These losses, apart from the abandonment of PA and immobility, can also be triggered by decalcification and the effects of certain treatments (Winer et al., 2005).

In relation to the reduction in physical activity levels, the lack of physical activity triggers some consequences, such as a reduction in muscle mass and muscle strength (Demark -Wahnefried et al., 2001), as well as other side effects such as a decrease in quality of life (Ligibel et al., 2016), resulting in a decrease in activities of daily living, which again increases the feeling/perception of fatigue (Berger et al., 2018).

This feeling of fatigue may be more pronounced in those patients who are undergoing treatment compared to those who are not (Font et al., 2002).

Likewise, the World Health Organization (1997) defines quality of life as "the way in which the individual perceives his or her life, the place he or she occupies in the cultural context and value system in which he or she lives, the relationship with his or her goals, expectations, standards, criteria and concerns, all of which are permeated by daily activities, physical health, psychological state, degree of independence, social relationships, environmental factors and personal beliefs".

It has been shown that those patients who exercise have a greater tolerance of fatigue, as well as an increase in quality of life (Pereira et al., 2020). In addition to the various beneficial effects of EF in cancer patients, demonstrating a positive association between physical activity during and after antineoplastic treatments, resulting in improved quality of life and functional capacity (Tejada-Medina et al.,2020).

Therefore, the aim of this systematic review is to assess the efficacy of PE programs in women with MC during adjuvant therapy according to their effects on quality of life, fatigue, and physical fitness.

Method

This systematic search was carried out between October and December, was based on PRISMA guidelines and was performed using three different electronic databases; Google Scholar, PubMed and Medline. Relevant keywords and input terms were defined using the PICO(S) methodology, implementing a Boolean search to obtain eligible studies. The following keywords were combined: "CM", "EF", "physical activity", "quality of life", "adjuvant therapy" and fatigue.

Table 1
Searching strategies with Boolean operators in different databases

Database	**Search strategy**
Pubmed	"breast cancer" AND "physical exercise" AND benefits OR "quality of life" OR fatigue "breast cancer" AND "physical exercise" NOT "Physical activity" AND benefits OR "quality of life OR fatigue "breast cancer" and "adjuvant therapy" and "benefits" and "physical exercise"
Google Scholar	"CM" AND "EF" AND benefits OR "quality of life" OR fatigue "CM" AND "EF" NOT "physical activity" AND benefits OR "quality of life" OR fatigue
Medline	"breast cancer" AND "physical exercise" AND benefits "breast cancer" AND "physical exercise" NOT "Physical activity" AND benefits OR "quality of life OR fatigue

Table 2
Inclusion and exclusion criteria

PICO	INCLUSION	EXCLUSION
P1	Adults (>18 years old)	
P2	Women with CM during adjuvant therapy.	Post-illness FE intervention.
I	The intervention should be a training program that works on muscular strength and/or cardiorespiratory capacity.	
C		
O	The result should be an indicator of fitness level, quality of life and/or fatigue.	
Others	The language must be Spanish, English or French. Published from 2010 onwards	

Results

Figure 1 shows the flow chart of the systematic review

Figure 1
Flow diagram

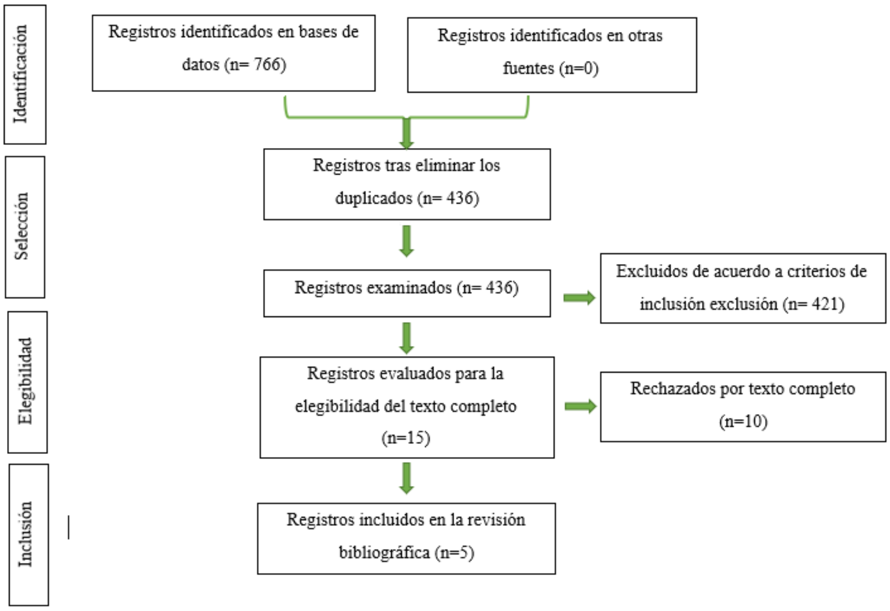

Table 3
Description of intervention studies

Authors	Type of study	Sample	Instrument	Intervention
Antunes et al, (2019)	Quantitative/qualitative	19 women (11 recent term and 8 late)	Balke's test *Test sit to stand* Manual dynamometer Questionnaire QLQ-C30	Aerobic training (<40% of the heart rate of the patient) reserve) Training strength (3 sets, 12-15 reps)
Casla et al., (2015)	Quantitative/ Qualitative	94 women (In early stage from 1 to 36 months after radiotherapy and chemotherapy)	Questionnaires Bruce Protocol (modified) TKK 5401 AND TKK 5402 Grip-D MRI test using the Mayhew formula	Combined aerobic and strength training (85% of heart rate reserve, 50% and 70% of 1RM)

			Electrical bioimpedance (BC-6001F) SF-36 Questionnaire	
Evigor el atl., (2010)	Quantitative/ Qualitative	Experimental group 27 women Control group: 15 women	6MWT Test sit and reach (modified) The brief fatigue inventory Beck depression inventory EORTC Questionnaire QLQ-C30 EORTC Questionnaire BR23	Rehabilitation training based on specific Pilates exercises, progressively increasing intensity over 8 weeks

Spartoo et al., (2012)	Quantitative/ qualitative	Experimental group: 236 women Control group: 237 women	UKK walking test 8-way race test EORTC Questionnaire QLQ-C30 FACIT-F Questionnaire Physical activity levels questionnaire Prospective journal	Aerobic exercise with an RPE between 14 and 16, which corresponds to 86-92% of HRmax, 76-85% of VO2max and 5-7 METs
Schmidt et al., (2015)	Quantitative/ qualitative	122 women in total, of which 101 passed the selection criteria	Fatigue Questionnaire (FAQ) Quality of Life EORTC QLQ-C30 Depression Questionnaire Trail making test Isomed 2000VR	Strength exercises (8 exercises performing 3 sets of 8-12 reps at 60-80% of RM)

		Vo2Max spiroergometry

The first article selected, was Antunes et al., (2019), where the main objective of this study was to evaluate the impact on health-related quality of life and physical fitness in patients with CM.

In that article, the women with MC were stage I to III and aged between 30 and 75 years.

The study included 19 women (52 ± 9.7 years of age) divided into group A (GA) and group B 79 (GB) according to follow-up time since CM diagnosis. The AG (n = 11) consisted of patients who had a recent term diagnosis of MC (23.5 ± 5.9 months; min-max: 14-30 months) and GB (N= 11) by patients with late term diagnosis (83.3 ± 5.7 months, 82 min-max: 74-92 months).

Study outcomes were assessed at baseline (M1), after 8 weeks (M2) and 16 (M3) weeks of M1. The following variables were evaluated: physical fitness and quality of life.

Aerobic capacity was assessed by a maximal treadmill exercise tolerance test using a modified Balke protocol. Maximal oxygen consumption (VO2max) was estimated indirectly using the Multi-Stage Submaximal Model.

Lower limb functionality was assessed by the sit-stand test, where the score was determined by the number of sit-to-stands performed in 30 seconds.

Grip strength was evaluated using a hand-held dynamometer, where each subject performed 3 trials for each arm with an alternating bilateral sequence. The average of the 3 trials was considered for the grip strength of the operated and non-operated limbs.

Quality of life was assessed using the European Organization for Research and Treatment of Cancer (EORTC) Quality of Life Questionnaire C30 (QLQ-C30). Scale scores for physical function, fatigue and global health status were taken into account for the analysis.

The GA women performed an exercise program with 3 sessions per week for 16 weeks, combining strength and aerobic training.

Aerobic training included aerobic circuits, treadmill and exercise bike.

During the first two weeks, they performed 5 minutes of all these exercises at light intensity (<40% of reserve heart rate, <11 on the Borg scale). After this time, 3 min were added every two weeks until a volume of 30 min of aerobic training was reached.

Eleven exercises were included in the strength training sessions. During the first two weeks, they performed 2 sets of 10 repetitions with no load. After this period, the resistance was adjusted according to the individual differences of each person, so that they could complete 3 sets of between 12-15 repetitions. When the patients reached the capacity to perform the volume mentioned above, the lowest load (5-10%) was added.

At the end of treatment, a significant effect was observed in all fitness scores. In addition, a medium effect size was found in the grip strength of the operated and non-operated limb and a large increase in VO2max and sit-stand test. Post-intervention analysis revealed that only GA significantly improved these outcomes.

Regarding the results in the quality of life questionnaire, a significant increase on physical function and global health status and a significant reduction in the fatigue scale score for GA were observed.

On the other hand, another selected article, is the one by Soraya-Calsa et al 2015, where the main objective was to evaluate the respiratory fitness of breast cancer patients after primary treatment by means of an FE intervention. For this purpose, they recruited 235 women of whom 94 with early stage (I-III) breast cancer 1 to 36 months after radiotherapy and chemotherapy were enrolled. These in turn, were randomly assigned to two groups, one composed of 44 people, who performed the intervention program combining aerobic and strength exercises (EX) and another of the same number who continued with the usual care (CON), both lasting 12 weeks.

A baseline test was performed at the beginning of the 12 weeks, a post-treatment test and a follow-up test at 6 months after the end of the intervention.

For this purpose, they evaluated Vo2Max as the primary endpoint and secondary criteria such as: muscle strength, shoulder range of motion, body composition and quality of life.

Prior to evaluating the aforementioned criteria, demographic and descriptive data were collected by means of questionnaires, including the level of physical activity.

Vo2max was assessed by a submaximal test at 85% of the reserve heart rate, using the modified (treadmill) Bruce protocol. They also applied the Canadian Society of Exercise Physiology equation to predict VO2max.

As for secondary assessments, isometric muscle strength and shoulder range of motion were evaluated using isometric dynamometers (TKK 5401 and TKK 5402) in hand, leg and back grip. Once obtained, they added up all the strength values and divided the result by the participant's body weight to obtain the strength index.

In relation to dynamic muscular strength, they performed chest press and leg extension exercises following a protocol of 8 repetitions maximum according to Mayhew's formulas (RM test using Mayhew's formula) and the indications of the

National Strength and Conditioning Association.

Muscle strength was evaluated following the test mentioned above so that the maximum number of repetitions at 50% of 1RM for the chest press and 70% of repetitions for the leg extension.

Regarding body composition and anthropometry, data on body composition were collected on the percentage of body fat and lean mass using electrical bioimpedance (BC-601F) and anthropometric values were obtained for weight, height, body mass index, waist-hip circumference and their relationship.

Finally, in reference to the secondary criteria, quality of life (QoL) was assessed through the SF-36 questionnaire, which consists of 36 items, including eight domains referring to physical functioning, role limitation due to physical health, bodily pain, general perception of health, vitality, social functioning, role limitation due to emotional health and mental health. Higher scores indicate higher levels of health.

At the conclusion, 87.7% of the patients completed the intervention, 86% of whom completed the follow-up evaluations at 6 months after the end of treatment.

According to the data reflected in this study, 91% of the women in the EX group met the guidelines for minutes of physical activity recommended by the ASCM guidelines at the end of the intervention, and at 6 months, 79% continued to meet these guidelines. On the other hand, as for the CON group, after 12 weeks only 49% were compliant.

As for the result of the primary assessment of Vo2Max, this was considerably higher in the women of the EX program than the CON. It should be noted that at 6 months the EX group maintained its Vo2max.

Regarding the results of the secondary evaluation, the index of isometric strength and maximal strength (chest press and leg extension) and muscle strength increased in the women of the EX program compared to those of the NOC. At the 6-month follow-up, EX improved or maintained these.

In reference to body composition, the women in the EX program reduced the percentage of fat mass with a consequent increase in lean body mass. However, these changes were not maintained at the 6-month follow-up.

Regarding quality of life, participants in the EX group had higher levels with respect to mental and physical dimensions in SF36 compared to the group of CON women. Again, these changes were maintained for the EX group in those 6 months.

Finally, it was concluded that the EF is beneficial both psychologically, physiologically and a clear survival factor for this type of patients. Similarly, it is found that after such an intervention there is a significant improvement in Vo2Max capacity levels, which has been observed in different studies to be related to the reduction of cancer-specific mortality, as well as favorable effects on muscle strength, body composition and quality of life.

Another article on CM was conducted by Eyigor el al., (2010). This study consisted of a randomized controlled trial on the multidimensional effects of Pilates on physical performance, flexibility, fatigue, depression and quality of life in women with MC.

The program was carried out for eight weeks, performing the exercises three times a week. The sample consisted of 52 patients between 18 and 75 years old with CM, not recurrent or progressive, finishing treatment with surgery, radiotherapies and/or chemotherapy, with or without hormonal treatment at that time. However, 10 patients did not complete the treatment, ending with 27 patients in the experimental group and 15 in the control group performing general PE at home.

The workouts were structured in a warm-up where ten repetitions of different pilates postures where the whole body is involved are performed; and a main part with more specific pilates exercises, progressively increasing the intensity each week.

An analysis of the subjects before, during and after the intervention was performed. The tests performed were: Six-minutes walk test, modified sit and reach test, the brief fatigue inventory and finally beck depression inventory. To measure patients' global quality of life, the EORTC QLQ-C30 scale was used, specifically the EORTC BR23 specialized in cancer.

