MLS Sport Research

ISSN: 2792-7156

https://www.mlsjournals.com/Sport-Research

January - June, 2024 VOL. 4 No. 1

MLS - SPORT RESEARCH

Vol. 4 ● Núm. 1 ● Junio – June – Junho – 2024

ISSN: 2792-7156

https://www.mlsjournals.com/Sport-Research

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SUMARIO / SUMMARY / RESUMO

- Editorial 6

- Revisión sistemática: entrenamiento de fuerza previo a un partido de fútbol..... 7
  Systematic review: strength training before a football match
  Roberto Seco, Carlos Lanza, Carlos Lago. Universidad Europea del Atlántico (España).

- Métodos de entrenamiento de fuerza en atletas de medio fondo. Una revisión sistemática 19
  Systematic review: strength training before a football match
  Pablo Cristóbal-Blázquez, Florent Osmani, Carlos Lago-Fuentes. Universidad Europea del Atlántico (España).

- Modelos de periodización del entrenamiento empleados en la natación convencional y para natación: Una revisión sistemática 33
  Training periodization models used in swimming and para swimming: A systematic review
  Esteban Izquierdo Rodríguez, Julian David Galeano Virgen, Diego Fernando Orejuela Aristizábal, Viviana Amparo López Ulchur, Angee Catalina Castro Rengifo. Institución Universitaria Escuela Nacional del Deporte (Colombia).

- La enseñanza de educación física en el período de pandemia (SARS-COV-2): un estudio de caso no Instituto Federal do Triângulo Mineiro – IFTM 49
  The teaching of physical education in the pandemic period (SARS-COV-2): A case study at the Federal Institute of Triângulo Mineiro – IFTM
  Arthur Braga de Oliveira. Instituto Federal do Triângulo Mineiro – IFTM (Brasil).

Editorial

With this new issue 1, 2024, of the MLS Sport Research journal, we continue to develop our commitment to research in Physical Activity and Sport Sciences by presenting four new papers, in this case, three focused on sport performance, based on the updating of specific knowledge through systematic review and one in the context of school Physical Education. The first study shows a systematic review on strength training prior to a soccer competition, in the same line of updating knowledge, another systematic review on strength training methods in middle-distance athletes is included, and a third review that investigates periodization models in swimming. The fourth paper analyzes the difficulties in teaching Physical Education during the COVID-19 pandemic.

With this new issue, the MLS Sport Research journal maintains its commitment to consolidate this publication 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

MLS – SPORT RESEARCH (MLSSR)
https://www.mlsjournals.com/Sport-Research
ISSN: 2792-7156

(2024) MLS-Sport Research, 4(1), 7-18. doi.org/10.54716/mlssr.v4i1.1861.

SYSTEMATIC REVIEW: STRENGTH TRAINING BEFORE A FOOTBALL MATCH

REVISIÓN SISTEMÁTICA: ENTRENAMIENTO DE FUERZA PREVIO A UN PARTIDO DE FÚTBOL

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Manuscript information:

Received/Recibido: 22/02/2023
Reviewed/Revisado: 13/04/2023
Accepted/Aceptado: 23/05/2023

Keywords:
performance, PAP, strength, activation, neuromuscular, priming.

ABSTRACT

Football is a sport of cooperation-opposition, with high uncertainty and in which there are constantly high intensity actions such as jumps, changes of direction or contact with the opponent that demand a high level of physical performance from the player. In recent years, gym training has become an essential tool and it has been demonstrated that strength training before the start of a match offers improvements in the physical performance of the players thanks to the effect of post-activation potentiation (PAP). The aim of the present review was to test which strength training protocols maximize the effect of PAP. A search for articles was carried out in the PubMed database, finding 144 articles which, once filtered according to the inclusion criteria, were reduced to 13. The guidelines for the design of reviews established by PRISMA were maintained. The results show that for most authors strength training, with protocols with concentric, eccentric or plyometric exercises, in all planes of movement, with low volume and at high intensities (±85%1RM) in conventional training or maximum in the case of plyometric exercises, with a test rest of between 5 to 10 minutes, could be beneficial for subsequent performance in a soccer match. It was concluded that there are differential aspects such as that not all people will respond in the same way to the same PAP protocol, being determinant the age or previous experience in strength training.

RESUMEN

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Palabras clave:
rendimiento, PAP, fuerza, activación neuromuscular.

El fútbol es un deporte de cooperación-oposición, con elevada incertidumbre y en el que se dan constantemente acciones de alta intensidad que demandan al futbolista un elevado nivel de rendimiento físico. El trabajo en el gimnasio se ha convertido en los últimos años en una herramienta imprescindible y se ha demostrado que un entrenamiento de fuerza antes del inicio de un partido ofrece mejoras en el rendimiento condicional del futbolista gracias al efecto de potenciación post-activación (PAP). El objetivo del presente trabajo de revisión fue comprobar qué protocolos de entrenamientos de fuerza maximizan el efecto de la PAP. Se realizó una búsqueda de artículos en PubMed, encontrando 144 artículos que, una vez filtrados en base a los criterios de inclusión, se redujeron a 13. Fueron mantenidas las directrices para el diseño de revisiones establecidas por PRISMA. Los resultados muestran que para la mayoría de los autores el entrenamiento de fuerza, con protocolos con ejercicios tanto concéntricos, como excéntricos o pliométricos, en todos los planos del movimiento, con un volumen bajo y a altas intensidades (±85%1RM) en el entrenamiento convencional o máximas si se trata de ejercicios pliométricos, con un descanso a la prueba de entre 5 y 10 minutos, podría ser beneficioso para el rendimiento posterior en un partido de fútbol. Se concluyó que existen aspectos diferenciales como que no todas las personas responderán igual ante un mismo protocolo de PAP, siendo determinantes la edad o la experiencia previa en el entrenamiento de fuerza.

Introduction

Soccer is a socio-motor sport of cooperation-opposition, with high uncertainty that takes place in a space standardized by the international soccer federation (FIFA) of 90-120 meters long by 45-90 meters wide, and must have rectangular geometry (The International Football Association Board, 2021). It is an acyclic sport in which the participation of both teams is simultaneous, which requires open skills and high intensity intermittent actions (Poch, 2008). During the development of the match, players, without a pre-established order, run at different intensities, jump, dribble, dive to the ground and receive contact from opposing players (Castellano & Casamichana, 2016). All of this means that the player must constantly adapt to new situations, changing realities and a diversity of stimuli.

The demands of competition require players to perform actions of high intensity and very short durations. Beyond the total distance covered, the physical performance that a player can give in a soccer match is determined through efforts at high intensity (Stølen et al., 2005). To do so, players must have high levels of speed, endurance, the ability to repeat high intensity efforts, strength and power. (Turner et al, 2011). In terms of external loading, during a soccer match, players travel a total distance of about 10-11 km (Dellal et al., 2011) (Taylor et al., 2017) (Reynolds et al., 2021), of which between 225 m and 335 m are sprinting (> 24km/h) (Dellal et al., 2011) (Barnes et al., 2020), reaching about 500 accelerations and decelerations (≥1.5 $\frac{m}{s^2}$) (Altmann et al., 2021).

Regarding the internal load, due to the characteristics of soccer, the aerobic and anaerobic energy systems are requested together (Bangsbo et al., 2006). To assess such load, physiological parameters can be considered such as heart rate, which ranges between 150 and 190 bpm or 80-90% of the maximum heart rate of athletes (Suarez-Arrones et al., 2015) (Stølen et al., 2005), blood lactate concentration, with values ranging from 3 Mmol/l to more than 10 Mmol/l in the different phases of the match (Stølen et al., 2005) or the percentage of maximal oxygen consumption (VO2Max), which can vary from 50-55 ml/kg/min to 60-65 ml/kg/min in professional soccer players (Hoff, 2005).

With the objective of achieving to prepare the soccer player for the demands of competition, one of the training models currently used in soccer is the structured microcycle (Seirulo Vargas, 2017), in which a microcycle organization methodology is used that allows optimizing the player's training loads (Martín-García et al., 2018). This microcycle bases the periodization of the training contents on the "macth day" (MD), i.e., on when the last game was played and when the next game will be played. In this way, it allows to include simultaneously the work of the conditional aspect as well as the technical, tactical and psychological aspects. Based on a standard 7-day microcycle, the training schedule will be as follows: the day after the match (MD+1), the group will be divided in two, differentiating between players who played more than 60 minutes, who will do regenerative work to eliminate fatigue, and players who played less than 60 minutes, who will do compensatory work to simulate the load of the match. Day MD+2 will be the rest day. From here, the acquisition block begins, which will comprise the MD-4 and MD-3 days (4 and 3 days before the next game respectively) and will be the two most demanding sessions of the week that will aim to provoke new adaptations in the player. Finally, days MD-2 and MD-1 (2 and 1 days before the next match) will belong to the tapering block in which the aim will be to eliminate fatigue in order to arrive at the match in an optimal state (Seirulo Vargas, 2017) (Martín-García et al., 2018).

The implementation of a well-planned and programmed strength training program can improve the performance of players during the match, since it has been

shown that benefits are obtained in several of the conditional actions that are most important in achieving optimal performance in a match: jumps, changes of direction, accelerations or sprints (Loturco et al., 2020) (Fiorilli et al., 2020) (Styles et al., 2016) (Thapa et al., 2021), as well as helping in injury prevention (Biz et al., 2021) (Beato et al., 2021). Thus, strength training should be oriented to the physical abilities and motor patterns that the sport itself will demand from the soccer player, there being a term called "adjuvant training" that refers to training tasks that are further away from the reality of competition but that prepare the soccer player to be able to assimilate the training loads in the best possible way (Gómez et al., 2019). On the other hand, it should be taken into account that the fatigue produced by this type of training in the days prior to the competition can affect the player both mentally, worsening the speed and quality of decision-making and positioning on the field, and physically, reducing the player's ability to make high-intensity efforts (Coutinho et al., 2018), so it is necessary to place this type of work far enough away from the competition to allow eliminating the fatigue it brings completely.

Furthermore, in relation to strength work, in recent years the concept of post-activation potentiation (PAP) has emerged, which is defined as a transient increase in muscle strength after previous contractile activity (Biz et al., 2021), i.e., improvements in sports performance can be obtained after performing strength work. The supposed improvement in performance after performing strength training seems to be given by the contractile history, but as discussed above, fatigue must be taken into account, which can be counterproductive and not allow PAP to be achieved (Picón-Martínez et al., 2019).

Because the physiological mechanisms are still partly unknown, how to obtain such an ideal or optimal contraction is a matter of debate and requires further research. Despite this, two possible responsible mechanisms have been highlighted (Picón-Martínez et al., 2019):

a) Phosphorylation of myosin light chains, because they make the actin-myosin interaction more sensitive to calcium release from the sarcoplasmic reticulum.

b) Increased motor neuron excitability, as evidenced by the amplitude of the H reflex.

Previous studies expose that the effect of PAP varies depending on the characteristics of each individual (Sánchez-Sánchez et al., 2018). There are also articles that support delayed PAP, taking effect even more than 24h after training (González-García et al., 2020). Since enhancing the physical performance of soccer players during competition is desirable for any coaching staff, the aim of the present study was to test which strength training protocols maximize the effect of PAP before playing a soccer match.