In the measurements taken before the program, no significant differences were observed between patients. However, at the end of treatment and assessment, changes were observed that positively affected the Pilates group in tests for functional capacity, depression, global quality of life and tumors. As for the control group, there was a significant decrease in the functional capacity test.

The results of this study revealed significant changes in the following parameters: functional capacity, depression, quality of life and, to a lesser extent, flexibility. However, the control group did not obtain significant changes in the different parameters evaluated.

In the article by Spartoo et al. where the aim was to determine whether physical training improves the quality of life (QoL) and physical fitness of MC survivors.

Patients were randomly assigned to a 1-year training or control group. The inclusion criteria for the study were: Histologically proven invasive CM, patient with premenopausal or postmenopausal CM treated with adjuvant chemotherapy or radiotherapy within 4 months, or patient who has initiated adjuvant endocrine therapy no less than 4 months prior and aged 35-68 years. The main reasons for exclusion were age over 68 years and the existence of health problems that contraindicated physical training.

Medical history was reviewed and physical examinations were performed at baseline and at 1-year follow-up. Patients completed the quality of life questionnaire, a questionnaire covering basic demographic and lifestyle issues, and an exercise diary two weeks before the intervention and after 6 and 12 months. Physical performance tests (2 km walking test and 8 km running test) were performed immediately before the start of the intervention and at 12 months follow-up.

The intervention focused on physical training at home, although, in turn, weekly supervised training sessions were held. Supervised group exercise training was organized once a week in groups of 5 to 15 people.

The supervised group exercise training consisted of two weekly classes with a duration of 60' each, where they alternated aerobic exercise training and circuit training. The intensity of the training program was based on the Rating of Perceived Exertion (RPE) scale. The target RPE of the training group was 14-16, a level of exercise that feels "somewhat hard" or "hard" and coincides with approximately 86-92 % of maximum heart rate, 76-85 % of VO2Max and 5-7 metabolic equivalents (METs).

The type of home training was optional but intended to be similar to supervised training, this consisted primarily of resistance training such as walking, Nordic walking or aerobic training, but also included jumping and hopping similar to step aerobics to promote bone health. Warm-up and cool-down exercises, such as walking or climbing stairs, were recommended before and after the home training session.

In addition, resistance training (walking, cycling, swimming, etc.) was recommended to the same RPE to meet the amount of weekly physical activity. It was intended that home training would be performed at least twice a week (but three times a week was recommended) so that total training would comprise a minimum of three training sessions per week. The control group was encouraged to maintain their previous level of physical activity and exercise habits throughout the study without any supervised or home training program.

Questionnaires were also conducted on leisure time physical activity levels prior to CM diagnosis, where activities were classified as low intensity, moderate intensity, high intensity or very high intensity activities.

In addition, information on the amount and intensity of current physical activity immediately prior to the start of the exercise intervention and at the follow-ups after 6 and 12 months was collected through a prospective physical activity diary, where patients reported the amount (minimum duration of 10 min) and type of physical activity.

As for the evaluation tests, cardiorespiratory capacity was assessed by a 2 km walking test (UKK walking test), neuromuscular performance was assessed by the 8-shape running test.

Quality of life was assessed using the European Organization for Research and Treatment of Cancer Questionnaire (EORTC QLQ-C30) with the addition of the CM module (BR-23). and finally, fatigue symptoms were assessed using the Functional Assessment of Chronic Illness Therapy (FACIT) questionnaire for fatigue (FACIT-F).

The amount of physical activity increased from baseline to 12 months in the exercise group and in the control group, with these increases being similar between groups. Neuromuscular performance improved significantly in the training group, while no improvement was observed in the control group. As for cardiorespiratory fitness, no significant effect was observed.

No significant differences were found between the experimental group and the control group in changes in quality of life during the intervention as measured by the EORTC-QLQ-

C30 or BR-23 module, and no significant differences were observed between the groups in depression or fatigue.

The last article selected in this review is the study conducted by Schmidt et al. in 2015, where the main objective was to investigate whether strength exercise during chemotherapy provides benefits on fatigue and quality of life beyond the possible psychosocial effects of group interventions. To do so, they recruited a sample of 101 women who passed the eligibility criteria for the study, which were to be over 18 years of age, have histologically confirmed primary breast cancer or after lumpectomy or mastectomy, be scheduled for adjuvant chemotherapy, have a body mass index (BMI) equal to or greater than 18/kgm2 and be able to follow and understand the study and be willing to participate in the study.

Once the sample was available, two groups were randomly formed where 49 women went to the exercise group (EX) and 46 to the relaxation control group (RC).

Regarding the EX group, they performed 8 different strength exercises on machines in a progressive manner, where they performed 3 sets of 8-12 repetitions at 60-80% of RM. On the other hand, the RC group performed progressive muscle relaxation using Jacobson's technique without any type of aerobic or strength exercise.

For this study, they will use several variables such as fatigue, through a fatigue assessment questionnaire (FAQ), which covers dimensions of both cognitive and physical fatigue. Quality of life (QoL), which was analyzed using a questionnaire (EORTC QLQ-C30). Another variable to be analyzed was depression, which was analyzed using the scale provided by the Center for Epidemiological Studies (CES-D), where high scales indicate greater depression, and within these, a scale greater than 38 from 0 to 100 indicates possible serious depressive disorders.

Cognitive function was assessed using a trail-making-test, which measures the time it takes the individual to connect numbers in a logical sequence.

Again, higher levels indicate worse cognitive function.

The last factors to be analyzed were medical history, BMI, weight and physical condition. Isometric muscle strength and cardiorespiratory capacity were assessed using tools such as IsoMed 2000VR, Vo2Max and spiroergometry.

The results of this intervention show a clear positive effect of strength exercise during chemotherapy in reducing physical fatigue, which is considered the most overwhelming side effect of chemotherapy, increasing quality of life and having psychosocial benefits, especially in the EX group. However, in the RC group, during chemotherapy physical fatigue worsened along with physical function. On the other hand, no significant difference was obtained over the EX and RC group in terms of cognitive fatigue.

Therefore, we conclude that the benefits observed in this study are not simply statistical, but are also clinically relevant.

Discussion and conclusions

In this systematic review, we examined the effectiveness of a PE program in patients with MS with the aim of looking at the potential benefits of PE.

Improvements have been found after a regular PE intervention in breast cancer patients, such as improved quality of life, decreased perceived fatigue and depression, improved body composition and physical fitness. The results found are in line with a study by Gebruers (2019) in which it was shown that EF is effective in increasing activities of daily living and reducing the feeling of fatigue. In addition, a review by Furmaniak et al. (2016) showed that there is conclusive evidence regarding the positive effects of EF during adjuvant therapy in patients with CM.

It has been considered that EF during adjuvant treatment for MC can be considered as a supportive self-care intervention that is likely to result in lower levels of fatigue, improved physical fitness, and little or no difference in quality of life and cancer-specific depression (Mutrie et al., 2007). In addition, there is ample evidence that EF has beneficial effects on mortality, perceived fatigue, quality of life, anxiety, and depression (Carayol et al., 2017; Palesh et al., 2018).

Several studies have proven the various beneficial effects of PE in cancer patients, demonstrating a positive association between physical activity during and after antineoplastic treatments, resulting in improved quality of life and functional capacity (Tejada-Medina et al.,2020).

According to Courneya (2003), EF may be an effective treatment to improve quality of life in patients with MC, although more scientific evidence is still needed to know the effects of exercise on cancer relapse, biomarkers, other diseases and overall survival.

We conclude that systemized PE performed on a regular basis during adjuvant therapy has numerous benefits such as improved quality of life, decreased perceived fatigue and depression, improved body composition and physical condition, regardless of the type of training program performed (endurance, strength or a combination of both).

As limitations, future lines of research are recommended, where more emphasis can be placed on the intensity of training, as well as on the principles of training adaptation and adaptations according to the state of health of the patients depending on the evolution of the disease.

Similarly, there is no distinction between different training protocols (resistance training, strength training or combined protocols of both), as well as the type of adjuvant therapy (chemotherapy, radiotherapy or both) that has been performed.

Likewise, it would be of great interest to be able to record the evaluations and comments given by the women who take part in these studies, as well as to record the type of analgesics they take and how these affect different variables such as fatigue or depression.

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EFECT OF AN ISOMETRIC EXERCISE TRAINING PROGRAM ON HAMSTRING INJURY RISK FACTORS IN AMATEUR SOCCER PLAYERS. A PILOT STUDY

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Abstract. In soccer, muscle injuries represent 38%. The hamstring musculature (HSM) was the most frequently injured muscle group, accounting for 39.5% of all muscle injuries and 16.3% of all injuries. Eccentric training of the hamstrings has been shown to increase the length of the fascicles of the long head of the biceps femoris (BFlh), that is, this training decreases the risk of injury, but may lead to the development of muscle soreness. Although, a training program with isometric exercises is less likely to cause muscle soreness. Therefore, the aim of the present pilot study was to analyze the effects of an isometric exercise training program (10 weeks) on HSM injury risk factors in amateur soccer players. Participants (n=18) were randomly assigned to a control (n=9) and experimental (n=9) group. Symptoms and injury risk in HSM (Hamstring Outcome Score), power (vertical jump) and strength (single leg bridge test) of HSM were evaluated. The analyses showed that in the experimental group there were improvements in all variables, but only the improvements in right HSM strength (p=0.003, d=0.679) and total HSM strength (p=0.038, d=0.52) were significant. It can be concluded that a training program with isometric exercises before the technical-tactical session could reduce the risk of injury in HSM, although these results should be taken with caution and future studies with a larger sample are recommended.

Keywords: Hamstring muscles; Soccer; Prevention; Injury risk.

EFECTO DE UN PROGRAMA DE ENTRENAMIENTO CON EJERCICIOS ISOMÉTRICOS SOBRE FACTORES DE RIESGO DE LESIÓN DE MÚSCULOS ISQUIOSURALES EN FUTBOLISTAS AMATEURS. ESTUDIO PILOTO

Resumen. En el fútbol las lesiones musculares representan el 38%. La musculatura isquiosural (HSM) fue el grupo muscular más frecuentemente lesionado, representando el 39.5% de todas las lesiones musculares y el 16.3% de todas las lesiones. Se ha demostrado que el entrenamiento excéntrico de los isquiosurales aumenta la longitud de los fascículos de la cabeza larga del bíceps femoral (BFlh), es decir, este entrenamiento disminuye el riesgo de lesión, pero puede conducir a la aparición de dolor muscular. Aunque, es menos probable que un programa de entrenamiento con ejercicios isométricos provoque dolor muscular. Por ello, el objetivo del presente estudio piloto fue analizar los efectos de un programa de entrenamiento con ejercicios isométricos (10 semanas) sobre factores de riesgo de lesión en la HSM en jugadores de fútbol amateurs. Los participantes (n=18) fueron asignados aleatoriamente a un grupo control (n=9) y experimental (n=9). Se evaluaron los síntomas y riesgo de lesión en HSM (Hamstring Outcome Score), potencia (salto vertical) y fuerza (single leg bridge test) de HSM. Los análisis mostraron que en el grupo experimental hubo mejorías en todas las variables, pero solo resultaron significativas las mejorías en fuerza de HSM derechos (p=0.003, d=0.679), y total (p=0.038, d=0.52). Se puede concluir que un programa de entrenamiento con ejercicios isométricos antes de la sesión técnico-táctica podría reducir el riesgo de lesión en HSM, aunque estos resultados deben ser tomados con precaución y se recomienda la realización de futuros estudios con una muestra mayor.

Palabras clave: Musculatura isquiosural; Fútbol; Prevención; Riesgo de lesiones.

Introduction

Epidemiology

In soccer, the incidence of injuries is very high in the lower extremities representing 64.2% (Jones et al., 2019). In a study of amateur players by van Beijsterveldt et al. (2014), 60% of players were injured during a season, with muscle injuries accounting for 38% and 14% were relapses. Likewise, the thigh region was the most common site of injury (31.7%) followed by the knee (14.6%) and ankle (13%) (Jones et al., 2019). In another study by Ekstrand et al. (2011) observed that one third of all injuries in soccer are muscle injuries and that the vast majority (92%) affect the 4 main muscle groups of the lower extremities: hamstrings (37%), adductors (23%), quadriceps (19%) and calves (13%). The ischiosural musculature (HSM) was the most frequently injured muscle group, accounting for 39.5% of all muscle injuries and 16.3% of all injuries (Jones et al., 2019). In line with the above, MSH injury is known as the number one muscle problem in men's amateur soccer and they account for 15.9% of all injuries (van Beijsterveldt et al., 2014). On the other hand, it should be noted that a team of 25 players can expect about 15 muscle injuries each season, with a loss of time of approximately 2 weeks per injury (Ekstrand et al., 2011). Although, in a study by Ekstrand et al. (2016) observed an annual increase of 2.3% per 1000 match hours and an annual increase of 4% per 1000 training hours.

Training program

From the perspective of performance improvement as well as injury prevention (Van Hooren & Bosch, 2017b; Van Hooren & Bosch, 2018), the type of muscle contraction is important, as eccentric training of the hamstrings has been shown to increase the length of the fascicles of the BFlh, i.e., this type of training decreases the risk of injury (Timmins et al., 2016). The most commonly used exercise is the Nordic Hamstring Exercise (NHE) which is an eccentric exercise that improves hamstring strength production only around one joint (the knee). Add, that eccentric exercises can lead to the occurrence of muscle soreness, especially in the first weeks of the training program (Petersen et al., 2011) and in several studies has been a reason for some players to drop out of the intervention (Arnason et al., 2008; van der Horst et al., 2015). Thus, an isometric exercise training program is less likely to cause muscle soreness (Van Hooren & Bosch, 2017b; Van Hooren & Bosch, 2018). In the same way, it has been demonstrated that isometric training involves a lower mechanical cost than plyometric training and that after 6 weeks of training, tendon stiffness and Rate of Force Development (RFD) are significantly increased (Burgess et al., 2007). As the competitive load is too high, due to the competitive period and HSM is likely to be at risk, we can reduce these mechanical demands by using an isometric exercise training program rather than other training (Burgess et al., 2007).

In the club where the intervention was carried out, the sample is composed of amateur athletes with no or little experience in strength training (Raya-González et al., 2021). The authors suggest using a maximum of 2-3 exercises activating the HSM, with a volume of 15-25 minutes per session, with a duration of repetitions ≤ 10 seconds (to avoid muscle acidity) and with a maximum of 3 sets (McGill, 2010; Van Hooren & Bosch, 2017b; Van Hooren & Bosch, 2018). This will provide an effective stimulus, but will avoid excessive fatigue and allow the isometric training program to be combined with other training (Van Hooren & Bosch, 2018). A frequency of 2 times per week may be sufficient to improve and maintain strength (Peterson et al., 2004). However, eccentric training should not be replaced by an isometric training program (Van Hooren & Bosch, 2018). To our knowledge, there have been no studies in the scientific literature with isometric exercise programs focused on MSH injuries.

The main objective of this study was to conduct a pilot study to determine the effects of a 10-week isometric exercise training program on hamstring injury risk factors in amateur soccer players. We hypothesize that performing a 10-week isometric training program can decrease risk factors for injury in MSH.

Method

Design

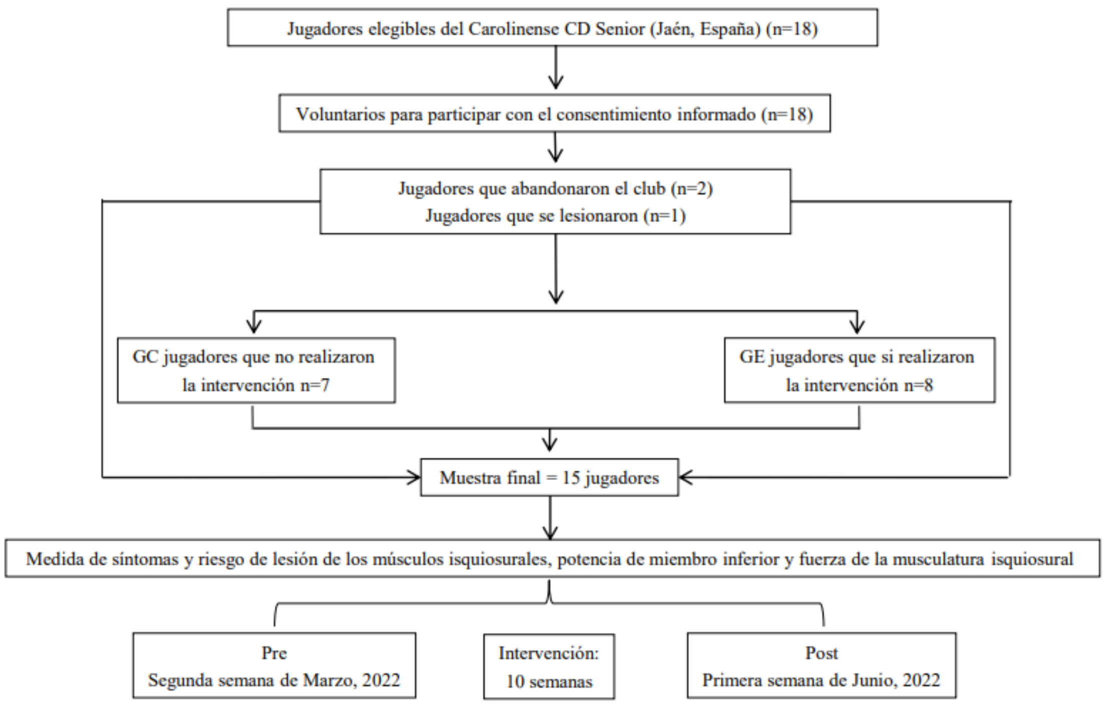
This is a longitudinal quantitative study and a randomized controlled trial composed of an experimental group (EG n=9) and a control group (CG n=9) was used. The SG was subjected to an isometric exercise training program for 10 weeks at a frequency of two sessions per week during the competition period beginning the week of March 14 and ending the week of May 23, 2022. Risk factors and physical performance were assessed before and after the strength program by means of the sociodemographic questionnaire, the Hamstring Outcome Score (HaOS) questionnaire, lower limb power and the Single Leg Bridge Test (SLBT). The questionnaires and jumps were performed in the locker room and the SLBT test was performed on the soccer field where the players train. Both assessment sessions were held between 7:20 p.m. and 8:00 p.m., and all players were instructed to give their best in both tests. No training program was applied to the CG, only the technical-tactical session. The GE conducted the strength session before starting the main training session. The procedure lasted between 15-30 minutes. All procedures were approved by the ethics committee of the University of Jaén (MAR.22/4.TFM) and were carried out in accordance with the Code of Ethics of the World Medical Association for human studies (Declaration of Helsinki).

Participants

Initially, 18 male players aged 18-38 years belonging to the Carolinense CD agreed to participate in the research. Players had to have participated in at least 70% of the training sessions during the 10-week duration of the EG. As inclusion criteria, players had to be federated and over 18 years of age. Exclusion criteria for the study were participation in any additional strength program during the weeks of the intervention, illness or musculoskeletal injuries that prevented the protocol from being carried out. A computer-generated random number table was used for group assignment. All participants continued with their usual training program and the GE also performed the isometric exercise program. The usual training consisted of a ball activation in small spaces, followed by possessions in medium and large spaces, and usually ended the session with attack-defense or modified games. The data were collected during the 2022 season by trained members of the research group. The distribution of the intervention can be seen in Figure 1.

Figure 1

Graphical Representation of Longitudinal Design with Study Intervention



Variables and instruments

Just before the start of the intervention period, a series of sociodemographic data were collected, such as age, educational, marital and occupational status, smoking habit. A SECA 634 scale and the SECA 22 stadiometer, Hamburg (Germany), were used to obtain weight and height measurements, respectively. Both measurements were performed with light clothing and without footwear. According to the World Health Organization (WHO, 2000), body typology was calculated by the Body Mass Index (BMI) using the formula: mass (kg)/height 2 (m). A BMI < 25 kg / m2 indicates normal weight, 25 ≤ BMI > 30 kg / m2 indicates overweight, and a BMI ≥ 30 kg / m2 indicates obesity. In addition, a series of data related to soccer practice were collected, such as experience playing soccer (years), games played (as starters and substitutes), dominant leg and position on the field. Finally, the history of lower limb injuries (ischiosural region, knee, leg and ankle/foot) was asked.

Dependent variables

Testing procedures were conducted one week prior to the start of the program on March 8 (Tuesday) and March 10 (Thursday), 2022, 40 min before the training session. The HaOS questionnaire and the SLHB test were conducted on March 8. On March 10, the vertical jumps were performed, and before performing the two vertical jump tests, all players performed a 10 min warm-up of continuous running with dynamic stretching (Venturelli et al., 2011). When the 10-week training program was completed, the tests were repeated again in the same order and at the same time, but on May 31 (Tuesday) and June 2 (Thursday), 2022 (Rey et al., 2017).

Symptoms and risk of injury to the hamstring muscles

Each player completed a baseline questionnaire that included the HaOS questionnaire score and the sociodemographic characteristics and previous injuries of the soccer players

(Engebretsen et al., 2010; van de Hoef et al., 2021). The original HaOS (Engebretsen et al., 2008) was translated into Spanish (Cronbach's alpha of 0.949 for items and 0.850 for domains) and consists of two parts. The first part collects the injury history of the HSM. Only the second part was used for the pre-post intervention analysis and consists of five dimensions: (1) Symptoms, (2) Inflammation/Anxiety, (3) Pain, (4) Function, Daily Life and Sport, and (5) Quality of Life (Sierevelt et al., 2015; Tak et al., 2018). The first four domains are relevant to daily life and to soccer and sport-specific tasks, while the quality of life domain measures fear of re-injury (Engebretsen et al., 2010; van de Hoef et al., 2021). The questions were scored from 0 to 4, from no discomfort to a lot of discomfort/pain (Engebretsen et al., 2008; van de Hoef et al., 2021). The HaOS questionnaire score can be calculated as an overall score and a score for each domain. Scores were calculated as percentages of the maximum score, with a player with no complaints scoring 100%, therefore, a higher score implies a lower level of discomfort. The scores were calculated using the following formula which is 1-(score/maximum score) * 100%. A score of 80% or more was considered to indicate a low risk of hamstring injury (Engebretsen et al., 2010; van de Hoef et al., 2021).

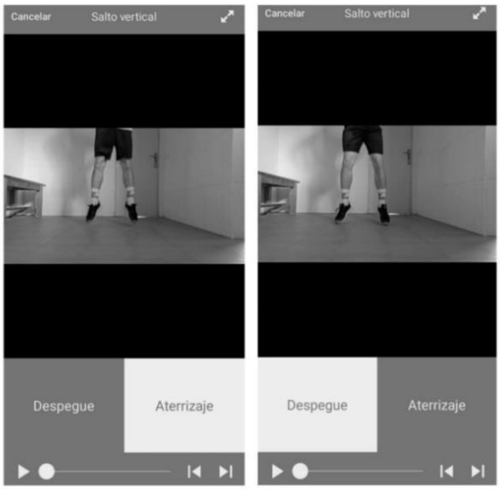
Lower limb power

The most common tests to assess explosiveness in soccer players are the vertical jump tests of both the SJ and CMJ (Bogataj et al., 2020; Gallardo-Fuentes et al., 2016). Three jumps were performed per player, the first two jumps were not recorded and the third jump was recorded for video analysis with the My Jump 2 app. A rest interval of 30 seconds was established between each jump (Bogataj et al., 2020).

The My Jump 2 app was used (created by Balsalobre-Fernández et al. (2015) which was designed to analyze vertical jumps). This app is capable of measuring vertical jump height accurately (without the need for prior experience in video analysis) for most populations, including trained athletes (Gallardo-Fuentes et al., 2016). To calculate the height of the jump, the take-off and landing frames of the video are manually selected (Figure 2). All recordings were made with the same phone and by the same researcher with no professional experience in video analysis (Bogataj et al., 2020). To record the execution of the jumps with the app, a researcher lay on the ground face down facing the player (in the frontal plane) at approximately 1.5 meters from the player and zooming in on the feet (Balsalobre-Fernandez et al., 2015; Gallardo-Fuentes et al., 2016). The researcher always recorded from the same position (Balsalobre-Fernandez et al., 2015; Bogataj et al., 2020; Gallardo-Fuentes et al., 2016). For data reliability, the videos were re-monitored twice for each player (Coswig et al., 2019).

Figure 2

Stills of the Takeoff and Landing Phase in My Jump 2 application



Strength of the ischiosular muscles

The SLHB test has been validated (Freckleton et al., 2014). The SLHB test followed the procedures proposed by Freckleton et al. (2014) that they conducted with Australian soccer players. Players were instructed to position themselves on the floor in the supine position with one heel on a box. A 60 cm high box was used for all participants (Figure 3). The test leg was placed in a knee flexion of approximately 20°. Players were instructed to cross the arms over the chest and push down through the heel to lift the buttock off the ground. Players were advised that the objective of the test was to do as many repetitions as possible until they could do no more. Constant feedback was provided throughout the procedure to ensure that the correct technique was achieved. It was essential that each test included the player touching his buttock to the ground, without resting, and then extending the hip to 0°. The non-working leg was to be kept stationary in an upright position to ensure that no momentum was gained by swinging this leg. When the correct form was lost, a warning was given and the test was stopped at the next technical failure. The maximum repetition was recorded and the test was repeated with the opposite leg. The side tested first alternated between participants (Freckleton et al., 2014; Mahnič et al., 2021; Rey et al., 2017). Using the recommended classification criteria (Freckleton et al., 2014), the results were categorically divided into three groups according to their performance on the SLBT test. The group with a poor score included all players who achieved less than 20 repetitions with at least one leg, while the group with a medium score included players who achieved between 20 and 25 repetitions with both legs and the group with a good score included those who achieved values of 30 or more repetitions with at least one leg (Freckleton et al., 2014; Mahnič et al., 2021).

Figure 3

Single Leg Bridge Test

One week before the test, the players performed 1 familiarization session with the SLHB test which was on March 1 (Tuesday) 2022 (Rey et al., 2017).

Independent Variable (Strength training program with isometric exercises)

A strength training program was designed with 4 isometric exercises. The strength training sessions ranged from 15 min to 30 min in duration. In addition, the sessions were conducted prior to the soccer training session, which lasted approximately 80 minutes. The strength training sessions were supervised by the physical trainer and first trainer (coaching staff) one day before for the preparation of the technical-tactical session. The strength training program with isometric exercises was applied twice a week (Tuesdays and Thursdays) with at least 48 hours of rest between training sessions, for a total of 10 weeks, with the first week being in March (March 15, 2022, first session) and the last week being in May (May 26, 2022, last session).

Each injury prevention training session included 2 strength training exercises that are hip dominant, knee dominant and two core stability exercises with isometric muscle actions only. These exercises were selected based on their effects on injury prevention in HSM (Bourne et al., 2018; Raya-Gonzalez et al., 2021; Van Hooren & Bosch, 2017a; Van Hooren & Bosch, 2017b). A progressive overload was applied during the intervention (Annex 1). The soccer players were familiarized with the strength training program with isometric exercises during the intervention period and all exercises had variants from lower to higher difficulty (Annex 2).