Method

An exhaustive search was carried out in the search engines "Pubmed" and "Google Scholar" using keywords such as "PAP", "Soccer", "Neuromuscular", "professional" or "resistance training", combining them with the Boolean operators "AND", "OR" and "NOT".

To perform this search, the following combinations were entered into the search engine: "PAP" AND "soccer", "post-activation potentiation" AND "soccer", "neuromuscular" AND "PAP" AND "soccer", "activation" AND "PAP" AND "soccer", "resistence training" AND "PAP" AND "soccer", "training" AND "PAP" AND "soccer", "PAP"

AND "performance" AND "soccer", "resistance training" AND "PAP" AND "performance" AND "soccer", "PAP" AND "recovery" AND "performance" AND "soccer", "Post-Activation Potentiation" AND "resistence training" y "Post-Activation Performance Enhancement" AND "soccer". Inclusion criteria were that the strength training was performed the day before the match. During the selection process, articles written in both English and Spanish were selected.

Original research articles were accepted. In addition, several articles found through other secondary methods were also useful.

Results

Figure 1 shows the articles selected for review:

Figure 1
Flow chart of the literature review.

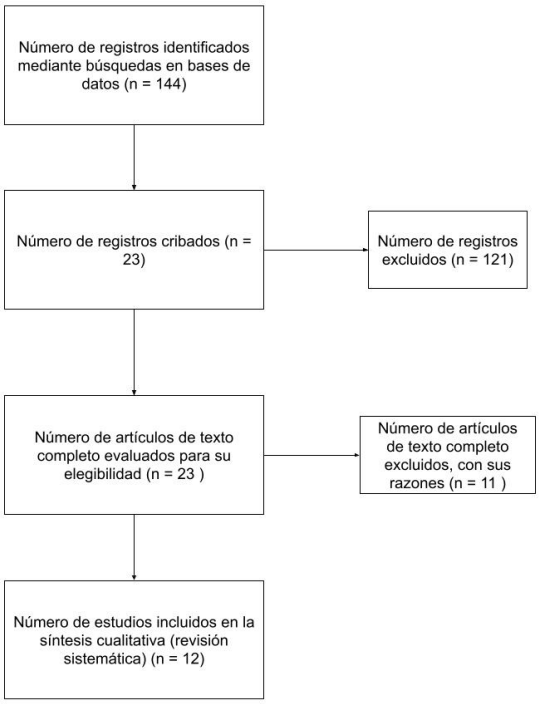

Table 1 shows a summary of the results of the selected articles:

Table 1
Summary of results

Article	Population	Exercise	Volume	Intensity	Rest to the test	Results
Beato et al. (2021)	31 male amateur soccer players	Inertial-Conic Cross-Cutting Step/ Flywheel Leg Extension/Squat Exercise	4x6 each leg/4x6 each leg/4x6 each leg	Maximum	No data	Significant improvements in COD with the dominant and non-dominant leg 4 minutes after INC, EXT and Squat
Cioca et al (2021)	18 college men's soccer players	Plyometry	3x10	Maxima	15 s, 2, 4, 8, 8, 12 and 16 min	Improvements at 2min in PAPE protocol, but no significant differences with control group
Guerra et al (2020)	24 professional soccer players	Ankle hops/hurdle hops/20m ballasted sprint	2x15/3x5/3 series	Max/Max/15% BW	1, 3 and 5 min	Plyometrics in combination with resisted sprinting improves vertical jump performance in professional soccer players
Iacono & Seitz (2018)	18 elite male players	Barbell Hip Thrust	3 x 6	85% 1RM	15s, 4 min and 8 min	Significant differences in the 3 distances
Keijzer at al (2020)	13 college men's soccer players	EOL Half Squat	1, 2 or 3 series x 6 reps	Incertia: 0.0011 kg-m2	3 and 6 min	1º: The effects are only seen in the PAP with more than one series. 2º: More effective with 6 minutes rest
Köklü et al (2022)	12 young players (17 years old)	Squat	3 reps	90%1RM	1, 2, 3 and 4 min	The study concludes that the improvement in both CMJ and sprinting was greater when the rest was 4 minutes. It is also observed that with the 4 different rest times, the marks of the no-load protocol were improved.
Mola et al. (2014)	22 professional male soccer players	Squat	3 reps	3RM	4, 8, 12, 16 and 20 min	First, a series of 3RM squats did not acutely improve the CMJ performance of all experimental

						participants through PAP, although there are both responders and non-responders to PAP. Second, the time constant of PAP elicited by responders differed among these individuals
Nealer (2017)	11 recreational girls soccer players, 13 collegiate girls soccer players	Assisted Sprint	20 m	30% BW	30s, 1min, 2min or 4min	Improvements in all distances, both trained and untrained
Nickerson et al (2018)	12 NCAA Division II men's players	Back Squat	1x3	85%1RM	1, 4, 7, and 10 min	Improved times in 20m. The fastest sprint was 10m later using the Cluster-30s.
Petisco et al (2019)	10 professional male soccer players	Back Squat	1x10, 1x5, 1x1	60%1RM, 80%1RM, 100%1RM	5min, 6min, 8min	Better performance at 80%1RM
Sanchez-Sanchez et al (2018)	8 national category players, 8 regional category players	Multipower Squat	Loss of speed 10%	60% 1RM/90 % 1RM	5 min	No improvement in the sprint with either PAP protocol. Better performance at the national level than at the regional level.
Till & Cooke (2009)	12 professional college soccer players	DeadLift/Double-legged tuck jump/MVC knee extensions	5 rep/5 rep/3 reps of 3s	5RM/Max/Maximum/Maximum	4, 5 and 6 min/7, 8 and 9 min	It finds no differences between the different PAP methods. Sprint performance and CMJ performance improved 7 minutes after the deadlift and Double-legged tuck jump, showing a positive effect on subsequent performance.
Willims et al (2021)	9 male and 6 female high school soccer players (16-18 years old)	Ballasted sprint	3 reps	40-50%Vdec	2 min	Weighted sprints with a weight that causes the loss of speed to be between 40 and 50% cause the time in a 15m sprint to drop. Only 2 athletes increased their time, both of them girls.

Note: BW: Body Weight; RM: Maximum repetition; Vdec: Loss of speed; MVC: Maximum Voluntary Contraction; EOL: Eccentric overload; INC: Inertial Conic Cross; EXT: Leg Extension; Min: Minutes; Reps: Repetitions; s: Seconds

Discussion and conclusions

Throughout the present work, an investigation focused on strength training before a soccer match as a means to achieve Post-Activation Potentation has been carried out, using the 13 articles shown in Table 1 as a theoretical framework.

Sánchez-Sánchez et. al. (2020), Petisco et. al. (2019), Nickerson et al (2018), Mola et. al. (2014), Köklü et. al. (2022), & Beato et. al. (2019) did the PAP protocol with both front and back squat on multipower and free weights. While Petisco et. al. (2019), Nickerson et. al. (2018) and Köklü et. al. (2022) found improvements in all subjects after performing this protocol, it was found that Mola et. al. (2014) does not find benefits in all participants. On the other hand, we can observe how the protocol proposed by Sánchez-Sánchez et. al. (2021) concluded that there was no improvement in any of the subjects. None of the investigations using Squat as an exercise to achieve PAP show changes in the application of the protocol, beyond the age and level of the soccer players, but there is no relationship between this level or age and the improvement of the results after strength training. This is in contrast to Petrella (1989) and Vandervoort & McComas (2002), who argue that age does determine the level of PAP, with younger athletes responding better than older athletes.

Regarding the force vectors, all the authors who worked on the horizontal vector (Hip Thrust or ballasted Sprint) agree that they obtained positive results in their respective tests. On the other hand, the studies that performed work on the vertical vector (Squat or DeadLift) also obtained the same positive result, with the exception of Mola et. al. (2014), where not all subjects improved after the PAP protocol and Sánchez-Sánchez et. al. (2018), where the marks were not improved. These results may be due to the fact that, during running, jumps or changes of direction, both horizontal and vertical forces are exerted, so the introduction of work in both vectors, benefits performance in the 3 types of tests (González-García et. al., 2019).

In terms of intensity, we must differentiate between protocols that were based on concentric strength exercises, those based on drags or those that involved eccentric or plyometric work. In the former, working at submaximal intensities positive results were found, but the greatest improvements were at 1RM percentages between 80%1RM and 85%1RM (Iacono & Seita, 2018; Petisco et. al., 2017). In this regard, we can see how Sánchez-Sánchez et. al. (2018), performed the PAP protocol with Squat, using as indicative to determine the volume, the loss of 10% speed in the series. According to González-García et. al. (2019), a 10% loss of speed is considered light work. This may result in not reaching sufficient activation level to find the PAP. However, if the work to be performed is plyometric or eccentric, all agree that the intensity should be maximum. (Beato et. al, 2021; Till & Cooke, 2009). Drag-based protocols differentiate between two ways of expressing work intensity: % body weight (Nealer, 2017) and % speed loss (Williams et. al., 2021). In both cases, the result was positive. The coincidence of all these authors is based on Picón-Martínez et. al. (2019): the work to be done to achieve PAP has to be at or very close to maximum intensities.

In reference to plyometric training, Till & Cooke (2009) and Guerra et. al. (2020) agree that their PAP protocols were able to improve the performance of soccer players if performed in conjunction with traditional methods, while the authors who based the PAP protocol on concentric strength training, Petisco et. al. (2020) and Beato et. al. (2021), did

not have to incorporate plyometric work to obtain the performance improvements. This may be due to the fact that, by using the method of contrasts or concentric training with loads in which power is worked, we will be in an optimal zone of the strength-velocity curve for the achievement of PAP than if only plyometric work is done, which is more oriented to speed.

One of the limitations found in the studies analyzed is that soccer is a multicomponent sport, where players' performance cannot be reflected by isolated and linear tests such as the CMJ (Guerra et. al., 2020) or Linear Sprint (Nickerson et. al., 2018). In addition to the above, the non-homogeneity of protocols, tests and the different participants selected for study, make the results obtained not easily comparable, and if this were corrected, more significant and binding results could be achieved. For this reason, the scientific community is encouraged to continue along this line of research, matching and improving the different protocols and tests in the following research proposals.

The objective of the present review was to test which loads maximize the effect of PAP before playing a soccer match. After analysis and comparison of the articles included in the study, the authors found the following conclusions:

1. Within the protocols that use concentric exercises, loads of 80-85% of 1RM are those that show the greatest post-activation potentiation effects.
2. Both eccentric and plyometric exercises require maximum intensities to achieve the greatest possible post-activation potentiation effects.
3. The volume with which the authors who find improvements in performance after a strength protocol work is 2 to 4 sets of 6 repetitions for eccentric exercises and 1 to 3 sets of 3 to 10 repetitions with concentric exercises.
4. Times between 4 and 7 minutes from the end of the strength protocol and the start of the test are shown to be the most effective in maximizing PAP, provided concentric or eccentric exercises are used.

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MLS – SPORT RESEARCH (MLSSR)
https://www.mlsjournals.com/Sport-Research
ISSN: 2792-7156

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STRENGTH TRAINING METHODS IN MIDDLE-DISTANCE ATHLETES: A SYSTEMATIC REVIEW

MÉTODOS DE ENTRENAMIENTO DE FUERZA EN ATLETAS DE MEDIO FONDO. UNA REVISIÓN SISTEMÁTICA

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Manuscript information:

Received/Recibido: 19/10/2023
Reviewed/Revisado: 15/12/2023
Accepted/Aceptado: 13/12/2023

Keywords:
runners, endurance, performance, running economy, maximal oxygen consumption.