Procedure

Before starting the study, we contacted the club, which authorized us to inform the players and coaching staff about the research. Subsequently, the rest of the club's directors were informed and provided with the necessary information for the development of the project. Once the participation and collaboration was accepted, a calendar of actions was established by the researchers in order to carry out the study without affecting the normal development of the training sessions. During the intervention period (March through May), the players performed their normal soccer training routines as the intervention was performed at the beginning of training without taking up too much time. Regarding the way it was set up during the week, the strength sessions were performed during the first and second training of the microcycle, thus ensuring that both sessions were not performed on consecutive days, i.e., they were performed on Tuesdays and Thursdays. During the intervention period, the week was carried out in the same way as before, with 3 days of training (Tuesday, Thursday and Friday) and an official competition match. Players from whom we obtained informed consent for subsequent participation in the research were informed. The name of each participating player was coded to ensure anonymity and confidentiality.

Statistical analysis

The data of the present TFM were shown as means and standard deviations and as frequencies and percentages for continuous and categorical variables, respectively. Student's t-test (continuous variables) and Chi-square (continuous variables) were used to study the differences between groups. To analyze the differences between the values before and after the intervention, a mixed analysis of variance was carried out, the between-group factor being the isometric exercise program (control vs. experimental) and the intra-group factor the measurement time (pre- and post-treatment). The dependent variables were: Symptoms and risk of injury in HSM (HaOS questionnaire), lower limb power (SJ and CMJ) and hamstring strength (SLHB). The independent variable was the isometric exercise intervention. The interaction "group x measurement time" was also analyzed. Cohen's d statistic was used to calculate the effect size in the exhaustive analysis of the possible group x time interactions. An effect size < 0.2 expresses an insignificant difference, a small difference between ≥ 0.2 and ≤ 0.5, a moderate difference between ≥ 0.5 and ≤ 0.8 and a value ≥ 0.8 refers to a large difference (Cohen, 1992). Results were considered statistically significant at a p value < 0.05. SPSS software (SPSS Inc, Chicago, IL, USA) for Windows, version 20, was used for statistical analysis.

Results

After the time of the experimental period had elapsed, there were three losses to follow-up, 2 in the CG (left the club, and the other due to an injury unrelated to the training program) and one in the GE (left the club). The general descriptive characteristics before the start of the intervention are shown in Table 1. The mean age of the participants was 24.61 ± 6.22 years and the BMI was within the normopese parameters (22.84 ± 2.44 kg/m2). Most of the participants were students (44.44%), were single (83.33%), had university studies (and were non-smokers 72.22% for both parameters). The analysis at baseline showed no significant difference between groups with respect to these variables (Table 1).

Table 1
General Descriptive Characteristics of the Participants

		Total (n=18)		Control (n=9)		Experimental (n=9)		
		Media	DT	Media	DT	Media	DT	P-value
Age		24.61	6.22	24.67	7.18	24.56	5.55	0.971
BMI (kg/m^2)		22.84	2.44	22.25	2.13	23.44	2.71	0.317
				Freq.	%	Freq.	%	P-value
Occupational status	Student	8	44.44	4	50.00	4	50.00	0.370
	Worker	7	38.89	4	57.14	3	42.86	
	Student and worker	1	5.56	1	100.00	0	0.00	
	Unemployed	2	11.11	0	0.00	2	100.00	
Marital status	Single	15	83.33	7	46.67	8	53.33	0.527
	Married	3	16.67	2	66.67	1	33.33	
State educational	No education	4	22.22	0	0.00	0	0.00	1.000
	Primary education	10	55.56	2	50.00	2	50.00	
	Secondary education	4	22.22	5	50.00	5	50.00	
	University studies	13	72.22	2	50.00	2	50.00	
Smoker	No	13	72.22	6	46.15	7	53.85	0.599
	Yes	5	27.78	3	60.00	2	40.00	

Note. DT: Standard deviation. Freq: Frequency. BMI: Body Mass Index.

Regarding the characteristics related to sports practice and (Table 2), the mean experience playing soccer of the participants was 15.33 ± 8.82 years and 16.11 ± 5.32 games as a starter. Almost all participants were right-handed (66.7%) and most had no history of hamstring, calf, or knee injuries, although 61.11% claimed to have suffered at least one previous ankle sprain. The pre-intervention analysis showed no significant differences between groups with respect to these variables (Table 2).

Table 2
Descriptive Characteristics Related to the Soccer Practice of the Participants

				Control (n=9)		Experimental (n=9)		
		Media	DT	Media	DT	Media	DT	P-value
Experience playing soccer (years)		15.33	8.82	16.11	9.75	14.56	8.29	0.720
Games played		16.11	5.32	14.22	6.57	18.00	3.00	0.145
Games played as starter		10.56	6.31	10.44	6.46	10.67	6.54	0.943
Games played as substitute		5.56	5.85	3.78	1.72	7.33	7.92	0.222
		Freq.	%	Freq.	%	Freq.	%	P-value
Dominance	Left	3	16.67	2	66.67	1	33.33	
	Right	12	66.67	5	41.67	7	58.33	0.607
	Both	3	16.67	2	66.67	1	33.33	
Position	Goalkeeper	2	11.11	1	50.00	1	50.00	
	Lateral	4	22.22	2	50.00	2	50.00	
	Central	3	16.67	0	0.00	3	100.00	
	Midfielder	2	11.11	2	100.00	0	0.00	0.502
	Half tip	3	16.67	2	66.67	1	33.33	
	End	2	11.11	1	50.00	1	50.00	
	Forward	2	11.11	1	50.00	1	50.00	
Injury ischiosurals prior to	No	14	77.78	7	50.00	7	50.00	
	Yes	4	22.22	2	50.00	2	50.00	1.000
Previous ACL injury	No	17	94.44	9	52.94	8	47.06	
	Yes	1	5.56	0	0.00	1	100.00	0.303
Another previous knee injury	No	13	72.22	7	53.85	6	46.2	
	Yes	5	27.78	2	40.00	3	60.0	0.599
Calf injury previous	No	18	100.00	9	50.00	9	50.00	
	Yes	0	0.00	0	0.00	0	0.00	1.000
Previous ankle sprain	No	7	38.89	2	28.57	5	71.43	
	Yes	11	61.11	7	63.64	4	36.36	0.147

Note. DT: Standard deviation. Freq: Frequency. LCA: Anterior cruciate ligament.

Symptoms and risk of injury to the hamstring muscles

The comparison between pre-intervention groups shows that there were no significant differences with respect to any of the sections or questions of the HaOS questionnaire. Table 3 presents the data related to the first part of this questionnaire, which refers to the history of hamstring injuries.

Table 3

Pre-Intervention Differences from HaOS Questionnaire Part 1

HaOS. Part 1		Left leg					Right leg				
		Control group		Experimental group			Control group		Experimental group		
		Freq.	%	Freq.	%	P-value	Freq.	%	Freq.	%	P-value
Question 1	0	5	50.00	5	50.00	0.766	6	50.00	6	50.00	0.717
	1	3	60.00	2	40.00		2	66.67	1	33.33	
	2	1	33.33	2	66.67		1	33.33	2	66.67	
	3	0	0	0	0		0	0	0	0	
	4	0	0	0	0		0	0	0	0	
	5	0	0	0	0		0	0	0	0	
	>5	0	0	0	0		0	0	0	0	
Question 2	0-6 months	2	50	1	25	0.069	2	66.67	1	33.33	0.343
	6-12 months	0	0	0	0		1	33.33	0	0	
	1-2 years	2	50	0	0		0	0	1	33.33	
	2-3 years	0	0	3	75		0	0	1	33.33	
Question 3	4-7 days	2	50	1	25	0.264	2	66.67	1	33.33	0.513
	1-4 weeks	2	50	1	25		1	33.33	1	33.33	
	> 4 weeks	0	0	2	50		0	0	1	33.33	
Question 4.1	No	1	25	3	60	0.294	0	0	3	75	0.143
	Yes	3	75	2	40		3	100	1	25	
Question 4.2	Almost never	2	66.67	2	66.67	1.000	2	66.67	1	50	0.709
	Sometimes	1	33.33	1	33.33		1	33.33	1	50	
	Often	0	0	0	0		0	0	0	0	

The analysis of the HaOS questionnaire in its second part (Table 4) showed that the post-intervention values in the CG and SG for both domains and for the total score of the right and left leg were higher compared to the values obtained in the pre-intervention measurements (Table 4), and more specifically in the HaOS questionnaire total score for the sum of both lower limbs the CG experienced an increase in score (and therefore a decrease in risk) of 5.53%, while in the SG this increase was 9.4%. Significant changes of the Time variable could be seen in domains 3 (p=0.021), 4 (p=0.038), and 5 (p=0.010) of the left leg, in domain 5 of the right leg (p=0.032), and total score of the left leg (p=0.011) and total of both legs (p=0.046). No significant changes were observed in the Group variable. No significant changes were found in the Group x Time interaction either.

Lower limb power

The study of lower limb power evaluated by the SJ and CMJ tests (Table 5) indicated that there were no significant differences between groups in the pre-intervention measurements. It could also be seen that all participants showed improvements after the intervention period, although the difference was greater in the GE than the CG (1.89 cm vs 0.31 cm respectively for SJ and 2.34 cm vs 0.86 cm respectively for CMJ). No significant differences were found with respect to the main effect for the Group variable nor for the Group x Time interaction, although they could be observed for the Time variable in both tests, $F(1,18)=23.801$, $p=0.001$, $\eta2=0.575$ for the SJ test and $F(1,18)=6.136$, $p=0.001$, $\eta2=0.566$ for the CMJ test.

Strength of the ischiosular muscles

Finally, the data obtained with respect to MSH strength (Table 5) showed that there were no significant differences between the two groups before the intervention period. Furthermore, in the post-intervention measurements, the group of participants who received the training program with isometric exercises showed much higher values in relation to those obtained in the pre-intervention measurements: left leg (-2.22 vs -8.39 repetitions for GC and GE, respectively) and right leg (0.7 vs -9.52 repetitions), as well as in overall strength (-1.53 vs -17.91 repetitions).

After analysis of the data obtained with respect to the strength of the HSM, the results indicated that no significant results could be seen with respect to the group effect, while they were seen for the variable Time effect in SJ ($p=0.001$), CMJ ($p=0.001$), and strength in both legs ($p=0.040$). Significant Group x Time interactions were also observed for right leg strength, $F(1,18)=8.923$, $p=0.010$, $\eta2=0.407$, and for the total strength variable, $F(1,18)=5.494$, $p=0.036$, $\eta2=0.297$.

The exhaustive analysis of this Group x Time interaction showed us that, with respect to HSM strength in the right leg, significant differences appeared between both groups in the post-intervention measure, $t(13)=-3.664$, $p=0.003$, with a large effect size (Cohen's $d=0.679$), as well as between pre- and post-intervention values in the GE $t(7)=-2.877$, $p=0.038$, with a large effect size (Cohen's $d=0.521$).

Similarly, in relation to total HSM strength, significant differences could be appreciated between both groups in the post-intervention measure, $t(13)=-3.719$, $p=0.003$, with a large effect size ($d=0.687$), as well as between pre- and post-intervention values in the GE $t(7)=-2.522$, $p=0.038$, with a large effect size ($d=0.521$).

Table 4

Effects of Strength Training with Isometric Exercises on the Domains and Total Score of the HaOS Questionnaire

HaOS	Pre-intervention				Post-intervention				Group			Weather			Group x time		
	Control		Experimental		Control		Experimental										
	Media	DT	Media	DT	Media	DT	Media	DT	F	P-value	Partial Stage^2	F	P-value	Partial Stage^2	F	P-value	Partial Stage^2
Dom. 1 left	83.33	21.65	75.00	25.00	85.71	24.40	87.50	23.15	0.000	1.000	0.000	4.603	0.051	0.262	1.421	0.255	0.099
Dom. 1 right	88.19	15.76	88.89	11.60	97.22	5.51	92.36	18.69	0.096	0.762	0.007	1.474	0.246	0.102	.205	0.658	0.015
Dom. 2 left	86.11	15.71	89.93	8.24	92.36	15.63	96.18	5.80	0.074	0.789	0.006	2.303	0.153	0.151	.499	0.492	0.037
Dom. 2 right	90.28	13.30	87.50	14.32	94.44	12.67	99.31	2.08	0.565	0.466	0.042	.895	0.361	0.064	.002	0.967	0.000
Dom. 3 left	76.39	30.26	83.33	19.76	87.50	21.65	97.22	5.51	0.444	0.517	0.033	6.860	0.021	0.345	.415	0.530	0.031
Dom. 3 right	83.75	20.28	83.27	12.81	90.97	16.21	94.79	8.08	0.000	1.000	0.000	0.353	0.562	0.026	.223	0.644	0.017
Dom. 4 left	83.33	21.65	75.00	25.00	85.71	24.40	87.50	23.15	0.068	0.799	0.005	5.329	0.038	0.291	2.231	0.159	0.146
Dom. 4 right	93.75	8.27	90.97	11.32	96.88	8.84	94.44	11.02	0.140	0.714	0.011	1.003	0.335	0.072	.355	0.562	0.027
Dom. 5 left	90.63	9.76	90.97	9.94	93.36	11.38	94.79	10.36	1.173	0.298	0.083	8.935	0.010	0.407	.110	0.745	0.008
Dom. 5 right	93.06	8.53	90.28	14.01	96.09	8.80	97.22	8.33	0.957	0.346	0.069	5.758	0.032	0.307	.399	0.539	0.030
Score Total left	81.94	19.87	87.50	18.75	93.75	11.57	95.83	6.25	0.173	0.684	0.013	8.744	0.011	0.402	.611	0.449	0.045
Score Total right	88.54	11.43	86.95	13.73	93.52	12.05	94.24	9.87	0.001	0.970	0.000	1.981	0.183	0.132	0.049	0.828	0.004
Total Score both	86.15	15.06	85.11	12.92	91.68	11.76	94.51	5.82	0.085	0.775	0.006	4.860	0.046	0.272	0.237	0.635	0.018

Dom: Domain. HaOS: Hamstring Outcome Score. Dom 1: Symptoms. Dom 2: Inflammation/Allergies. Dom 3: Pain. Dom 4: Function, Daily Life and Sport. Dom 5: Quality of life.