ABSTRACT

The aim of this systematic review has been to compare different strength training methods to improve performance in events between 800 and 5000 m in athletics, events characterized by high requirements of aerobic capacity, maximal strength, and power. The Pubmed database was used to search for original articles about strength training in middle distance runners. For this purpose, different combinations of some terms such as "middle distance," "running performance," "VO2max," "running economy," "resistance training," "strength training," "concurrent training," and "plyometric training" were introduced. Articles whose interventions were evaluated with time trials longer than 5 km were excluded. Initially, 298 articles were collected, of which 9 were selected according to the inclusion and exclusion criteria. After an intervention period lasting 6 to 12 weeks, improvements in physiological and neuromuscular parameters were observed in all but one of the articles. The studies that obtained the greatest improvements performed strength training with loads of 70% RM or higher. In addition, this strength training was combined with plyometric exercises performed without additional weight or by adding 30% of body weight. In conclusion, combining strength training at an intensity of 70% RM or higher at 4-10 repetitions with plyometric training appears to be the most effective method for optimizing performance in middle-distance running

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Palabras clave:
corredores, resistencia, rendimiento, economía de carrera, máximo consumo de oxígeno

RESUMEN

El objetivo de esta revisión sistemática ha sido comparar los diferentes métodos de entrenamiento de fuerza para mejorar el rendimiento en pruebas de entre 800 y 5000 m en atletismo, eventos caracterizados por altos requerimientos de capacidad aeróbica, de fuerza máxima y de potencia. La base de datos Pubmed fue empleada para buscar artículos originales acerca del entrenamiento de fuerza en medio fondistas. Para ello se introdujeron diferentes combinaciones de algunos términos como: "middle distance", "running performance", "VO2max", "running economy", "resistance training", "strength training", "concurrent training" y "plyometric training". Los artículos cuyas intervenciones fueron evaluadas con test de contrarreloj superiores a 5 km fueron excluidos. Inicialmente se recolectaron 298 artículos, de los cuales 9 fueron seleccionados atendiendo a los criterios de inclusión y exclusión. Tras un periodo de intervención con una duración de 6 a 12 semanas, en todos los artículos se observaron mejoras en parámetros fisiológicos y neuromusculares, a excepción de uno. En este estudio se apreció una tendencia a la mejora, aunque los cambios no fueron significativos. Los estudios que mayores mejoras obtuvieron, realizaron entrenamiento de fuerza con cargas del 70 % RM o superior. Además, este entrenamiento de fuerza fue combinado con ejercicios pliométricos realizados sin peso adicional o añadiendo un 30% del peso corporal. En conclusión, combinar el entrenamiento de fuerza a una intensidad del 70%RM o superior a 4-10 repeticiones con entrenamiento pliométrico, parece ser el método más efectivo para optimizar el rendimiento en carreras de medio fondo

Introduction

Within the wide range of events held in athletics, the 800 and 1500 meter sprint events are the Olympic events belonging to the middle-distance sector (Real Federación Española de Atletismo, 2020, Annex 1). Due to their physiological characteristics, the 3000 and 5000 meter races could be considered as middle-long distance and similar to those previously mentioned (Lacour et al., 1990). This is due to the fact that, in the case of national and international championships, where athletes compete for a medal, the mark is of secondary importance. Therefore, athletes use tactics with changes of pace and the last lap is run at a speed around 110% of VO2max (Billat, 2001). In abbreviated form, performance in these tests is given by the ability to cover the required distance in the shortest possible time (Ramírez-Campillo et al., 2014). On the other hand, Blagrove et al. (2018) define running performance as a complex interaction of physiological, biomechanical, psychological, environmental and tactical factors. The approximate duration of these events according to the marks made by the world elite in the 2021 outdoor season was 1'45" in 800 m, 3'30" in 1500 m, 8' in 3000 m and 13' in 5000 m (World Athletics, 2021). Given the duration of these sports events, García-Pallarés & Izquierdo (2011) state that they require high levels of aerobic capacity, maximum strength and power.

Regarding the energetic contribution of the metabolic systems, we found that in the 800 m race, the aerobic system contributes from 60 to 75% of the energy, while the anaerobic system contributes between 25 and 40%. This great variability is due to the different types of athletes who run this test. If we refer to 1500 m, it is known that 75-85% of the energy is obtained aerobically and 15-25% anaerobically (Haugen et al. 2021). On the other hand, in longer events such as the 3000 and 5000 m, the aerobic system appears to provide 85 to 95% of the energy, with 5 to 15% being the contribution of the anaerobic system (Sandford & Stellingwerff, 2019).

In predicting performance in these tests Haugen et al. (2021) suggest attending to the parameters of Maximal Oxygen Consumption (VO2max), Running Economy (RE), Anaerobic Threshold Velocity (VAT) and VO2max Velocity (vVO2max). In recent years, ER is taking a leading role in the search for the path to improved performance. This is influenced by biomechanical factors, muscle fiber distribution, age, gender and anthropometric factors (Balsalobre-Fernandez et al., 2016). In addition, SR is affected by different strength work: low loads, high loads, explosive strength and plyometric training. These different strength trainings have been shown to improve the performance of both popular athletes and moderately and highly trained athletes (Balsalobre-Fernandez et al., 2016). On the other hand, thanks to research such as that of Beattie et al. (2014) or Moore's (2016) we know that both RE and anaerobic factors, depend on rapid force generation during the ground contact phase.

However, García-Pallarés & Izquierdo (2011) state that the benefits that strength training brings to the performance of athletes will occur only in the case that the training plan is properly designed. In recent studies it was found that when comparing a group that only trained strength and another group that performed concurrent training, the

former group obtained greater gains in maximal strength. This was because the second group suffered from what we know today as interference phenomena. However, several studies suggest that a properly designed and executed training protocol can minimize or even avoid this phenomenon. This will be very interesting in cyclic sports modalities whose duration ranges from 30 seconds to 8 minutes and require high demands of strength and endurance simultaneously (García-Pallarés & Izquierdo, 2011).

Jiménez-Reyes & González-Badillo (2011) state that the three main elements of strength training load are volume, intensity and frequency; to which should be added the exercise performed. An optimal relationship of these variables would cause an adaptation in the athlete, which should have a direct impact on his performance. That said, knowing how to structure strength training within a middle-distance athlete's training program correctly will allow us to improve their performance by minimizing or avoiding the aforementioned interference phenomenon.

The scientific literature affirms that weight training is an effective strategy for improving running performance. However, it does not seem to be very clear which are the best methods to work on strength and how to modulate the parameters of the load of this stimulus to achieve the most efficient results. On the other hand, evidence is found about strength work in sprinters and long distance runners, however, there seems to be a paucity of research regarding middle distance runners. Therefore, the objective of this review is to compare different strength training methods to improve performance in 800 to 5000 m events.

Method

Search strategy

In order to carry out this systematic review, a search for articles was carried out in the PubMed database. The main terms used to search for articles were: "middle distance, running performance, VO2max, running economy, resistance training, strength training, concurrent training and plyometric training. These terms and others were combined with Boolean parameters to perform the search as follows: ("middle distance" OR "800 meter" OR "1500 meter" OR "3 km") AND ("running performance" OR "running economy" OR "vVO2max" OR "VO2max speed" OR "maximal oxygen intake") AND ("resistance training" OR "strength training" OR "plyometric training" OR "concurrent training") AND ("interference phenomenon"). In addition, the Boolean parameter NOT was added to exclude the terms "marathon" and "ultra-endurance".

Inclusion criteria

This systematic review included articles related to middle-distance running up to 5 km in athletics, written in both Spanish and English. The articles whose evaluation tests included time trials of distances between 800 and 5000 meters were included. On the other hand, articles whose evaluations contained laboratory tests to assess physiological and biomechanical parameters (VO2max, RE, RFD, etc.) directly related to middle distance tests were also included. In addition, no limit was imposed as to the date on which the article was written.

Exclusion criteria

Articles whose research focused on sprinters (runners of 400 m or less) or long-distance runners (runners of distances greater than 5 km) were excluded. Articles whose post-intervention evaluation tests included time trials longer than 5 km were discarded. Includes design, participants, instrument, data analysis, etc.

Results

Figure 1 below shows the flow chart representing the item selection process. The search for articles was initiated and 298 studies were identified, and finally, 9 were included in the review.

Figure 1

Item selection flowchart

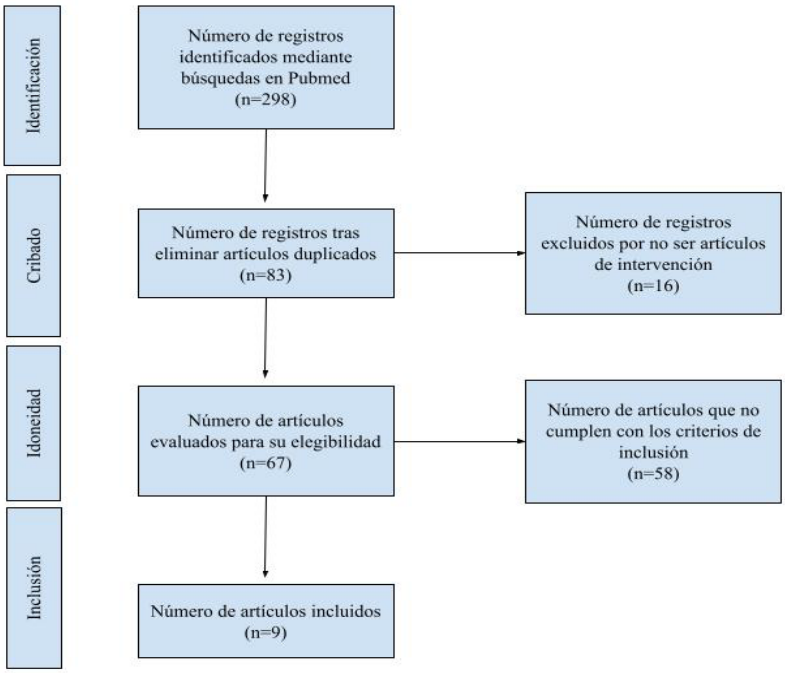

Table 1 shows the different variables and results of the selected studies. On the one hand, there are variables related to the subjects and, on the other, those related to the intervention carried out.

Table 1 shows a summary of the results of the selected articles:

Table 1

Characteristics of the studies, their participants and training programs

Study	Subjects			Research							
	n and Sex	**Age (years)**	**Experience and characteristics**	**Group design**	**Program**	**Duration**	**Training**	**Intensity**	**Running training**	**Evaluation test**	**Results**
García-Pinillos et al. (2020)	51 H + 45 M (27+24 IG / 24-21 CG)	Range between 18 - 40	Recreational runners (3-5 running sessions per week). Able to run 10 km in <50'.	Random	Plyometrics (jumping rope)	10 weeks 2-4 times/week 10-20'/week	5' of jumping rope in the warm-up of each session.	Weekly progression, starting with 30":30" (work:rest) bilateral and ending with 40":20" unilateral-alternate.	Regular training. The IG modified his warm-up routine to introduce jumping jacks. 42.1 ± 6.5 km/week	Stiffness CMJ Squat Jump Drop Jump Reactive Strength Index 3-km test	Significant improvements in GI in all variables tested, while CG did not improve significantly.
Mikkola et al. (2007)	18 H + 7 M (9+4 IG / 9+3 CG)	Range between 16-18	Post-pubertal long-distance runners with at least 2 years of long-distance running training experience.	Non-random division of the groups.	Explosive strength training	8 weeks 3 sessions/week 30-60' /session	Sprint: 5-10x30-150m Jump: alternative jumps, calf jumps, squat jumps, hurdle jumps Resistance: half squat, knee extension-flexion, calf raises, abd curls, back extensions (2-3 sets x 6-10 reps)	Low loads. Maximum execution speed.	8,8 ± 2,1 h 12.4 ± 3.0 sessions/week >95% <LT The IG exchanged 19% of the running hours for explosive strength training.	Muscle strength measurements VMART (9-10x150m) 30m Sprint 5J + CMJ Aerobic parameters	Improved MI in VMART and 30m test. Improvements in GI strength. Parameters aerobic =

Paavolainen et al. (1999)	18 H (10 IG / 8 CG)	23 ± 3 (IG)	Elite cross-country orienteering runners. VO2max (63.3 ± 2.1)	Selection of groups based on VO2max and time of the 5 km test.	Explosive strength training	9 weeks 2.7 h/week in sessions of 15-90'	Sprint: 5-10x20-100m PT: alternate jumps, CMJ, landing, hurdle jumps, 5-JUMP TEST on one leg. (30-200 jumps) RT: leg-press, knee extensor-flexor (5-20 reps.)	0-40% MR Maximum execution speed.	8,4 ± 1,7h 9 ± 2 sessions/week 84% <LT and 16% >LT The IG exchanged 32% of career hours for EST.	5 km test RE VO2max VMART Test 20m Sprint 5-Jump Test VO2MAX and LT	Improvements in the 5 km test and RE and VMART values by the IG. Improvements in the 20m test and 5-Jump test in the IG while the CG worsened. VO2max =
Ramírez-Campillo et al. (2014)	22 H + 14 M (10+8 IG / 12+6 CG)	22,1 ± 2,7	>2 years of experience in national and international competitions. 1500m MMP = 3'50" (H) - 4'27" (M) Marathon MMP = 2:32 (H) - 2:52 (M)	Random	Plyometry	6 weeks 2 sessions/week < 30'/session	2x10 Drop Jumps 20cm 2x10 Drop Jumps 40cm 2x10 Drop Jumps 60cm	Body weight. Maximum intentionality and minimum contact.	67.2 ± 18.9 km/week	CMJ + DJ 20m Sprint 2.4 km test	IG significantly improved 2.4 km and 20m test times and CMJ and DJ values compared to CG.
Saunders et al. (2006)	15 H (7 IG / 8 CG)	23.4 ± 3.2 (IG)	Highly trained national and 6 international level long-distance athletes. Mark in 3 km = 8.5 ± 0.4 min. VO2max (71.1 ± 6.0 ml/min/kg)	Random	Plyometrics + Strength training	9 weeks 3x30' /week	Back extension, Leg press, CMJ, Knee lifts (technical), Ankle jumps, Hamstring curls, Alternate-leg bounds, Skip for height, Single-leg ankle jumps, Hurdle jumps, Scissor jumps for height	Plyometry: 0 Strength training: 60%RM	107 ± 43 km/week 3 interval sessions 1 run-in of 60-150' 3 shoots of 30-60' 3-6 runs of 20-40'	RE VO2max 5-CMJ RFD	Non-significant improvements in ER, although tendency to improve in GI. VO2max = Strength data muscular =
Sedano et al. (2013)	18 H (6 EG / 6 GS / 6 ESG)	23,7 ± 1,2	Athletes (3000-5000 m) trained with a VO2max >65 and more than 4 years of training. National level competitors in Spain.	Random	Plyometric Strength Strength-endurance	12 weeks 2 sessions/week	ST: Barbell Squat, Lying leg curl, Seated calf raises and Leg extension PT: hurdle jumping (40 cm) and horizontal jumps	3x7 70%RM + 3x10 PLYO (SG) 3x20 40%RM (ESG)	6 sessions/week Runs and fartleks of 0.5-1.5h Series training	CMJ 25" Hopping test 1RM RE VO2max 3-km test	SG obtained improvements in all tests
	17 H	25 ± 4	Training history of	Random	Plyometry	6 weeks	Squat Jump, Split	Progression		RE	The IG improved the

Spurrs et al. (2003)	(8 IG / 9 CG)		10 ± 6 years.			2-3 sessions/week	Scissor Jump, Double Leg Bound, Alternate leg bound, Single Leg forward hop, Depth Jump, Double leg hurdle jump, single leg hurdle hop	from 60 to 180 contacts per week. Body weight. Maximum intentionality and minimum contact.	Regular training. 60-80 km/week	VO2max Lactic Threshold Force parameters CMJ 5-Bound Test 3-km test	values of the 3 km test, RE, CMJ, 5-bound test and strength parameters. VO2max and LT = No changes were observed in the GC.
Støren et al. (2008)	9 H + 8 M (4+4 IG / 5+4 GC)	28,6 ± 10,1 (IG)	Trained athletes VO2max 61.4 ± 5.1 Mark in 5-km= 1122,4 ±5 8,4	Division according to age and 5 km mark, randomized.	Maximum strength training	8 weeks 3 sessions/week	4x4 Half Squat	4RM	Regular resistance training	RE VO2max MORE 1RM Half Squat RFD	Improvements of MI in MRI, RFD, RE and MAS tests. VO2max =
Trowell et al. (2022)	18 H +12 M (9+6 IG / 9+6 CG)	33.1 ± 7.5 (IG)	Moderately trained runners. >30km/week	Random	Plyometrics + Strength training	10 weeks 2 sessions/week	Ankle bouncing, Back Squat, Hurdle Jumps (40 cm), Frontal Plank, High-knee drill, Single-leg deadlift, Split Squat Jump, Side-Stepping, CMJ, DJ, Glute Bridge	ST: 70%RM, 10 reps. PLYO: body weight or 30%BW	Regular resistance training	2-km test Time to exhaustion VO2max RE	Improvement in 2-km test time and "time to exhaustion" in VO2max test. VO2max = RE =

Note. M/F = men/women, IG/CG = intervention/control group, CMJ = countermovement jump, DJ = drop jump, 5J = 5-jump test, RM = repetition maximum, RFD = rate of force development, RE = running economy, VO2max = maximal oxygen consumption, LT = lactic threshold, MAS = maximal aerobic speed, VMART = maximal anaerobic running test, ST = strength training, RT = resistance training, PT = plyometric training, EST = explosive strength training, EG = endurance-only group, ESG = endurance-strength group, SG = strength group, MMP = personal best, BW = body weight, (=) = no significant variation of the values

Discussion and conclusions

The objective of this systematic review was to compare the effects of different strength training methods on the performance of both high-level and recreational athletes in middle-distance events. To test the effect of these programs on performance, different types of assessments have been used. On the one hand, we found those of a physiological nature, which evaluated predictors of performance such as RE, VO2max or LT (Brandon, 1995). Other assessments, measured neuromuscular parameters, highly related to sports performance as is the case of CMJ (Aragón-Vargas & Gross, 1997) and other jumping skills, also related to performance in 800m, 3000m and 5000m events (Hudgins et al., 2013). In terms of strength, the most notable tests that have been used are the 1RM of different exercises and the RFD, both highly related to the improvement of RE (Hoff & Helgerud, 2003). Finally, in a more direct way and similar to the competitive reality, time trials of distances from 2.4 km to 5 km were also carried out. Understanding sport performance as a complex interaction of factors (Blagrove et al., 2018), the studies previously analyzed, have compared a mixture of those previously described.

In the case of the articles analyzed, it was observed that 3 types of programs were mainly applied: plyometric training, strength training (with different intensities) and plyometric and strength training together. As for those who used plyometry only, in the studies of García-Pinillos et al. (2020) and Ramírez-Campillo et al. (2014), significant improvements were observed in neuromuscular assessments, jumping ability and time trial times. In addition to these improvements over the control groups, in the intervention of Spurrs et al. (2003) improved ER values without varying VO2max and LT parameters. This improvement was caused by an increase in the muscle-tendon stiffness of the lower limbs, which increases reactive strength and decreases energy cost (Spurrs et al., 2003). The only program that included strength training only was that of Støren et al. (2008). In this study, which implemented maximal strength work, improvements similar to those obtained by plyometric programs were achieved, improving RFD, RM, CMJ and aerobic values, while maintaining pre-test values in VO2max. Again, this suggests a relationship between the RFD of the musculature involved in running and the ER (Støren et al., 2008). Finally, the rest of the interventions combined plyometrics with strength training at different intensities. In the case of Mikkola et al. (2007), Paavolainen et al. (1999), Sedano et al. (2013) and Trowell et al. (2022), participants improved in neuromuscular parameters, anaerobic test (VMART) and time trial times, again maintaining initial VO2max data. However, in the study by Saunders et al. (2006) did not show significant improvements by combining plyometrics and strength, although a tendency to improve RE was observed. This appears to be because high-level athletes will require longer periods of training and/or higher intensity loads to see significant improvements.

Considering load parameters such as intensity and volume of the exercises proposed by the studies, we observed from interventions that only used body weight, to others that approached the maximum external load to perform the exercises. Almost all of the studies that included jumping and other plyometric exercises used only body weight, however, there is a progression of loading in terms of volume (number of contacts) and density in the case of the articles by Spurrs et al. (2003) and García-Pinillos et al. (2020). The only study that used external loading in plyometric exercises was that of Trowell et al. (2022), where 30% of body weight was carried in CMJ, DJ and Split Squat Jump. In the case of the intervention by Ramírez-Campillo et al. (2014) there is also a variation in intensity, going through 20, 40 and finally 60 cm in the height from which the DJ was performed. On the other hand, the studies by Mikkola et al. (2007) and Paavolainen

et al. (1999), chose to perform strength exercises with low loads at maximum speed, combining them with plyometrics with their own body weight and sprints of 20 to 150 m. While the participants in the studies by Saunders et al. (2006), Sedano et al. (2013) and Trowell et al. (2022), used loads of 60% in the first study and 70% of the RM in the last two, with superior improvements in the group that worked with a higher RM. On the other hand, the protocol that proposed the highest % of RM for strength training was that of Støren et al. (2008), where the subjects increased their load by 2.5 kg in the case of being able to perform one more repetition than programmed, indicating that their training was of maximum intensity with few repetitions. Therefore, regardless of the % of MR used, all subjects improved their pre-intervention values. However, according to the study by Sedano et al. (2013) it seems to be more effective to work with a moderate-high RM %, in this case 70% to optimize performance if compared to an intensity of 40%. Finally, the intervention with the longest duration was that of Sedano et al. (2013) with a total of 12 weeks with a frequency of 2 weekly sessions. In contrast, the studies of shorter duration were 6 weeks with a frequency of 2 and 2 or 3 weekly sessions in the case of Ramírez-Campillo et al. (2014) and Spurrs et al. (2003) respectively. This suggests that the minimum duration to observe improvements in performance was 6 weeks, where 2 plyometric sessions were performed weekly.