Table 5

Effects of Strength Training with Isometric Exercises on Hamstring Muscle Strength and Lower Body Power

	Pre-intervention				Post-intervention				Group			Weather			Group x time		
	Control		Experimental		Control		Experimental										
	Media	DT	Media	DT	Media	DT	Media	DT	F	P-value	Partial Stage^2	F	P-value	Partial Stage^2	F	P-value	Partial Stage^2
SJ (cm)	27.34	5.48	29.87	3.21	27.65	5.32	31.76	2.69	3.403	0.088	0.207	17.616	0.001	0.575	0.509	0.488	0.038
CMJ (cm)	27.80	5.03	31.19	4.02	28.66	6.12	33.53	3.22	2.647	0.128	0.169	16.928	0.001	0.566	3.682	0.077	0.221
Strength left leg (rep)	17.78	8.61	23.11	10.43	20.00	7.37	31.50	5.37	4.428	0.055	0.254	4.103	0.064	0.240	2.102	0.171	0.139
Strength right leg (rep)	20.56	8.31	22.11	10.97	19.86	7.97	31.63	4.14	2.074	0.173	0.138	4.617	0.051	0.262	8.923	0.010	0.407
Strength both legs (rep)	38.33	16.32	45.22	18.82	39.86	15.06	63.13	8.77	3.591	0.081	0.216	5.175	0.040	0.285	5.494	0.036	0.297

CMJ: Countermovement jumping. Rep: Repetitions. SJ: Squat Jump.

Discussion

The main objective of this pilot study was to analyze the effects of a 10-week isometric exercise training program on MSH injury risk factors in amateur soccer players. The results showed significant results with respect to right leg muscle strength and total strength. In addition, improvements could be observed with respect to the HaOS questionnaire and the vertical jump tests, but they did not reach statistical significance. These results suggest that increasing the number of hours in prevention programs could help decrease the risk of injury in HSM and increase physical performance in soccer.

Symptoms and risk of injury to the hamstring muscles

Pain on palpation and discomfort during and after (sport-specific) exercise, pain and discomfort during daily activities, and fear of re-injury are associated with muscle injuries (Jones et al., 2019; Van Der Horst et al., 2015). The HaOS questionnaire is useful in identifying gamblers with these symptoms (van de Hoef et al., 2021). The main difference of our study compared to previous investigations (Engebretsen et al., 2008; Engebretsen et al., 2010; van de Hoef et al., 2021), is that we conducted a longitudinal study and the other investigations are prospective cohort studies whose aim was to detect risk factors for MSH in soccer players.

For this reason, in the study by van de Hoef et al. (2021) players who had suffered an injury in the previous season and players who suffered a new HSM injury (during the new season) had in the total score and the mean of the HaOS questionnaire domains a lower score than players without HSM injury. The same is true in a previous study (Engebretsen et al., 2010). The results of our study show that the players were not at risk of HSM injury (because their score was > 80%), i.e., our results indicate that the players do not experience bad symptoms, do not have discomfort and no pain, have a good ability in their sport and a correct quality of life in terms of HSM. Although, statistical significance was not reached, the GE participants experienced a 9.4% increase in the HaOS total score, which would signify an evident decrease in the risk of HSM injury.

Lower limb power

It should be noted that jumping is a variable to evaluate lower extremity explosiveness and the most common tests to evaluate athletes are the vertical jump tests of both the SJ and CMJ (Bogataj et al., 2020; Gallardo-Fuentes et al., 2016). Likewise, the research by Venturelli et al. (2011) reported for the first time that a lower and negative ΔJH between CMJ and SJ height is a risk factor for MSH.

Therefore, in soccer the tactical indications commanded by coaches such as, for example, "individual pressing" and "pressing after loss" in order to have an immediate recovery of the ball are considered high-intensity actions, i.e. explosive actions (Križaj et al., 2019). Thus, it has been found that a 10-week eccentric training program in Danish players improved CMJ height over time in both CG and GE, but GE obtained better results (GE: 2.1 cm vs. GC: 0.55 cm). The same is true for the results of our study after the isometric exercise training program for 10 weeks (GE: 1.89 cm vs GC: 0.31 cm for SJ and GE: 2.34 cm vs GC: 0.86 cm for the CMJ). In any case, these results should be taken with caution because no statistical significance was found. On the other hand, the results of vertical jumps (SJ and CMJ) in our study are lower compared to other investigations (Krommes et al., 2017; Venturelli et al., 2011).

This may be because the players in our study are amateur players compared to players in other studies who were elite professional players (Krommes et al., 2017; Venturelli et al., 2011), where the IAD performed by players during a match separates world-class professional footballers from amateur footballers (Mohr et al., 2003), i.e., this is because professional footballers perform more IAD and explosive actions than an amateur player because the physical demands of their competition are lower.

Strength of the ischiosular muscles

Testing the hamstrings in a more functional capacity similar to the late swing phase of running may better assess strength as a risk factor for injury (Freckleton et al., 2014). The study conducted by Freckleton et al. (2014) developed a simple clinical field test to measure hamstring strength known as the SLBT test. The use of SLBT in soccer is scarce and has only been used twice in youth soccer players (Mahnič et al., 2021; Rey et al., 2017).

Regarding mean leg repetitions (left and right) and strength in both legs the data agree with previous research (Freckleton et al., 2014; Mahnič et al., 2021), but the group that received the training program with isometric exercises showed much higher values in relation to previous studies. On the other hand, the study by Rey et al. (2017) showed higher values than the results of our study. This could be explained by the relative strength levels of the player, which are related to the body mass of the individual (Mahnič et al., 2021). Especially the players in our study were heavier compared to (72.1 kg vs. 68.3 kg) players in the other study (Rey et al., 2017). Although after applying an eccentric strength program in the HSM (GE1 vs GE2 vs GC) their two GE (who performed an eccentric training program) obtained better results with respect to their GC.

It is usually common to hear that a muscle injury has had an inadequate recovery, therefore, prevention of the first injury should be a priority, because relapses result in significantly longer sports absences than previous injuries (Ekstrand et al., 2011). The most likely explanation for a previous injury being such a consistent risk factor is that the joints or muscles in question are not fully restored structurally and/or functionally. Based on this, it seems reasonable to suggest that one thing teams can do, even at the lowest levels, is to focus on improving post-injury rehabilitation and implement appropriate return to play guidelines by measuring risk factors for muscle injury (Engebretsen et al., 2008). Add, that players should undergo a rehabilitation program and experts advise that the "absence of pain" is a criterion to return to play safely and to prevent relapses (Engebretsen et al., 2008; Van Der Horst et al., 2015).

Therefore, we recommend that all players participate in strength programs at HSM. In the future, it may be possible to target prevention programs to those amateur players at greatest risk of injury to this musculature (van de Hoef et al., 2021). Recall, that hamstring injuries are a multifactorial problem, and a multifactorial approach to their prevention and treatment is needed (Freckleton et al., 2014; Van Dyk et al., 2017).

In the case of the HaOS questionnaire and vertical jumps have beneficial effects, although they did not reach the range of statistical significance, but we did detect significant differences between both groups in the strength of the right leg and the total strength of both legs in the SLBT test, therefore, we can affirm that a 10-week strength training program seems to be an excellent content to reduce risk factors in MSH. This is in line with the study by Rey et al. (2017) who after applying a 10-week eccentric training program obtained improvements in their GE and Raya-González et al. (2021) who examined the short- and long-term effects of a strength training program on muscle injury prevention in youth soccer players, reducing the incidence of muscle injuries during its implementation period. Therefore, the implementation of a strength training program in soccer players seems to be a valid option to reduce the risk of injury (Petersen et al., 2011; Raya-Gonzalez et al., 2021; van der Horst et al., 2015).

The results obtained in this study indicate that a strength training program with isometric exercises applied as complementary training for amateur soccer players can reduce the risk factors for MSH in the short term in this group of athletes. The strength training program was specially designed to be applied without expensive equipment, in order to be massively implemented in soccer training programs with senior teams belonging to teams such as the "Primera Andaluza Senior". The current results may be of relevance to players, coaches and researchers.

Limitations and future research

This study has some limitations. First, the low number of participants included per group makes the statistical power of the results limited and could explain why some results, despite showing evident improvements, did not reach statistical significance. On the other hand, only short-term outcomes were measured, i.e., immediately after the intervention. It is recommended that future studies be conducted with a larger number of participants, using various indicators of power or strength measurement and evaluating the medium and long-term effects.

Conclusion

The results of this study allow us to conclude that the performance of an isometric exercise program, in addition to regular training, has positive effects on the prevention of ischiosural muscle injuries. More specifically, statistically significant benefits were found in muscle strength assessed with the Single Leg Bridge Test. Improvements could also be found in scores on both the Hamstring Outcome Score questionnaire and vertical jump height, although they did not reach statistical significance, possibly in relation to the sample size. This should be taken into account when interpreting the results, which should be considered with caution. Therefore, it is suggested that the practice of a strength training program with isometric exercises before the technical-tactical session does not negatively affect soccer players and could reduce injury risk factors associated with the ischiosural musculature, and future studies with a larger number of participants are recommended.

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Annexes

Annex 1

Strength Training Program with Isometric Exercises

	Weeks									
Exercises	1	2	3	4	5	6	7	8	9	10
Split step	2 x 3 C/L x 6"	3 x 3 C/L x 6"	3 x 5 C/L x 8"	2 x 4 C/L x 6"	3 x 4 C/L x 6"	2 x 3 C/L x 6"	3 x 3 C/L x 6"	2 x 4 C/L x 8"	3 x 4 C/L x 6"	3 x 5 C/L x 8"
Prone bridge	2 x 4 x 8	3 x 5 x 8	3 x 4 x 8	2 x 4 x 8	3 x 4 x 8	2 x 4 x 8	3 x 4 x 8	2 x 4 x 8	3 x 3 C/L x 6"	3 x 3 C/L x10"
Supine straight	2 x 4 x 6	3 x 4 x 6	3 x 5 x 10"	2 x 4 C/L x 8"	3 x 4 C/L x 8"	2 x 4 C/L x 8"	3 x 4 C/L x 8"	2 x 4 C/L x 8"	3 x 4 C/L x 8"	3 x 5 C/L x 8"
Side bridge	2 x 2 C/L x 8"	3 x 2 C/L x 8"	3 x 2 C/L X 8"	2 x 2 C/L x 8"	3 x 2 C/L x 8"	2 x 3 C/L x 4"	3 x 3 C/L x 8"	2 x 3 C/L x 4"	3 x 3 C/L x 8"	3 x 3 C/L x 8"

Note. 2 x 3 x 8" means 2 sets of 3 repetitions with a duration of 8 seconds, while 2 x 2 C/L x 8" means 2 sets of 2 repetitions each side with a duration of 8 seconds.

Annex 2

Variants of isometric exercises

Split step squat	Prone bridge	Supine straight leg bridge	Side bridge
			

Note. The exercises are arranged in order of intensity, i.e., the first exercise is in the upper left corner being the exercise of less difficulty and the progression ends with the exercise of greater intensity, corresponding to the right side of the lower corner.

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BIKE DESK AN INTERVENTION PROPOSAL TO IMPROVE THE LEVEL OF PHYSICAL ACTIVITY AND COGNITIVE PERFORMANCE IN PRIMARY SCHOOL CHILDREN

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Abstract. The aim of this study was to analyze the effect of 5 weeks of interactive pedaling during classes on physical fitness, school skills and creativity in primary school children. A total of 89 children (age range = 10-12 years) participated in this study, although due to the COVID-19 pandemic only 37 students could be considered for the analysis of the results. The students were randomly assigned to two groups, experimental group (EG) and control group (CG). The GE performed a moderate to vigorous intensity cycling program with cognitive engagement for 5 weeks, 4 days a week. Physical fitness, school skills and creativity were assessed. No significant differences were found between groups in terms of creativity. The CG experienced significant improvements in numeracy and total ASD. In addition, both groups showed significant improvements in the horizontal jump test. In conclusion, the implementation of pedal machines does not interfere with the academic performance of schoolchildren and can therefore be an effective means of improving students' physical activity levels.

Keywords: Interactive pedaling, physical fitness, school skills, creativity.

BIKE DESK UNA PROPUESTA DE INTERVENCIÓN PARA MEJORAR EL NIVEL DE ACTIVIDAD FÍSICA Y EL RENDIMIENTO COGNITIVO EN ESCOLARES DE EDUCACIÓN PRIMARIA

Resumen. El objetivo de este estudio fue analizar el efecto de 5 semanas de pedaleo interactivo durante las clases en la condición física, aptitudes escolares y creatividad en niños de Educación Primaria. Un total de 89 niños (rango de edad = 10-12 años) participaron en este estudio, aunque debido a la pandemia del COVID-19 solo 37 alumnos se pudieron considerar para el análisis de los resultados. Los estudiantes fueron asignados al azar a dos grupos, grupo experimental (GE) y grupo de control (GC). El GE realizó un programa de pedaleo de intensidad moderada a vigorosa con compromiso cognitivo durante 5 semanas, 4 días a la semana. Se evaluaron la aptitud física, las aptitudes escolares y la creatividad. No se encontraron diferencias significativas entre los grupos en cuanto a creatividad se refiere. El GC experimentó mejoras significativas en el cálculo y el total TEA. Además, ambos grupos mostraron mejoras significativas en el test del salto horizontal. En conclusión, la implementación de pedaleadores no interfiere con el rendimiento académico de los escolares por lo que puede ser un medio efectivo para la mejora de los niveles de actividad física del alumnado.

Palabras clave: Pedaleo interactivo, condición física, aptitudes escolares, creatividad.

Introduction

It is well known that, in the 21st century, childhood obesity remains one of the most important public health problems in the world(Yi et al., 2019). This problem is worldwide and affects many countries. Obese and overweight children are likely to become obese adults, leading to a greater tendency to suffer from diseases common in adults such as diabetes, arterial hypertension and cardiovascular diseases at younger ages, as well as various types of cancer (Muñoz and Arango, 2017). Consequently, it is essential to prioritize the prevention of childhood obesity because this global problem is generally preventable.