Before drawing conclusions, it is necessary to look at the characteristics of the subjects who participated in the studies, as there is great diversity. In the first place, the study by Saunders et al. (2006), since it is the only one where improvements were not significant. Possibly for a sample of highly trained athletes at a national and international level, it may take more than 9 weeks for the improvement to be significant. In addition, it is possible that the intensity (60% MR) was not sufficient, compared to the study by Sedano et al. (2013), where despite the fact that the subjects had a national competitive level, the group that worked at 70% RM for 12 weeks, obtained greater improvements compared to the rest. On the other hand, in the study by Ramírez-Campillo et al. (2014) also improved the performance of high-level athletes in less time (6 weeks) but did employ a progression of loads by tripling the plyometric intensity from 20 to 60 cm in DJ height. On the contrary, it seems that low intensity is sufficient in the case of recreational subjects (García-Pinillos et al., 2020) and adolescent subjects (Mikkola et al., 2007). This suggests the need to adjust both the duration of the training period and the intensity and other parameters of the load, depending on the level of the subjects, since the lower the level, the lower the stimulus needed to produce adaptations and vice versa.

The main limitations of the present systematic review are related to the number of studies analyzed and their sample characteristics. Although there is a large number of articles linking strength training to improved athletic performance, the availability of studies comparing strength training programs with middle-distance performance is very limited. On the other hand, most studies use a sample whose specialty within middle-distance running is inclined towards longer events such as the 3000m and 5000m, and there are no interventions that demonstrate the validity of these programs to improve performance in 800m events. Finally, it should be noted that most of the studies show low ecological validity, since they measure performance through laboratory tests that are very expensive and to which most trainers do not have access.

The main objective of this systematic review was to compare different strength training programs to improve performance in middle-distance events in athletics. It appears that strength training combined with plyometrics produces the greatest improvements in running performance. The parameters of the load must always be individualized according to the characteristics of each subject, however, the following are

some guidelines to optimize the programming of the training. This review suggests using a percentage equal to or greater than 70% RM to work strength with 2 to 4 sets of 4 to 10 repetitions. As for plyometrics, it is proposed to increase the external load progressively. This increase in load can be generated by varying any variable related to the external load such as height, number or ballast in the jumps. However, in lower-medium level subjects, lower intensity strength and/or plyometric training could be sufficient to generate adaptations that optimize sports performance. Finally, more research is needed to reaffirm these conclusions.

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https://www.mlsjournals.com/Sport-Research
ISSN: 2792-7156

(2024) MLS-Sport Research, 4(1), 33-48. doi.org/10.54716/mlssr.v4i1.2597.

TRAINING PERIODIZATION MODELS USED IN SWIMMING AND PARA SWIMMING: A REVIEW

MODELOS DE PERIODIZACIÓN DEL ENTRENAMIENTO EMPLEADOS EN LA NATACIÓN CONVENCIONAL Y PARA NATACIÓN: UNA REVISIÓN SISTEMÁTICA

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Manuscript information:

Received/Recibido: 13/02/24
Reviewed/Revisado: 05/06/24
Accepted/Aceptado: 29/06/24

Keywords:
swimming, paraswimming periodization models, adapted sports, individual sports.

ABSTRACT

This study aimed to carry up a systematic review of the literature on periodization models used in competitive swimming and paraswimming. A search was performed in electronic databases including Google Scholar, Dialnet, SportDiscus ans SciELO, following PRISMA guidelines. Inclusion criteria were: (1) studies that implemented a periodization structure or model, (2) included competitive swimmers or paraswimmers, (3) were published in scientific journals, (4) and less than 10 years old. A total of 56 potential studies were identified, of which 7 met the inclusion criteria. Of the 7 included studies, 6 were conducted with swimmers and 1 with paraswimmers. In swimming, 5 periodization models were identified: traditional periodization, ATR, inverse periodization, polarized and modeling periodization. On the other hand, in paraswimming, the traditional periodization model was used. In both sports, the periodization models used showed significant improvements in athlete performance. The results of this study show that the periodization models are effective for improving the performance of competitive swimmers and paraswimmers, however, more studies are needed to determine the effect of periodization models on athlete experience level.

Additionally, more studies are needed to determine the use of other periodization models in paraswimming.

RESUMEN

Palabras clave:
natación, para natación, modelos de periodización, deporte adaptado, deportes individuales.

El objetivo de esta investigación es realizar una revisión sistemática de la literatura acerca de los modelos de periodización empleados en la natación y la para natación en deportistas de alto rendimiento. Se realizó la búsqueda en diferentes bases de datos electrónicas como Google Académico, Dialnet, SportDiscus y SciELO, siguiendo las directrices PRISMA. Los criterios de inclusión fueron: (1) estudios que implementaran una estructura o modelo de periodización, (2) que incluyeran nadadores de nivel competitivo en Natación carreras o para natación, (3) con menos de 10 años de antigüedad, (4) publicados en revistas científicas. Se identificaron un total de 56 estudios potenciales, de los cuales 7 cumplieron con los criterios de inclusión. De los 7 estudios incluidos, 6 fueron realizados con deportistas de natación y 1 con deportistas de para natación. En la natación se evidenció 5 modelos de periodización utilizados: periodización tradicional, ATR, periodización inversa, polarizado y modelamiento, por otro lado, en la para natación, se utilizó el modelo de periodización tradicional. En ambas modalidades deportivas, los modelos de periodización empleados evidenciaron mejoras significativas en el rendimiento de los deportistas. Los resultados de esta investigación muestran que los modelos de periodización son efectivos para la mejora del rendimiento de los deportistas de natación y para natación, no obstante, son necesarios más estudios para determinar el efecto de los modelos de periodización en relación al nivel de experiencia de los deportistas. Además, se necesitan más estudios para determinar el uso de otros modelos de periodización en la para natación.

Introduction

This study aims from a literature review to explore the periodization models used in swimming and para-swimming, taking into account the theoretical foundations of different authors that support these models, providing also, an overview of the characteristics associated with each model, passing through the traditional periodization model, inverse, block, ATR, polarized, and modeling, so that coaches and sports professionals can make informed decisions regarding the periodization of training in swimming and para-swimming.

While it is true that swimming races is one of the oldest known sports, according to some historians it was present at the first modern games in Athens in 1896. According to the International Olympic Committee (IOC), swimming is both an individual and a team sport, in which swimmers propel their bodies through the water in a pool (50 m), either outdoors or indoors, using different swimming techniques such as freestyle, backstroke, breaststroke and butterfly. On the other hand, Domínguez & Saraví (2013), indicate that swimming is an individual sport in which there is no partner, adversary or uncertainty in the environment. On the other hand, this sport comprises four techniques, which, according to Astray (2014), are:

- Free: consists of the swimmer moving the arms in the air with the palm down to enter the water while the other arm moves underwater, at the same time, moving the legs in a swinging kicking motion. This is the fastest technique and the most used in the different events, being 50m, 100m, 200m, 400m, 800m, 1500m and 3000m.
- Backstroke: consists of swimming floating face up in the water, with a sequence of movements similar to the free technique.
- Breaststroke: consists of opening the arms backwards until they are in line with the shoulders above or below the surface of the water, while shrinking the legs closer to the body, with the knees and feet out, then stretching with an impulse while the arms return to the starting point.
- Butterfly: this technique is a variation of the breaststroke or breaststroke technique where both arms are brought forward over the water and then backward in a coordinated manner.

Swimming stands out as one of the oldest disciplines within the field of adapted sports, since, after the Second World War, the rates of people with physical disabilities were high, which is why adapted sports were developed and swimming, which is part of the Paralympic Games, became popular among them (Ruiz, 2011).

Currently inclusion has acquired great relevance, transcending even to sports, trying to accommodate all people regardless of their social, physical and even mental conditions, as mentioned by Forest & Pearpoint (as cited in Macías $ Gonzales, 2012) "It is a fact that people who have some kind of disability, historically have suffered some kind of marginalization and social exclusion", and further specifies that, "in the face of this trend, a large number of authors defend a society for all, that is, a society in which we are all part of it, since inclusion entails the acceptance of diversity". Thus, trying to cover especially the physical and mental aspect of the athlete, adapted sport arises, being understood according to Perez, et al. (2012), Como:

> That sport modality that is adapted to the group of people with disabilities or special health conditions, either because a series of adaptations and/or modifications have been made to facilitate the practice of those, or because the structure of the sport itself allows its practice. Thus, the different adaptations or

modifications of the sport are intended to adjust to the conditions of the athlete so that he/she can be competent.

Among the variety of existing adapted sports, para-swimming, presents various benefits, as mentioned by Catala (2015), it can help reduce both physical and psychological impairments, taking into account the social, occupational, functional, recreational benefits, in short, it helps the integral development of people with physical, visual and intellectual disabilities. This sport has been practiced since the first Paralympic Games, and it should be noted, as mentioned by Gómez & Prada (2019), that swimming is the only sport that, since its regulatory classification, groups athletes according to their ability to compete, allowing the participation of people with various disabilities, including cerebral palsy, spinal cord injuries, among others.

As indicated by the International Paralympic Committee, para-swimming emerged as a Paralympic sport in Rome 1960, which is defined as the sport modality that through adaptations of conventional swimming can be directed to people with disabilities, or in special health conditions so that they can be competent (Perez, et al., 2012). In addition, it should be noted that swimming is the only sport that groups athletes according to their ability to swim, regardless of the cause of their disability, cerebral palsy, spinal cord injury, and other disabilities (Gómez & Prada, 2019).

Thus, race swimming and para-swimming are sports that involve the athlete as a whole, so the athlete's preparation process is immersed in the use of the appropriate periodization models according to the stage of the athlete's life, in this sense González (2022) mentions that traditional periodization is still valid for athletes and is the predominant training methodology among individual sports.

In the sports field, periodization is a fundamental tool to reach the peak of the athlete's form and minimize the risk of injury, therefore, planning encompasses on the one hand making forward-looking decisions regarding the improvement and effectiveness of sports training depending on the context in which we find ourselves, whether in initiation or in high performance sports (González, Navarro, & Pereira, 2015), in the same sense, Navarro (2001) suggests that in order to achieve adaptation in the specific capabilities of each sport modality in search of maximum performance, the application of training loads should be taken into account according to their nature, magnitude, orientation and organization, which are conditioned in turn, by the individual characteristics of the athlete, the sport specialty and its respective system of competitions. In addition, it is important to highlight that within the periodization process there are several principles that support the training that the athlete fulfills, these principles are overload, progressive increase of the load, recovery, reversibility, specificity, individuality, periodization and the active and conscious participation of the athlete (Puga, 2022). Thus, the training process of athletes is conditioned by the selected periodization model, which over time affects the sports results (Beltrán Rodríguez & Agudelo, 2020).

In recent years, there has been a growing interest in the former concept of periodization; so the traditional periodization of Matveev (1977, as cited in Marques Junior, 2022) shows the logic from his concept, dividing the training process into multiple periods with variation of volume and intensity, based on the development of multiple physical abilities in an extensive period of time (Ordiñana, Cuquerella, 2018). The first period is called the preparatory period, which is divided into two stages, general preparation and special preparation, this period is characterized by the application of general loads; the second period is the competitive period, similarly, it is divided into two stages, pre-competitive and competitive, it is in this period where the athlete seeks to reach the state of sporting form and competes in competitions of minor and major

importance. Finally, the transition period, in which, through active or passive rest, the aim is to temporarily lose sporting form (Marques Junior, 2022). The duration of these periods should be adapted to the needs of today's sport so that athletes achieve an adequate sporting form for sport competition (Marques, 2022). On the other hand, in para swimming, the traditional periodization adapted by Maglischo et al., (1992, as cited in Arroyo, 2014) presents four periods denominated as follows: general resistance, specific resistance, competitive period and fine-tuning period, being one of its main characteristics the high volume of work used in the general and specific resistance periods (Arroyo, 2014).