People who spend more time in physical activity (PA) show lower risks of developing metabolic syndrome, cardiovascular disease, diabetes, cancer, hypertension, obesity and mental health problems such as anxiety and depression (Belmonte Darraz et al., 2021; Esteban-Cornejo et al., 2015; Parvin et al., 2020; Wu et al., 2022). The benefits of physical activity are multiple, being its main objective the improvement of physical condition in different populations (Cobo-Cuenca et al., 2019; Huang et al., 2019; Kritsilis et al., 2018; Ruiz et al., 2006) but in addition, evidence from the last decades has shown the influence of regular physical activity in improving the quality of life (Arbinaga et al., 2011; Ruiz et al., 2016), improvement in cognitive processes (Bahdur et al., 2019; Kvalø et al., 2019; Latorre-Román et al., 2020; Van Der Niet et al., 2016), improving social and personal relationships, (Alves Donato et al., 2021; Gentile et al., 2011) and as a preventive mechanism for degenerative diseases (Buchman et al., 2020; Ma et al., 2022; Soulard et al., 2021).

This is why the World Health Organization (WHO) recommends that children and young people between the ages of 5 and 17 years should engage in at least 60 minutes a day of moderate to vigorous physical activity, with the aim of improving cardiorespiratory, muscular and bone health functions (WHO, 2021, para. 2-3). In Spain, physical education classes are taught only 2 hours a week, which makes it difficult for students to comply with these recommendations the rest of the week.

Several studies demonstrate the positive acute effects of exercise on several executive functions (EF) and cognitive variables in primary school students, such as inhibitory control, creativity, change, attention and memory (Berrios Aguayo et al., 2018, 2019; Latorre Román et al., 2018; Peruyero et al., 2017; Tsukamoto et al., 2016). In addition, previous studies have shown benefits in cognition after different school PA programs (Fisher et al., 2011; Lind et al., 2018). In addition, as people age, the deterioration of functional reserve (cognitive-motor) accelerates, increasing motor variability throughout old age, and PA through dual tasks is a predictor of health to prevent the prevalence of falls in older populations (Grobe et al., 2017; Wollesen et al., 2017).

In this sense, dual tasks represent a great opportunity to improve the cognitive and attentional capacity of schoolchildren, since a dual task refers to the ability of a person to perform two tasks (motor-cognitive) simultaneously (Plummer et al., 2011). The positive benefits of dual tasks focus on the ability of students to maintain attention in the face of internal or external stimuli that are presented in the learning process (Theill et al., 2013).

Some previous studies employed non-validated methods to analyze the link between PA and student cognition levels, relying on short-term, non-randomized, small-sample trials (Donelly et al., 2016).

Therefore, to date, there is no evidence of beneficial effects of PA interventions on cognitive learning. To that effect, the assumption that PA will have benefits in the school learning environment has not yet been validated (Donelly et al., 2016).

Most schoolchildren in Spain sit for an average of 20 hours per week. Researchers looking at the Primary Education workplace and environment with active workstations to combat sedentary behavior have shown improved cognition without distraction (Ojo et al., 2018).

Taking into account the above information, the main objective of this research was to analyze the effect of 5 weeks of interactive pedaling during classes on physical fitness, school skills and creativity in primary school children. We hypothesized that those children exposed to this training program would improve both the physical and cognitive abilities analyzed.

Method

The study involved 89 schoolchildren, 51 girls and 38 boys. The children were selected from a school in the province of Córdoba. The structuring of the groups, both control (CG) and experimental group (EG), was done in a rounded manner. Inclusion criteria were established as not suffering from physical, mental or intellectual disease or disorders. The parents and/or legal guardians of the child had to give consent to participate and the study complied with the ethical criteria of the Helsinki declaration (2013). Due to the COVID-19 pandemic situation, finally only 37 children could be considered for data analysis, 19 in the CG and 18 in the GE.

Parents completed a sociodemographic questionnaire with information on marital status, educational levels and socioeconomic status. Height (cm) was measured with a stadiometer (Seca 222, Hamburg, Germany) and weight with a balance (Seca 899, Hamburg, Germany). Body mass index (BMI) was calculated by dividing weight (in kilograms) by height squared (in meters).

Physical Condition: For aerobic capacity, the Léger test was performed (Léger et al., 1988)which consisted of a 20 m multi-stage out-and-back run with increasing speed in each run, indicating the pace with audible signals; the best result corresponds to the highest number of stages completed. In addition, to measure the explosive strength of the lower body, the horizontal jump test was used (J. R. Ruiz et al., 2011)which consists of a two-legged horizontal jump in which the help of the arm action can be used. The best score was the distance achieved (between take-off and the heel of the nearest foot on landing), a shorter distance indicating poor performance. The test was performed twice and the best score was recorded in centimeters.

Cognitive tests: School skills were assessed by the School Aptitude Test (TEA) (Ruiz Alva, 2014). This test evaluates intelligence from the classical approach that understands it as the subject's aptitude to learn. It is divided into 3 levels on homework performance. Each level explores 3 fundamental school skills: verbal, numerical and reasoning.

Verbal ability is assessed by means of images (verbal identification of the image), different words (verbal reasoning) and vocabulary (verbal comprehension); the sum of these parts comprises the total verbal aptitude (maximum and minimum values = 0-50). On the other hand, the sum of reasoning (maximum and minimum values = 0-27) and numerical skills (maximum and minimum values = 0-55) is the total of nonverbal skills (maximum and minimum values = 0-42).

Finally, the sum of verbal and nonverbal skills is the total score that measures actual school aptitude (maximum and minimum values = 0-132). In order to evaluate any aptitude, there is a maximum time to perform. When time ran out, the children had to stop writing. As for internal consistency reliability, this test yielded a Cronbach's alpha = 0.86 for the verbal component; Cronbach's alpha = 0.82 for numerical; Cronbach's alpha = 0.93 for reasoning and Cronbach's alpha = 0.92 for total score (Ruiz Alva, 2014).

The Torrance Thinking of Creative Test (TTCT Torrance Thinking of Creative Test) was used to assess creative ability. The test was developed by Torrance and his collaborators in 1966. It has subsequently been revised at different times, 1974, 1984, 1990 and 1998. It consists of two independent tests, the TTCT-Verbal and the TTCT-Figurative, each of them with two parallel forms, A and B. In our work we have used the TTCT-Figurative (form A), which aims to assess creative productions through drawings and compositions. It consists of three subtests: composing a drawing, finishing a drawing and parallel lines. In the first one, composing a drawing, the child is asked to make a drawing from a given shape, consisting of a piece of colored adhesive paper. The paper, according to the author, could resemble a tear, an egg or a pear. It should be noted that if the child does not provide a title, it cannot be graded.

The objective is to give a purpose to something that previously had no purpose. The skills that are assessed with this first subtest are: a) originality, consisting of considering novel, unfamiliar and unusual responses; and b) elaboration, which refers to the amount of detail that the child adds to the drawing in order to embellish it.

The second subtest, finishing a drawing, consists of 10 strokes, from which the child has to use them to make different drawings and give them a title. Elaboration (number of details added to the drawing), originality (unusual and unconventional answers), flexibility (variety of categories in the answers) and, to a lesser degree, fluency (number of drawings with title made) are evaluated. The third and final subtest, parallel lines, consists of 30 pairs of parallel lines. The objective is to make as many drawings as you can from the lines. It measures fluency (ability to make multiple associations from a single stimulus); flexibility (ability to change the pattern or structure of compositions), originality (ability to make different and unfamiliar structures) and elaboration (ability to add detail to structures made with parallel lines) (Torrance, 1974).

Procedure

After obtaining the corresponding permissions from the school and informed consent from the parents, we proceeded with the application of the test battery. All tests were conducted in schools - sports facilities and classrooms - and were supervised by in-house researchers, with teachers present. In three separate sessions, 48 hours apart, a team of researchers previously trained to perform the different tests evaluated the participants.

During the first session, the standing long jump test (two attempts, the best attempt was recorded) and the Leger test (one trial) were recorded and then the children indicated their level of perceived exertion using the Borg scale (Borg, 1970). Prior to the test sessions, the children performed a typical warm-up consisting of five minutes of low-intensity running and five minutes of general exercise (i.e., jumping jacks, leg lifts, lateral running, and front-to-back arm rotations). The children were motivated and encouraged to achieve the best possible score in each test. In a third session, the students were evaluated on the different questionnaires. The questionnaires were completed individually and in the presence of the researchers, respecting the confidentiality of the data and clarifying any doubts that arose. Data collection was carried out during the State of Alarm, in this case from April to May 2021.

Intervention

Once the feasibility of the installation of the bike desks (see Figure 1) had been verified and it was ensured that their use did not interfere with the normal development of the different classes, 3 bike desks, model Wakeman Under Desk Bike Pedal Exerciser, were installed in different classrooms in such a way that the 3 participating classes, 4th, 5th and 6th grades of Primary Education, were represented.

Figure 1

Bike Desk Illustration

The GE participants performed 4 times per week (Monday, Tuesday, Thursday and Friday) a static pedaling program during classes between 4 to 5 weeks. Each classroom had an established pedaling schedule that coincided with the subjects taught in the classes, being supervised at all times by the teachers of each subject. The teachers and students were previously informed about the protocol and the operation of the pedelecs, being of vital importance to record the data obtained from each student in their personal file, provided by the researcher, after the hour of pedaling. The time spent pedaling, calories burned and number of laps pedaled were recorded on the card. In addition, an intensity program was designed by regulating the pedaling, with the first week of pedaling being a less intense level, the second and third weeks a higher level and the last two weeks the intensity was increased even more. During these 5 weeks, the control group did not perform any intervention program.

Statistical analysis

Data were analyzed using SPSS, v.19.0 for Windows (SPSS Inc, Chicago, USA). USA) And the significance level was set at $\alpha = 95\%$. Data are shown as descriptive statistics including mean, standard deviation (SD) and percentages. Normal distribution and homogeneity tests (Kolmogorov-Smirnov and Levene, respectively) were performed on all data before analysis.

A chi-square and Student's t-test were used to compare demographic variables between groups. A 2x2 analysis of variance (ANOVA) with repeated measures (measure x group) was performed for the dependent variables (school aptitude, creativity and physical fitness). In addition, the effect sizes for group differences were expressed as Cohen's d (Cohen, 2013). Effect sizes are reported as: trivial (<0.2), small (0.2-0.49), medium (0.5-0.79) and large (≥0.8)

Results

Table 1 shows the descriptive results of the CG and SG in terms of age, anthropometric variables and mean number of steps taken during the intervention protocol. No significant differences were observed between groups.

Table 1

Age, anthropometric measurements and level of physical activity by sexes

	GC Mean (DT)	GE Mean (DT)	p-value	Cohen's d
Age	10.73 (0.87)	10.77 (0.73)	0.878	0.051
Weight (Kg)	40.73 (11.29)	40.03 (9.92)	0.855	0.067
Size (cm)	143.65 (12.56)	143.50 (9.84)	0.970	0.013
BMI (Kg/m^2)	19.17 (2.99)	18.99 (2.46)	0.859	0.067
Daily steps	7376.18 (1935.15)	7665.15 (2369.68)	0.791	0.137

Note. CG= control group; EG= experimental group.

Table 2 shows the pedaling values during the intervention.

Table 2

Descriptive statistics of pedaling performance during the intervention in the GE

	Minimum	Maximum	Media	Standard deviation
Weeks of pedaling (days)	4,00	5,00	4,55	0,41618
No. of pedal strokes (cycles)	708,90	5247,05	2394,37	1326,79
Pedaling time (min)	17,047	44,25	31,58	8,58
Pedaling frequency (cycles per minute)	40,94	122,19	71,17	24,63

Table 3 shows the pretest and posttest results of the CG and SG for both physical fitness and cognitive variables. In the group time analysis it is observed that only the CG experiences a significant improvement in the calculation dimension and in the total score of the TEA. In turn, both groups show a significant improvement in horizontal jump performance.

Table 3

Results on physical and cognitive fitness variables

Groups	Groups	Pre-test Mean (SD)	Post-test Mean (SD)	p-value (Time x group)	Cohen's d
Léger test (period)	GC	3.23 (0.88)	3.36 (0.95)	0.607	0.141
	GE	4.27 (2.00)	4.16 (1.73)	0.672	0.058
p-value (Group x time)		0.047	0.089		
Cohen's d		0.698	0,593		
Horizontal jump (cm)	GC	123.05 (15.38)	134,68 (15.39)	0.000	0,755
	GE	128,22 (19.81)	136,00 (21.01)	0.001	0.381
p-value (Group x time)		0.381	0.829		
Cohen's d		0.300	0.074		
Borg scale (0-10)	GC	7.13 (2.85)	7.78 (2.27)	0.487	0.252
	GE	6.97 (7.05)	6.50 (2.06)	0.629	0.090
p-value (Group x time)		0.863	0.080		
Cohen's d		0.030	0.606		
Vocabulary	GC	10.52 (3.50)	11.15 (3.76)	0.223	0.173
	GE	9.44 (3.69)	8.83 (3.95)	0.251	0.159
p-value (Group x time)		0.367	0.076		
Cohen's d		0.309	0.619		
Reasoning	GC	17.05 (5.43)	18.15 (5.39)	0.320	0,203
	GE	17.11 (4.15)	17.94 (5.36)	0.464	0.173
p-value (Group x time)		0.971	0.905		
Cohen's d		0.012	0.040		
Calculation	GC	37.10 (13.30)	43.21 (9.43)	0.003	0.529
	GE	38.77 (11.88)	39.72 (8.15)	0.635	0.093
p-value (Group x time)		0.690	0.238		
Cohen's d		0.135	0.406		
Total TEA (0-132)	GC	85.21 (22.76)	94.63 (18.61)	0.000	0.453
	GE	84.00 (18.66)	86.27 (16.83)	0.318	0.127
p-value (Group x time)		0.861	0.162		
Cohen's d		0.059	0,483		
Torrance test	GC	190.05 (62.57)	194.47 (57.89)	0.569	0.073
	GE	184.38 (60.97)	195.11 (56.72)	0.184	0.182
p-value (Group x time)		0.782	0.973		
Cohen's d		0.094	0.011		

Discussion and conclusions

Finally, the conclusions of the article will be presented in a last section, followed by the main conclusions. Where appropriate, limitations and proposals for continuity will be included.

The main objective of this research was to analyze the effect of 5 weeks of interactive pedaling during regular school classes on physical fitness, school skills and creativity in primary school children. Our main finding was that the hypothesis put forward could not be demonstrated. The proposed protocol was insufficient to bring about significant improvements in physical fitness and cognitive abilities beyond those that would have occurred due to the school process. It is noteworthy that even the CG improved the total score on the TEA.

Another relevant finding was that considering that children and adolescents who make <12 000 steps/day could be considered physically inactive (Colley et al., 2012), the children of both the GE and GC could be classified in this way since they performed over 7500 steps per day. However, the introduction of the pedelec during the classes increased the weekly physical activity levels of the CG participants by 126 minutes on average. In this way, they have been able to comply with one of the main WHO recommendations regarding physical activity, which is to perform at least an average of 60 minutes of moderate to vigorous intensity physical activity per day.

Although there are previous studies demonstrating the acute (Berrios Aguayo et al., 2019; Latorre Román et al., 2018; Peruyero et al., 2017) and chronic effect (Aadland et al., 2019; Ludyga et al., 2018; Latorre et al., 2021) of physical activity on cognitive processes, these studies have been conducted outside the dynamics of the formal school classroom, i.e., either at recess or between classes, or after school. In addition, other previous studies showed no significant effects of PA on cognitive processes. Kvalø et al. (2017) found no significant differences in children aged 10-11 years who performed physically active academic classes, physically active breaks, and physically active homework for 10 months in their EF. In addition, Donnelly et al. (2016) reported that no studies examining the use of PA breaks in the classroom showed positive results on academic achievement.

Although the results of our study are in line with the findings provided by Sui et al., (2019) in a recent review and indicate that active workstations do not appear to decrease workplace performance; although bicycle workstations may decrease some aspects of productivity and performance, but this could be due to unfamiliarity with the workstations. Similar to the findings of this study, other authors noted that low-intensity cycling during a university course maintained students' academic performance and possibly reduced weekly sedentary behavioral time (Joubert et al., 2017). Recently, a study with Spanish secondary school students showed that after 4 weeks of pedaling in the mathematics class, 4 times a week, there was an improvement in the performance of the Leger test but not in mathematical competence (Polo-Recuero et al., 2020).

A possible explanation for the results of this study could be due to the design of the activity, a dual activity (Dual Task paradigm), in which it has been previously shown that one of the two activities, physical or cognitive, is impaired. Thus, coordination of a motor and cognitive task may result in decreased performance on one or both tasks, relative to performance on each task separately (Schott & Klotzbier, 2018). Dual tasks during locomotion, for example during walking, when people are asked to walk and simultaneously perform another cognitively demanding task such as reciting words or calculations, may represent a new methodological approach to the assessment of brain function via cognitive-motor interference (Klotzbier & Schott, 2017; Montero-Odasso et al., 2014). Two theories have been used to explain the effects of dual-tasking on gait, the capacity trade-off theory proposes that attentional resources have limited capacity and must be shared between two tasks and the bottleneck theory which proposes that two tasks being performed simultaneously can only be performed sequentially which in turn can lead to a decrease in performance on one or both of the tasks (Hagmann-von Arx et al., 2016). That is, there is a worsening of performance, known as dual-task cost, i.e., there is a reduction in performance in dual-task performance, as compared to single-task performance) (Rabaglietti et al., 2019).

According to Gallotta et al., (2014) further studies, of an ecological nature, testing different components of the training load (exercise duration, exercise intensity, physical condition of the participants and the specific type of physical exercises) may be needed to elucidate the true effect of physical activity on the cognitive processes of schoolchildren. In addition, previous studies were very diverse, the duration of the interventions ranged from 8 weeks to 3 years, occurring through increased PA, with physical activity lessons in the classroom, PA breaks in the classroom, additional PA at school, an after-school fitness program, in laboratory or school settings (Donnelly et al., 2016).

Finally, it is worth mentioning the recent review by Guirado et al., (2021) in which they highlight that there is a 36% increase in energy expenditure for the "cycling desks", in turn the children increased inhibitory control and selective attention capacity while pedaling on the desk. Although these same authors indicate a heterogeneous quality of design and outcomes that limited comparisons and conclusions for each "active desk"; yet despite the lack of a robust methodology for the included studies, active desks appear to be a promising classroom intervention for improving health-related outcomes.

One of the main limitations of this study was the high "experimental mortality" due to the confinements produced in the School Center by the COVID-19 pandemic, which reduced statistical power and the possibility of a more prolonged intervention. It should be noted that it is not possible to control the interventions because the subject is not part of the center, and this could influence the results obtained. In addition, external validation problems can be distinguished since it is focused only on one school and on a not very wide age range. However, as strengths of this study, we highlight the fact that it was possible to carry out all the planned tests in spite of the inconveniences, so that it was possible to complete the research.

In conclusion, and in accordance with (Torbeyns et al., 2017) as the implementation of pedelecs in the classroom did not interfere with the academic performance of schoolchildren, this strategy can be seen as an effective means to reduce sedentary lifestyles in the classroom and at the same time it could improve the physical health of children, improving the time they spend sitting and thus complying with the global recommendations of the WHO. However, we appreciate that more intervention time is needed in order to obtain better results and to be able to compare with a larger number of subjects.

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MOTIVATION, ANXIETY, DEPRESSION AND STRESS IN UNIVERSITY ATHLETES IN TIMES OF HEALTH RESTRICTIONS CAUSED BY THE COVID 19 PANDEMIC

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Abstract. In the return to face-to-face university activities after the strict and total confinement initiated in March 2020 in Chile, there is a need to know the state of psychological variables in university athletes, since the new adaptive process to face-to-face training, together with new health regulations and not being able to have competitive objectives yet, are a problem to be solved. The objective of the study is to evaluate the variables of motivation, anxiety, stress and depression in active university athletes in the return to face-to-face academic and sports activities, as well as to know if there is a relationship between motivation and the others. The methodology used is quantitative, with an exploratory cross-sectional design, with the participation of 135 subjects. The results presented in this study show through Spearman's correlation coefficient between motivation with depression (<.001) and anxiety (<.001), while not with stress (<.079), using a p value of .05. It is concluded that, although the relationship is low (Spearman's rho anxiety <.339, depression <.289 and stress <.152), it is also evident in the sample a high degree of self-determination in motivation (M 5.76) and how this has a favorable relationship with the other study variables, which present the score of a stable mental state in the population of athletes during the return to university sports and academic activities.

Keywords: motivation, anxiety, depression, stress, university.

MOTIVACIÓN, ANSIEDAD, DEPRESIÓN Y ESTRÉS EN DEPORTISTAS UNIVERSITARIOS EN TIEMPOS DE RESTRICCIONES SANITARIAS PRODUCIDAS POR LA PANDEMIA DEL COVID 19

Resumen. En el regreso a las actividades universitarias presenciales posterior al confinamiento estricto y total iniciado en marzo del año 2020 en Chile, surge la necesidad de conocer el estado de las variables psicológicas en deportistas universitarios, ya que el nuevo proceso adaptativo a entrenamientos de manera presencial, junto con nuevas normas sanitarias y no poder tener objetivos competitivos aún, son un problema a resolver. El objetivo del estudio es evaluar las variables de motivación, ansiedad, estrés y depresión en deportistas universitarios activos en la vuelta a la presencialidad de actividades académicas y deportivas, así también conocer si existe relación entre la motivación y las demás. La metodología que se utiliza es de carácter cuantitativo, con un diseño exploratorio de corte transversal, con participación de 135 sujetos. Los resultados que se presentan en este estudio manifiestan a través del coeficiente de correlación de Spearman entre la motivación con la depresión (<..001) y la ansiedad (<.001), mientras que con el estrés no (<.079), usando un p valor .05. Se concluye que, si bien la relación es baja (rho de Spearman ansiedad <.339, depresión <.289 y estrés <.152), también se evidencia en la muestra un alto grado de autodeterminación en la motivación (M 5,76) y como esta tiene una relación favorable con las demás variables de estudio, los cuales presentan la puntación de un estado mental estable en la población de deportistas durante el regreso a las actividades universitarias deportivas y académicas.

Palabras clave: *motivación, ansiedad, depresión, estrés, universitarios.*

Introduction

The Covid-19 pandemic, which began in early 2020, has been one of the major health crises of the last decade, and as a result, the world population has been confined to a long period of time due to the rapid spread of the virus throughout the world. The year 2022 is a time when the so-called "new normality" begins to be restored, where health restrictions are less severe and allow the return to face-to-face activities in different social, labor, educational and sports contexts. Particularly the last two contexts mentioned are the ones that have suffered the greatest delay in the face-to-face return, and it is in the university field where the present research is focused.

Entering university by essence brings with it a series of processes of adaptation, maturation and growth on the part of individuals, both in the first year and in subsequent years, so the pandemic undoubtedly had negative and positive effects (increase in technological knowledge), creating situations difficult to cope with and generating a new awareness on different fronts of everyday life, such as virtual classes, health protocols, sports, among others (Vilca et al., 2022). It is at this point that it becomes interesting to know the mental state of university students who are part of the various sports disciplines in which they develop within their houses of studies.

The spread of the pandemic has caused feelings of fear in people due to the risk of dying from a biological agent; activating emotions that are difficult to control at the population level. Ruiz et al. (2022), that health measures, such as social distancing or quarantines, generate a sense of uncertainty and anxiety, causing a negative impact on people's mental health.

The world has been abruptly destructured in this social and contemporary daily life, the confinement has generated a confrontation of people with themselves, increasing a strange stress as the pandemic was prolonged, as González (2020) states, which significantly affects the academic, mental and social processes of the various groups of university students, not only in Chile, but in the vast majority of countries in the world. In this context, the student considers most of the situations he faces in his educational process as distressing, since he attributes that his coping strategies are insufficient or ineffective to cope with the demands of his school environment, which in turn favors the appearance of reactions such as physical exhaustion, anxiety, insomnia, poor academic performance, disinterest in his career, absenteeism and even dropping out of school. As Llédo (2014) rightly points out, the response to stress, for example, in the university setting depends on the student's willingness to cope with the demands imposed by the educational environment. It is important to highlight that coping strategies can be considered as effects and variables that modulate stress levels in the university and sports environment.

In countries such as Spain, researchers have currently implemented studies on the university population to understand how students have adapted their physical activity habits and lifestyle to the confinement situation, where they ratify information such as that provided by the World Health Organization (WHO), which is to maintain the recommendation of 150 minutes of moderate physical activity per week, translated into approximately 30 minutes per day (Andreu 2020; Bustamante et al., 2022). One of the benefits found is based on the fact that physical activity helps to reduce the pulmonary inflammatory process generated by this virus, as well as to reduce the levels of depression and anxiety. That is why Andreu (2020), says that the practice became something destined to the beneficial aspects that it has in favor of health, more than any other reason.

The sudden change to the distance education modality caused a certain lack of support that affects the previous levels of motivation and stress in the educational environment, which are added to the process already experienced by young people during this stage of university life. Studies such as that of Pajarito et al. (2020), shows as protective factors both the family and the support of teachers, being the facilitators in the students to face the academic context in pandemic in a better way.

As for academic stress (the stress that is present to a greater extent in the student stage), it has been defined as "the situation of physical and emotional tension linked to the demands of the academic world" (González, 2020). The student's perception of his or her ability to cope successfully with academic demands can generate negative thoughts and emotions, physical affectation such as sleepiness, headaches, anxiety, lack of concentration, disorganization and adaptation problems. Within the context of higher education, both in the first year and in subsequent years, there is also an increase or lack of control of anxiety levels, and it is usually part of everyday life, due to the responsibilities and demands generated by university life (Andrade et al., 2015). Along with this, there are times that are often more complex to deal with for many, such as the period of tests, papers, internships and final exams. The pandemic and adaptations in distance education has been a turning point in how to deal with these situations.

Another variable that is necessary to consider is anxiety, which usually manifests itself cognitively, limiting the possibility of attending and concentrating to face classes, practices or exams, having repercussions on academic performance (Trunce et al, 2020; Núñez and García, 2017). Although local universities usually have departments or units that support their students in psychological aspects, it is complex to favor a higher percentage of students for their attention, as described by Bustamante et al. (2020), mentioning that especially in times of pandemic, there has been a considerable increase in anxiety and other pathologies that are detrimental to academic performance.

Along with anxiety and stress, one of the pathologies associated with university students, is depression, which in Chile has a prevalence in its various symptoms with 14.4%, being an alarming figure considering that this is increasing (Rossi et al., 2019). The university process or stage, as has been expressed in previous paragraphs, is a moment in life where important aspects of life are defined and which are part of the identity that form the young person in his or her growth towards adulthood, reaching sufficient maturity for aspects such as personal independence. For those student athletes, depression is also often associated with sports dropout, which is why the pandemic has hit hard on many, but they have been able to resolve and have patience for the time of return to activity (Mendoza et al., 2022; Reche et al., 2018).

Another factor that affects university students is unquestionably motivation, which suffers as a result of facing the new academic methods adjusted to virtuality during the pandemic and the fact of not being able to practice sports due to confinement. Motivation is understood as the energy, direction, persistence, and purpose of people's behaviors, which includes intentions and actions (Deci and Ryan, 2008; Stover et al., 2017). This is a factor strongly linked to people's emotional states, as shown in Bustamante's study (2020), that during the pandemic and under various health restrictions, university students presented a decreased level of physical activity and motivation towards movement.