Currently, there is a growing interest in inverse periodization as an alternative to traditional periodization. This new training model also presents the application of high volumes and low intensities, but unlike traditional periodization, the training program starts with high intensity and low volume and, in the following periods, a decrease in intensity and an increase in volume is evident, or intensity is maintained and volume is increased depending on the sport discipline (Clemente Suárez et al., 2018).

However, the increase in the number of competitions per year and the specificity within the different sports disciplines, has led to the emergence of new periodization models, among them, the block models of verkhoshansky and the ATR of Issurin and Kaverin, which present shorter preparation times (Ordiñana, 2018), where concentrated and selective loads are administered, maintaining a unilateral objective, leading the training in a single direction (Ortiz, 2016). This type of periodization has proven to be very beneficial in high performance sports, however, its use is not advised in beginner athletes, but in experienced athletes, athletes whose capabilities and results have proven to tolerate concentrated loads (Ortiz, 2016). On the other hand, modeling focuses on the training process taking into account the particular characteristics of the swimmer, his strengths, weaknesses, motivations, environment and other aspects that allow enhancing his performance towards high sporting achievements (Agudelo, 2020).

Based on the above, the present research aims to conduct a systematic review of the periodization models used in swimming and for swimming.

Method

A systematic review was carried out in order to obtain relevant information about the implementation of periodization models used in swimming and for swimming, in the electronic databases Google Scholar, SportDiscus, Dialnet and SciELO, this review was performed following the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement. The keywords used in the search were: Swimming, for swimming, periodization models, adapted sports, individual sports.

Once the search was performed, duplicate articles were eliminated, then the remaining records were filtered by title and abstract to exclude research unrelated to the objective of the study. Studies were then selected according to the following inclusion criteria:

- Publications that featured competitive level athletes in swimming and/or para-swimming.
- Studies in which a training periodization structure or model was implemented
- Studies published in scientific journals
- Studies less than 10 years old

Descriptive data were extracted from the selected studies, based on the periodization model used, the number of athletes included in the study, the duration of

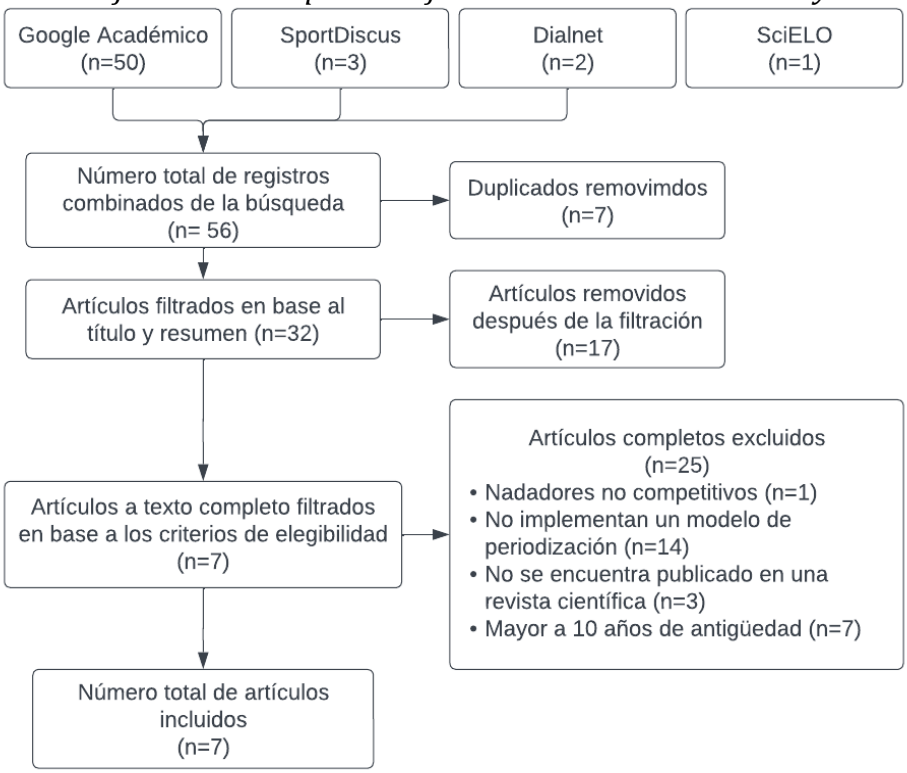
the training periodization used and the main findings once the intervention had been carried out.

Results

A total of 56 potential studies were identified after searching the databases; after elimination of duplicate studies and according to the title and abstract, 32 articles remained, of which 7 met the inclusion criteria and were therefore included in the present review (Fig. 1)

Figure 1

PRISMA flowchart of the selection process of the articles included in the systematic review



Characteristics of the studies

The characteristics of the articles are shown in Table 1. A total of 7 articles met all the inclusion criteria, of which the study by Pla, et al. (2019) presents a polarized periodization in swimming, Arroyo et al., (2021) compared the pyramidal and polarized periodization, Rodríguez & Velásquez, (2020) applied a plan by modeling, Zacca, et al. (2020) implemented a traditional training plan, Usma & Tamayo, (2022) applied a reverse periodization, while, Clemente, et al., (2018) compared traditional and reverse periodization, finally, Gonzales, et al., (2022). implemented a mixed periodization structure with a traditional and polarized training load distribution.

All studies were conducted on competitive swimmers, there were a total of 87 athletes in the included articles. six studies were conducted on swimmers without any disability, while only one study took into account a para-swimming athlete, moreover, only three studies used a control group to evaluate the implemented periodization model. The mean duration of the training interventions was 20.57±15.95 weeks, one of the studies was 28 weeks (Pla, et al., 2019), one study had a duration of 22 weeks (Rodriguez

& Velasquez, 2020), one study 12 weeks (Arroyo, Sortwell & Clemente, 2021), one study lasted 10 weeks (Clemente, et al., 2018), one study lasted 4 weeks (Usma & Tamayo, 2022), one study lasted 52 weeks (Gonzales, et al., 2022), finally, one study lasted 16 weeks (Zacca, et al., 2020).

Effects on performance

Polarized training presented a moderately greater improvement with less fatigue than threshold training in the 100 m test (0.97 % ± 1.02 %; within-group change: ± 90 % CI vs. 0.09 % ± 0.94 % respectively) (Pla, et al., 2019), likewise, compared to a pyramidal distribution, the polarized training presents a greater improvement in the 100 m test, however the pyramidal training presents a greater improvement in the 800 m test (Arroyo, Sortwell & Clemente, (2021), on the other hand, the periodization by modeling implemented by Rodríguez & Velásquez, (2020), presented significant improvements in the 100 m test compared to traditional periodization ($p < 0.05$), while Usma & Tamayo, (2022) obtained improvements in the 100 m test and in the jumping capacity of the athletes through inverse periodization, while Zacca, et al., (2020) obtained improvements in technique and swimming performance in the 400 m event, in turn, Clemente, et al, (2018), evidenced that the inverse periodization is more effective in improving VO2max in swimmers than the traditional one, however, the latter is more effective in improving technique, finally, a reverse periodization (Traditional-polarized) has shown significant improvements in strength and fitness in swimming athletes, Gonzales, et al., (2022).

Table 1
Description of the studies

Authors	Periodization model	Duration	Main findings
Pla, et al., (2019)	Polarized	22 elite junior swimmers participated in a 28-week crossover intervention study involving 2 x 6-week training periods, separated by 6 weeks.	Polarized training (POL) resulted in a moderately greater improvement in 100 m performance than threshold training (THR) with less fatigue and better recovery quality. No clear differences in physiological adaptations were observed between the groups.
Rodríguez & Velásquez, (2020).	Modeling	10 elite female swimmers participated in a 22-week modeled training plan, six sessions per week of three hours per session (experimental group) and a traditional training plan (control group) of equal duration.	They showed significant differences in the times of the 100 m crawl test between the groups that trained with the traditional plan and the periodization by modeling.
Arroyo, Sortwell & Clemente, (2021)	Pyramidal and Polarized	12 swimmers from a nationally competitive program participated in the 12-week plan. They were divided into a control group and experimental group. The control group performed a pyramidal training intensity distribution and the experimental group performed a polarized training intensity distribution.	Changes in t100c were significantly greater in polarized distribution and t800c greater in pyramidal, as well as decreases in fat mass and increases in fat-free mass.
Clemente, et al., (2018)	Inverse and traditional	17 athletes participated in two training plans, one group (N.=7) performed 10 weeks of traditional periodization (TTP) and the second (N.=10) participated in a similar period of reverse periodization (RTP).	RTP performed for 10 weeks was more effective than TTP in increasing VO2max in trained swimmers, but TTP produced greater swimming efficiency, probably due to the greater volume of technical training performed during the training program.
Usma & Tamayo, (2022)	Inverse	A swimming athlete with motor functional disability participated in a 4-week plan of traditional periodization.	The results of the program show improvements in the 4 times evaluated in 100 meters, increases in the explosive strength of the power jump and changes in the athlete's body composition.
Gonzáles, et al., (2022)	Mixed (Traditional - Polarized)	An international male swimmer participated in a 52-week plan in a traditional periodization model using three macrocycles. The training intensity distribution (TID) followed the pattern of a traditional pyramidal model in general training and polarized and threshold models during specific training before competitions.	The season was successful with substantial improvements in strength, fitness and competitive performance. Regular monitoring of both training and competitive swimming performance, power and selected physiological measures informed training decisions.
Zacca, et al., (2020)	Traditional	24 swimmers participated in a traditional 16-week macrocycle in a competitive season.	Improvements in technique had the greatest influence on swimmers' T400 performance, supported by improvements in energy (fitness) and underlying physical growth and maturation.

Discussion and conclusions

There are some descriptive studies of periodization models in the literature, such as the one conducted by Ramos et al. (2012), which was carried out with the coaches participating in the South American Games Medellin-2010, concluding that the most used periodization models were traditional, cycles, blocks and individual, although the

traditional periodization model predominates, in addition, they state that differences were recorded depending on the group of sport and the final classification of countries by gold medals. It should be noted that it was carried out for all the sports that take place in the competition, both individual and collective.

In relation to the purpose of this study, which is to identify the periodization models used in swimming training and for competitive level swimming, the periodization models used in each of the documents that make up this review are related to competitive level populations of various ages and with different application times, some applied throughout the season, others applied in different periods, however, all obtained significant improvements for their athletes.

In a review conducted by Bolaños (2020), based on the results obtained from ten studies, it is evident that the different periodization models; traditional, inverse, polarized and block, positively influence the performance of athletes in terms of improving their physical abilities, likewise, it was determined that the use of one or another periodization model depends on the objectives set, as well as the preparation time to which the athlete is subjected. However, this review does not discriminate the level of performance or experience of the athletes and did not include in its search which periodization models have been used in para-swimming. On the other hand, Galeano, Orejuela & Cardona (2023), describe the periodization models used by coaches in Valle del Cauca, in different sports modalities, finding that the periodization models most used by coaches in Valle del Cauca are the contemporary models and, of the traditional models, the one considered most valid is the classical model, proposed by Matveiev.

In relation to the results obtained from the present review, studies such as the one carried out by Zacca et al. (2020), demonstrated that, by using the traditional periodization model, improvements in technique can be obtained, which were evidenced in T400 performance. Similarly, as evidenced by Neto, et al., (2016), the effects of a linear (traditional) intensity distribution presents improvements in critical speed in well-trained young swimmers. Although the traditional periodization model has proven to be effective in training swimmers, a major limitation is its inability to obtain multiple peaks of performance during a competitive season, as required by contemporary elite sport (Ravé, 2021).

Likewise, Guerrero, Ubaque & Gómez (2021), state that the classical periodization is not the most appropriate for the training of swimmers, because in swimming it is necessary that intensity prevails over volume due to the short distance and duration of the tests, so they suggest that the ATR model is more accurate to design a training plan in elite swimmers (finswimming) since the adaptations to concentrated loads are more significant. In other research, such as that conducted by Calderón & Lozano (2017), the ATR model has been implemented, finding that after 14 weeks of the application of this model, cardiovascular adaptations are evidenced, represented in the improvement of aerobic capacity and specific swimming power, as well as improvements in aerobic and anaerobic endurance.

On the other hand, some authors have compared the benefits of traditional and inverse periodization, Clemente & Ramos (2019), indicate that inverse and traditional periodization are effective for the improvement of biomechanical, performance and physiological variables during the 2km race in triathletes, as well as in aerobic and anaerobic swimming performance. Arroyo (2011) found that after 14 weeks of training, inverse periodization was more effective for improvement in the 100m crawl than a program based on the traditional periodization model. In addition, it reduces the risk of muscle damage and MME loss (Arroyo, 2012). Likewise, Arroyo, Clemente & González (2013), compared 10 weeks of inverse and block periodization, finding improvements in

the time of the 100m race by the inverse periodization, so this model indicates a successful result in competitive performance, while block training showed a significant decrease in terms of body composition of athletes, being a good alternative for improving the body composition of swimmers. In contrast, Arroyo, (2014c) found that, in terms of 100 m crawl performance, specific swimming power (SSP) and maximum drag load (MDC), reverse periodization proved to be more effective in training sprinters, while greatly reducing the volume of the load.

Some research conducted on the implementation of inverse periodization, have shown that this type of periodization allows improvements in the time of the 100-meter races, increase in the explosive strength of the power jump and changes in the body composition of swimmers (Usma & Tamayo, 2017), as well as significant improvements in the 200 and 400-meter crawl races (Riaño & Arroyo, 2021), demonstrating the effectiveness of the application of inverse periodization. However, in the study conducted by González et al. (2022) found that reverse periodization does not provide superior improvements in swimming, running, muscular endurance, maximal strength and VO2max performance compared to traditional or block periodization.

In relation to polarized periodization, it is indicated that implementing polarized training in swimming, causes improvements in performance in the 100 m time trial, accompanied by less fatigue perceived by athletes (Pla, et al., 2018), similarly, it has been shown that polarized training intensity distributions produce improvements in swimming performance, body composition and VO2max in swimmers Arroyo, Sortwell & Clemente (2021), constituting itself as a viable alternative for the periodization of swimming training.

In contrast to the above, Sitko & Laval (2019), conducted a systematic review, in which they found that the scientific evidence indicates that a polarized training distribution is more effective in improving performance in endurance sports, such as cycling, where Rivera, et al, (2021), evidenced that in comparison with the periodization between thresholds, a polarized distribution presents significant improvements in the performance of athletes in terms of power at functional threshold (PUF) and watts per kilogram (V/kg), likewise, in the review conducted by Rosenblat, Perrotta & Vicenzino (s.f.), mention that a polarized distribution is more effective in the improvement in time trials, VOmax/peak and tests to exhaustion, compared to a distribution between thresholds, however, these show no difference in the economy of exercise.

According to the findings of this review, another possible way for swimming training is periodization by modeling, which has proven to be effective in improving the performance of swimmers, because, as evidenced by Beltrán & Agudelo (2020), there is a significant difference in the performance of the 100-meter crawl by implementing this model compared to traditional periodization. Idárraga (2021), mentions that an important aspect that leads to choose periodization by modeling is the specificity that can occur in the sport modality and the reality of situations that may not be common in sport.

On the other hand, when researching the literature on periodization models for swimming, Paralympic or adapted swimming, some related articles were found, however, very few present a periodization model, instead they present methods and methodologies. Thus, researches such as the one conducted by Reyes & Solange (2021), present analytical methods but do not present periodization models, alluding to the lack of preparation of professionals in the area. In the same line Caballero and Aguilar (2020), present a teaching methodology but do not shed any light on the periodization model. However, Gomez & Prada, (2019), in their research make use of a traditional Matveiev model, likewise, Fulton, et al., (2010), quantified the weekly intensity and volume pattern in Olympic para-swimming athletes, determining that they follow a traditional training

distribution pattern, observing high volumes at the beginning of the season with a substantial decrease as competition approaches. In addition, Querido Santos & Silva (2009), propose a classic Macrocycle, but in a superficial manner. In this sense, Oyola & Solís (2020), make a very significant contribution, although what they do is an adaptation of a training program, and recommend designing training models adapted for a greater volume of time since the experience generated, taking into account the characteristics and needs of the population, requires more time dedicated to each objective.

Finally, because the periodization of training remains in constant change, due to the high standards and modern competitiveness that occur in sport today (Camacho, Ochoa & Rincón, 2019), it is the job of coaches to choose the periodization model that best fits the demands of the sport, as well as the needs of the athletes.

The present review, has allowed to attend from the literature, on the models of periodization in Swimming races and for swimming of high performance, configuring in completion of the level of sport specialization and mastery of the same; carrying out searches in different databases, following the PRISMA guidelines. As a result, only seven (7) studies were found that met the inclusion criteria. In these studies, it has been shown that the periodization models used in swimming races are the traditional, polarized, modeling and inverse model, and in swimming the traditional model was used, according to its competition system. Based on the above, it is possible to conclude that there is a need to expand the investigation of periodization models in the sport of para-swimming, in order to evaluate the relationship between periodization models and athletes' performance experience, as well as to explore the application of other models in this emerging field of study.

This study analyzed, based on previous research, the periodization models used in swimming races and para-swimming, taking into account the research carried out in this context, the use of traditional, polarized, modeling and inverse models was observed, in which it is evident that the traditional model is present in the authors' discussions. In general, it can be concluded that the models applied in the different studies provided significant improvements in their respective populations. Even though the researches include competitive level athletes, they do not express in detail the level of experience in the sport of each athlete.

As for the para-swimming, the periodization model used is the traditional one, demonstrating improvements in T400 performance with the adjustment of loads from the traditional theory, during a period of 52 weeks, which makes it have a tune-up for the main competition. This study has shown that the choice of a traditional periodization should obey the achievement of the peak of form in competition, which indicates that in this case they did not have a high competition system for their tuning. Although traditional periodization has proven to be effective in swimming athletes, there is little information in this regard, so it is unknown whether the application of other periodization models can also provide improvements in the performance of athletes.

Limitations

A number of important limitations need to be considered in the present review. In the first place, a greater number of studies in conventional swimming races was evidenced. Secondly, in the for swimming only one study was found against performance, which allows addressing the research interest itself on the effects of classical, contemporary or emerging periodization models. Thirdly, an issue that is not addressed is the one referred to load undulation, since it is mainly specified on periodization, so it is clear that it focuses on the effects of models already studied in terms of weekly volume; in short, it remains a challenge to solve variables in load, model and performance reviews.

Continuity proposals

It is recommended that research be undertaken in the areas of Paralympic sport, since there is little evidence on the periodization models used in para-swimming; the analysis of loads versus the applied model, the distribution or periodization of the load from the theorization of the model to be applied, since the lack of research in this field limits to discuss broadly on the models used in Paralympic swimming, in each of its classifications.

Despite certain limitations mentioned above, this study helps swimming and para-swimming coaches to take into account when planning their competitive calendar, the theory of the model they are going to follow and the performance implications according to their discipline, i.e., whether it is swimming races or para-swimming, since the model has its own characteristics of design, application and distribution of training loads.

The results of this review have a series of important implications for the future practice of periodization in swimming races and para-swimming, such as the fine-tuning with the approach of the theory and scientific review of the same. It is also evident that field diaries of practical findings and veracity of the load must be kept to identify whether the correct model is being addressed or whether another should be addressed from the performance point of view, all to seek fine-tuning in the context in which the model is being applied.

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ISSN: 2792-7156

(2024) MLS-Sport Research, 4(1), 49-61. doi.org/10.54716/mlssr.v4i1.2777.

THE TEACHING OF PHYSICAL EDUCATION IN THE PANDEMIC PERIOD (SARS-COV-2): A CASE STUDY AT THE FEDERAL INSTITUTE OF TRIÂNGULO MINEIRO – IFTM

O ENSINO DA EDUCAÇÃO FÍSICA NO PERÍODO PANDÊMICO (SARS-COV-2): UM ESTUDO DE CASO NO INSTITUTO FEDERAL DO TRIÂNGULO MINEIRO – IFTM

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DE CASO NO INSTITUTO FEDERAL DO TRIÂNGULO MINEIRO – IFTM

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Manuscript information:

Received/Recibido: 23/04/24
Reviewed/Revisado: 05/06/24
Accepted/Aceptado: 08/07/24

Keywords: professional and technological education, physical education, pandemic, precariousness, remote teaching.

ABSTRACT

This work aims to present a study on the teaching of Physical Education mediated by videoconferencing platforms during the pandemic period (sars-cov-2), in Technical High School Integrated to High School, at the Federal Institute of Triângulo Mineiro – IFTM. Therefore, aiming to verify, through teaching discourse, possible pedagogical solutions, or not, in this scenario, with regard to the aforementioned discipline. In turn, the methodological instruments are based on a case study, carried out through interviews with eight (8) Physical Education teachers, from eight (8) IFTM campuses, using French discourse analysis as a basis. theory for discussion of the data, under the approval opinion of CEP number 6,055,812. Given this, we conclude that classes in the aforementioned discipline, mediated by videoconferencing platforms, generated a series of vulnerabilities, which made Physical Education classes precarious. It is clear that, although remote teaching has been a viable solution, it will never replace face-to-face teaching and that, consequently, it is necessary to be very careful, post-pandemic, when using and trying to replace this with that, given that remote activities do not offer the same quality offered by in-person education and should only be an aid to face-to-face education.

Palavras-chave: educação profissional e tecnológica, educação física, pandemia, precarização, ensino remoto.