For the above mentioned reasons, this study was carried out in order to know and evaluate these psychological variables of the university population in the return to on-site activity (even with health restrictions), who lost the possibility of practicing sports as they used to do. Also, the degree of motivation is related to the other variables of anxiety, depression and stress, essentially considering intrinsic motivation as the most self-determined in human beings.

Method

The methodology of the study is quantitative, exploratory and cross-sectional. The research was conducted during the month of July 2022.

Design

A study was developed by applying two psychometric scales by forms in virtual platforms, in order to evaluate four psychological variables in a population of university students practicing sports during the return to face-to-face activities after the increase in freedom of action due to the decrease in health restrictions and confinement. The data collection lasted four weeks, considering the corresponding permits from the authorities of each institution to carry out the research and the application of the instruments by two professionals, for their subsequent analysis.

The general objective of the study is to evaluate the variables of motivation, anxiety, depression and stress in active university athletes in the return to face-to-face academic and sports activities, even when the restriction measures are maintained due to the Covid-19 pandemic. The specific objectives are to analyze the data obtained in the university sample population through the IBM Spss version 29 software; to describe and identify the mental state through the variables of motivation, anxiety, depression and stress of the athletes in each of the dimensions of the applied instrument; to identify whether positive or negative orientations are presented related to the different study variables; to correlate the results between the variables of motivation, anxiety, depression and stress; to design tables that express the results obtained in the research.

Participants

The participants are from the city of Punta Arenas, capital of the Magallanes Region, Chile. Due to the distance that separates the area geographically, the customs are different and particular to the rest of the country, describing the community as a place of quiet people, with southern habits in the way of eating, dressing and sharing. The context of the sample population is located in a sports, academic and university environment. Information was collected in a total of 135 subjects enrolled in local universities, who maintain the practice of sports activities in the return to the presential.

The inclusion criteria for the study were: university students between 18 and 38 years of age, actively practicing sports according to attendance records at university training sessions, and enrolled in any of the 3 universities in the city. The exclusion criteria for the study were: suffering from some type of mental disorder, taking medications that alter mental states and consuming illegal drugs. The elimination criteria for the study were: answering the scales and not being an active participant in any sport. Inconsistency and inconsistency in the answers provided under software analysis.

Instrument

For the measurement of the variables of anxiety, depression and stress, an existing instrument validated for the university context in Chile was chosen, known as the Depression, Anxiety and Stress Scale (DASS-21). This was translated and adapted in Chile by Vinet, Rehbein, Román and Saiz (2008), the latter version being the one used. The DASS-21 has 21 items, with four response alternatives in Likert format, ranging from 0 ("It does not describe anything that happened or felt to me during the week") to 3 ("Yes, this happened to me a lot, or almost always"). In order to answer the question, the question asks the respondent to indicate to what extent the sentence describes what happened or what he/she felt during the last week. This instrument has the advantage of being a self-reporting scale, brief, easy to administer and answer, and its interpretation is simple. The instrument was validated in the Chilean university context by Antúnez and Vinet (2011).

The measurement instrument that fits the present research to assess the motivation variable, corresponds to the Escala de Motivación en el Deporte 2 (EMD-2), adapted to the Chilean context (Vallejo et al., 2017). This study was validated in university athletes of various disciplines and categories, with ages between 18 and 38 years, which makes it relevant to apply in this study. The EMD-2 has 6 dimensions, which are: intrinsic motivation, integrated regulation, identified regulation, introjected regulation, external regulation and amotivation. In total there are 18 items to be answered by the athletes, and each dimension has 3 items.

Variables

The variables presented in this research are measured through psychometric scales that allow the assessment of the level of motivation, depression, anxiety and stress. All these variables tend to suffer variability in their levels, according to the different contexts in which they are manifested and how they are processed by each person. The pandemic has had an effect on life, and this study seeks to identify the implication and relationship between the levels of intrinsic motivation and the other variables mentioned above, also yielding data on their mental state. Below is a description of each:

Intrinsic motivation: continuous scale-type variable, obtained through the first dimension of the EMD-2.

Depression: continuous scale-type variable, obtained through the depression subscale in the DASS-21.

Anxiety: continuous scale-type variable, obtained through the anxiety subscale in the DASS-21.

Stress: continuous scale-type variable, obtained through the stress subscale in the DASS-21.

Hypothesis

In relation to the hypotheses proposed in this research, hypothesis 1 or alternative hypothesis and hypothesis 0 or null hypothesis are described below:

Hypothesis 1: the degree of intrinsic motivation is favorably related to the mental state (depression, anxiety and stress) of university student athletes after returning to the classroom.

Hypothesis 0: the degree of intrinsic motivation is not related to the mental state (depression, anxiety and stress) of university student athletes after returning to the classroom.

Data analysis

The processing of all the information collected in this research is carried out using IBM Spss v29 software, in which the corresponding analyses described in the following paragraphs are performed.

The Cronbach's Alpha coefficient test is used for the reliability of the instruments. To process the data collected, the Kolmogorov Smirnov normality test was initially performed to determine whether the random sample has a normal distribution, which provides guidance on whether parametric or nonparametric tests should be used. A descriptive analysis of each of the variables and dimensions that make up the scales applied to the sample population is applied. This included the mean, median and standard deviation of each one, together with the preparation of tables that favor their understanding.

To establish whether there is a relationship between the intrinsic motivation variable of the EMD-2 scale and the depression, anxiety and stress variables of the DASS-21 scale, Spearman's rho correlation coefficient was calculated with a significance of <.05.

Results

Tests of normality, descriptive statistics of means, medians and deviation of the data obtained from the instruments applied were performed, where tables are presented for their understanding. Spearman's correlation coefficient was used to identify and relate the variables.

The results of the analysis of the normality tests shown in Table 1, having a significance of < .001, below the < .05 level, establishes that: a normal distribution is not present, therefore the use of non-parametric tests was established in the subsequent analyses of the study.

Table 1

Kolmogorov-Smirnov normality test

	Kolmogorov-Smirnova		
	Statistic	gl	Sig.
Intrinsic motivation	.156	135	<.001
Depression	.158	135	<.001
Anxiety	.186	135	<.001
Stress	.152	135	<.001

The maximum score for each dimension of the EMD-2 is 7 points on a Likert scale from 1 to 7. With regard to the dimension of intrinsic motivation, which is considered the most self-determined, it presents a mean of 5.76 in Table 2, which expresses a high degree of self-determination, understanding the practice of sports as part of the pleasure of the activity itself, where the individual moves for personal reasons and not outside the context. Considering that the data were obtained when starting a semester in person, the high score is inferred as a need to return to the physical and social activity produced by sport.

Table 2

Descriptive analysis of intrinsic motivation.

Intrinsic motivation	
N valid	135
Lost	0
Average	5.76
Median	6
Rank	5
Minimum	2
Maximum	7

Within the DASS-21 instrument validated for the university population of Chile, a score between 5 and 6, shows a mental state which suffers from mild depression, and as shown in Table 3, it is possible to affirm the presence of this condition in the population of university athletes who are returning to sport and academic activity in a face-to-face manner. Isolation and restrictions caused by the pandemic are part of the problem that can generate arguments for the appearance of this variable in people.

Table 3

Descriptive analysis of depression.

Depression	
N valid	135
Lost	0
Average	5.36
Median	4
Rank	21
Minimum	0
Maximum	21

The mean score presented in Table 4.6, within the instrument used for its measurement, expresses that 4 points is the manifestation of mild anxiety in people, a state that can be variable, understanding the circumstances that it is possible to live daily to face the situations that may occur. The return to face-to-face presence may increase anxiety levels after a period of confinement, however, it is a score that it is possible to estimate as favorable.

Table 4

Descriptive analysis of anxiety.

Anxiety	
N valid	135
Lost	0
Average	4.03
Median	2
Range	20
Minimum	0
Maximum	20

Table 5 presents a description of stress with a mean of approximately 7, where according to the DASS-21, it is a score below the manifestation of mild stress, which is between 8 and 9 points. It is possible to infer that, in a period of return to face-to-face activities, after a long break of being locked up at home with many limitations, it is favorable for this mental variable, because of how liberating it is to return to a certain "normality" in daily life.

Table 5

Descriptive analysis of stress.

Stress	
N valid	135
Lost	0
Average	7.01
Median	6
Rank	18
Minimum	0
Maximum	18

Table 6 shows a p-value of <.001, less than .05, indicating that the null hypothesis is rejected and the alternative is accepted. Spearman's rho coefficient being negative -.289, indicating that the relationship between the variables is inverse and its degree is low. This expresses a low negative relationship, which is favorable in the sense that the higher the intrinsic motivation, the lower the levels of depression.

Table 6

Correlation analysis between intrinsic motivation and depression.

		Intrinsic motivation	Depression
Intrinsic Motivation.	Correlation Coefficient	1.000	-.289**
	Sig. (bilateral)	.	<.001
Rho of	N	135	135
Spearman Depression	Correlation Coefficient	-.289**	1.000
	Sig. (bilateral)	<.001	.
	N	135	135

Table 7 shows a p-value of <.001, less than <.05, indicating that the null hypothesis is rejected and the alternative is accepted. Spearman's rho coefficient being negative -.339, indicating that the relationship between the variables is inverse and its degree is low. This expresses a low negative relationship, which is favorable in the sense that the higher the intrinsic motivation, the lower the levels of anxiety.

Table 7

Correlation analysis between intrinsic motivation and anxiety.

			Intrinsic motivation	Anxiety
Rho of Spearman	Intrinsic Motivation.	Correlation coefficient	1.000	-.339**
		Sig. (bilateral)	.	<.001
		N	135	135
	Anxiety	Correlation coefficient	-.339**	1.000
		Sig. (bilateral)	<.001	.
		N	135	135

Table 8, which analyzes the correlation between intrinsic motivation and stress, shows a p-value of .79, a result greater than <.05, which indicates that there is no statistical relationship between the two variables.

Table 8

Correlation analysis between intrinsic motivation and stress.

			Intrinsic motivation	Stress
Rho of Spearman	Intrinsic Motivation.	Correlation coefficient	1.000	-.152**
		Sig. (bilateral)	.	.079
		N	135	135
	Stress.	Correlation coefficient	-.152**	1.000
		Sig. (bilateral)	.079	.
		N	135	135

Discussion

The results obtained within this research are highlighted as positive and expected, considering the context and the moment in which the information is sought to be collected is within a period of vulnerability in transition to an advance towards greater ¨freedom¨ of action in their daily lives as students, especially in the possibility of being able to return to practice sport, which brings implicit favorable effects on the body and mind of people with a high degree of motivation (González et al., 2020; Andrade et al., 2015; Pérez et al., 2015). In addition, it is not unusual to find, although low, levels of anxiety and mild depression in the study population, since during the development of the pandemic these variables were increasingly on the rise due to various moments of crisis, from economic to social and academic, where the latter two aspects usually have adverse effects if adaptation comes from a sudden change (Bustamante et al., 2020; Anicama et al., 2021).

According to the studies of Vilca et al. (2020), where it shows how the Covid-19 pandemic has evidently generated changes in the way of living, and attending to this study in the university area, where the main change was mostly noticed in the transition to virtual education, which generated high levels of stress and academic stress, it has been an adaptation that has not been fully achieved during the pandemic (Ruiz et al., 2022), therefore, the results obtained in the stress levels in this research show low, understanding that although they must now adapt from virtual to face-to-face, it is a situation that favors a better way to face the various areas of university performance (modules, sports, social service, practices, etc.), along with having recreational spaces different from confinement and quarantines caused by confinement (Barahona and Ojeda, 2019).

Studies that allude to the university population during the strict process of health restrictions, show an increase in the levels of anxiety and depression, and a decreasing motivation for academic and sporting activity from the plane of virtuality as the only resource of realization (Mendoza et al., 2022; Ruiz et al., 2022), which contrasts with the data obtained from the students upon returning to a new academic and sports semester after confinement, where they present a favorable mental state, with a high desire to practice sports (Huamán and Barrial, 2022), which allows them to face the university process in an optimal way, respecting and accepting the norms established in the new ¨normality¨ (Bustamante et al., 2020).

The correlative implication of motivation on the level of depression and anxiety, allows the possibility of exploration in research that inquires and ratifies the fact that this is so, since inferring this is subject to further scientific evidence and studies that are introduced in the university context as such in times after the problems caused by the pandemic (Lopez and Pineda, 2015; Caro et al., 2019).

Conclusions

University athletes, like the general population, had to experience adverse processes during the pandemic, and the psychological evaluation of the effects of this constant adaptation that they had and will have to face, allowed us to see and deduce in this study that the transition from confinement to greater freedom, yielded balanced mental states with a motivational tendency towards sports practice that is related to the enjoyment of being able to do it, outside of the need to have competitive events to train or participate in any discipline. This reinforces the ideas of sport as a useful tool for the general welfare of people, even in adverse times.

When describing and identifying in the population the parameters of the psychological variables investigated, a positive orientation of the results obtained is reflected, where the hypothesis expressed that high intrinsic motivation was a factor to be considered when related to the other variables of stress, anxiety and depression. In this case, intrinsic motivation is present to a high degree, correlated with a lower degree of anxiety, depression and stress. This result is a determining element to understand, since there may be tools or means of intervention to work particularly on the intrinsic motivation of student-athletes to improve other mental conditioning factors.

The high levels of intrinsic motivation in the return to the sport activity, allows us to realize that it is a need in university students, where returning to practice their sport is not due to the search for recognition or external stimuli, but rather for the pleasure of wanting to do it, to feel fulfilled, being a protective factor against the development of pathologies such as anxiety and depression in particular. It is important to mention in a special way that the results of the study showed the relationship that the higher the intrinsic motivation, the lower the pathological manifestation of these two variables, therefore, understanding that during a long period of time they were confined with an unfavorable mental, social and sporting implication, returning to the classroom had a positive impact, and the students who practice sports were able to see a stable mental state to return to face the university stage.

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