RESUMO

Este trabalho visa a apresentar um estudo sobre o ensino da Educação Física mediado pelas plataformas de videoconferências durante o período pandêmico (sars-cov-2), no Ensino Médio Técnico Integrado ao Ensino Médio, do Instituto Federal do Triângulo Mineiro – IFTM. Objetivando, portanto, verificar, por meio do discurso docente, possíveis soluções pedagógicas, ou não, nesse cenário, no que concerne à referida disciplina. Por sua vez, os instrumentos metodológicos baseiam-se em um estudo de caso,

realizado por intermédio de entrevistas com oito (8) docentes de Educação Física, de oito (8) campi do IFTM, tendo a análise do discurso de linha Francesa como lastro teórico para discussão dos dados, sob o parecer de aprovação do CEP de número 6.055.812. Visto isso, concluímos que as aulas da disciplina mencionada, mediadas pelas plataformas de videoconferência, geraram uma série de vulnerabilidades, que vieram por precarizar as aulas de Educação Física. Ficando claro que, apesar do ensino remoto ter sido uma solução viável, ela jamais substituirá o ensino presencial e que, consequentemente e que, consequentemente, é preciso ter muito cuidado, no pós-pandemia, ao utilizar e tentar substituir este por aquele, posto que as atividades remotas não oferecem a mesma qualidade ofertada pela educação presencial, devendo ser apenas uma auxiliadora à educação presencial.

RESUMEN

Palabras clave:
educación profesional y tecnológica, educación física, pandemia, precariedad, enseñanza remota.

Este trabajo tiene como objetivo presentar un estudio sobre la enseñanza de la Educación Física mediada por plataformas de videoconferencia durante el período de pandemia (sars-cov-2), en la Escuela Técnica Superior Integrada a la Enseñanza Media, del Instituto Federal del Triângulo Mineiro – IFTM. Por tanto, pretendiendo verificar, a través del discurso docente, posibles soluciones pedagógicas, o no, en este escenario, con respecto a la referida disciplina. A su vez, los instrumentos metodológicos se basan en un estudio de caso, realizado a través de entrevistas a ocho (8) docentes de Educación Física, de ocho (8) campus del IFTM, utilizando como base el análisis del discurso francés y la teoría para la discusión de los datos, bajo el dictamen de aprobación del CEP número 6.055.812. Ante esto, concluimos que las clases de la disciplina antes mencionada, mediadas por plataformas de videoconferencia, generaron una serie de vulnerabilidades, que precarizaron las clases de Educación Física. Está claro que, si bien la enseñanza a distancia ha sido una solución viable, nunca sustituirá a la presencial y que, en consecuencia, hay que tener mucho cuidado, pospandemia, a la hora de utilizar e intentar sustituir esta por aquella. , dado que las actividades remotas no ofrecen la misma calidad que ofrece la educación presencial, y sólo debería ser una ayuda a la educación presencial.

Introduction

The SARS-CoV-2 pandemic, also known as COVID-19, began on December 31, 2019, when the first case was reported in Wuhan, Hubei province, China. The disease spread rapidly throughout the country and to other parts of the world in a short period of time, generating uncertainty, fear and killing millions of people. On January 30, 2020, the World Health Organization (WHO) declared the SARS-CoV-2 outbreak a Public Health Emergency of International Concern (PHEIC), due to its rapid spread, severity and pandemic potential . ESPII is theWHO's highest alert level, declared when a disease outbreak is considered aninternational risk. On March 11, 2020, the Pan American Health Organization (PAHO) declared the disease caused by the new coronavirus a pandemic and recommended that cities and countries with higher rates of cases and deaths implement social distancing measures, such as closing schools, businesses, and public events. These measures were considered to be the most effective strategies to prevent the spread of the virus and save lives, as to date there have been no treatments or vaccines proven to be effective against COVID-19 (Florêncio Júnior et al., 2020).

As a result, many governments took unprecedented action to contain the spread of the pandemic, such as quarantines and lockdowns. In addition, factories, schools, universities, shops, offices, clubs and spaces for physical exercise were closed, as well as the suspension of cultural and social activities, since, in modern history, a health problem has never had such a categorical impact on society (Broucke, 2020). As a result, many people have had to work from home, adopting home-office jobs, which has led to significant changes in the way people (con)live. We can call this "[...] new format remote teaching, a form of teaching that uses synchronous communication tools (in real time) with the aim of reproducing what is done in person" (Nunes; Amorim; Caldas, 2020, p. 46).

In this way, the use of digital platforms and videoconferencing (remote learning) was a viable solution for maintaining and sustaining education, as it allowed children and young people to continue learning even during the pandemic. However, there were a number of challenges. It's enough to see that many schools, especially public ones, didn't have the right infrastructure for this modality, creating a number of challenges.

Not surprisingly, these challenges have made remote learning more difficult and less effective in many educational institutions, even though it has been the best option available, quickly, to prevent students from losing an academic year. However, taking into account that the right to quality education was not lost in the meantime, and bearing in mind that the right to regular education is a constitutional guideline, provided for in Art. 208, III of the Federal Constitution, schools adapted and sought new horizons, in an attempt to minimize the damage caused by the pandemic as much as possible. After all, for Paulo Freire (1992), education is not limited to a mere transmission of knowledge, a simple "depositing" of content that the students are left to make up in their heads.

In this sense, Physical Education emerges as an ally in this humanizing process, since its classes, through the practice of sport, encourage the development of essential skills for a healthier life, physically and socially, stimulate team spirit and help with students' cognition and emotions. In line with this, De Marco (1995, p.77) states that Physical Education is a privileged educational space for promoting interpersonal relationships, self-esteem and self-confidence, valuing what each person is capable of doing according to their personal possibilities and limitations. It is therefore one of the curricular components and essential skills for primary and secondary education.

As a school subject, Physical Education should approach bodily practices according

to the different forms of social expression, since human movement characterizes cultural aspects, and classes should enable students to build a body of knowledge about their movements, in order to develop autonomy over body culture for the care of themselves and others (Brazil, 2018). This, as recommended by the National Curriculum Parameters (PCN's), without losing sight of its articulation with other school practices, such as: the organization of spaces and times, regulations, content, teaching methodologies, among others (Brasil, 1998).

However, with the outbreak of the pandemic and, consequently, the suspension of face-to-face classes, teachers, including Physical Education teachers, started using videoconferencing platforms, with the aim of trying to maintain as much of the experience of the face-to-face model as possible. Although not perfect, these platforms have allowed teachers to continue teaching and students to continue learning.

We mustn't forget that the transition from face-to-face to remote learning has been rapid, requiring an almost immediate response. Increasing the already great challenges facing Brazilian education. This situation generated shared feelings of insecurity, anxiety and fear among the teachers, as they had to adapt to new methodologies in order to carry out their daily work. Added to this context of insecurity is the difficulty of accessing the internet. According to the United Nations Children's Fund (UNICEF), 4.8 million pupils between the ages of 9 and 17 do not have access to the internet. This makes remote learning far from the reality of a large proportion of Brazilians (Tokarnia, 2020).

As far as the IFTM is concerned, in view of the pandemic reality, Resolution 33/2020 was published on July 9, 2020, which regulated remote activity within each *campus*. This was an important step in adapting teaching and learning, as it allowed classes to be taught remotely using digital technologies. Thus, virtual classrooms were created on the *Google Classroom* platform for all high school and college classes.

Thus, the scope of analyzing this experience mediated by videoconferencing platforms during the pandemic period, through the discourse of teachers, here with the focus on Physical Education classes, in IFTM's Integrated Technical High School, is justified, as it sheds light on possible contributions to education, work, science and technology.

Method

This work is characterized as field research based on a case study methodological approach, with a qualitative and descriptive approach. The locus of the research was the IFTM, an educational institution with 9 (nine) campuses spread across the Triângulo Mineiro. However, it focused on 8 (eight) of these 9 (nine) campuses, with Campina Verde being left out, given its classification as an advanced campus and the fact that it does not offer regular high school in its curriculum, but only subsequent (concurrent) courses. Data was collected through semi-structured interviews, using a questionnaire with 9 questions. The interviews were recorded on a laptop connected to the internet and then transcribed and interpreted using Discourse Analysis. The interviews were transcribed using the TransKriptor mobile application and the speeches reread to identify and organize the topics presented. All the data was transcribed reliably, individually, question by question, without mentioning their identity or any other information that could identify them.

Results and discussion

Question 1: During the process of implementing remote learning at the beginning of the pandemic, did your campus offer support to develop it? If not, what are the main difficulties encountered?

We began our research with the first part of question number 1, which deals with the implementation of remote classes at the beginning of the pandemic. When asked about this proposition, most of the interviewees were adamant that there was little or no support to start working remotely:

> The campus didn't offer anything, in fact, the internet was on us, the computer was on us, what happened was that they, the campus, stopped for a week that was for the pedagogical part and management to set up a scheme for the students to have online classes and then a series of difficulties began, but not so much for the teacher, more for the student (Interviewee no. 2, 2023).

These first statements already show the helpless reality of Brazilian education, forcing the teachers themselves to organize on their own amid the neglect of the government.

> And I remember that we had a meeting, if I'm not mistaken, on a Wednesday, saying that we were going to suspend face-to-face classes and that from then on everything would be done through Meet. And that's it, there was no preparation, there was nothing. The only thing that happened was the presentation of Google Meet and Google Classroom and so, look, this is how it's going to be and we'll get on with it. It was just like that. I personally didn't have any support (Interviewee 5, 2023).

In addition, the passage "look, it's going to be like this and get on with it and everyone can manage" clearly shows us what happened and what always happens to teachers who want to find new and better ways of teaching, they have to manage on their own and the pandemic was no different.

As for the second part of the first question, about the main difficulties encountered if the campus hadn't offered support, see the following excerpt:

> The biggest difficulty was staying at home. So everyone had to make do. The support offered by the institution was practically zero (Interviewee no. 3, 2023).

Another important point mentioned here, "the biggest difficulty was staying at home", well, teaching from home, with children, parents, grandparents, was something totally new. When you're at school, it's you and the students. You don't have to worry about answering a small child's call, giving medicine to elderly grandparents, answering the bell in the middle of a remote class. A new reality that may have led to a drop in teacher and student performance:

> But the system used there made me suffer even more, because I was returning to teaching. So I didn't know anything about the system that worked at the IFTM, it was all a learning experience. My colleagues helped out in Meet meetings, where they shared screens (Interviewee no. 8, 2023).

In the passage, "I suffered even more": the word or expression "sofri" from the verb sofrer, is a way for the teacher to express/demonstrate his emotions and feelings. He's showing that he had a difficult experience and had to work hard to learn the system. In this other fragment, "it was all a learning experience" is the teacher's way of re-evaluating his experiences. He shows that, even though remote learning was difficult, he managed to learn the system and overcome the challenges, and by quoting "helping", he shows gratitude to those who helped him and how important they were in this process.

Question 2: Which platforms were used during this period? And what difficulties have you encountered in using them?

Most of the interviewees, or almost all of them, used Google Meet as the main tool for running their classes, along with Google Classroom. According to the Brazilian Internet

Steering Committee (CGI.br, 2019a), one of the most widely used tools has been WhatsApp, but education requires much more than rapid communication.

> The platforms we had access to were Classroom, first, and Meet. These were the ones I was given, so I wasn't given any instructions on how to use it, just how to access it. The rest came from researching YouTube videos. But, at first, it was just these tools (Interviewee no. 1, 2023).
>
> Little by little we extend what that tool is, right? And then we also internalize it and get used to it. The main platform was Meet, but I used, I can't remember off the top of my head, but anyway, gaming platforms, online games, we used TikTok, Instagram, Youtube. I think those were the ones I remember now (Interviewee 5, 2023).

When quoting the fragments, "a gente vai entendendo" and "e vai se habituando", the idea of extending the understanding of the tool and getting used to it, suggests a process of adaptation and continuous learning that the teachers experienced, reflecting a power dynamic in which teachers seek to master these technologies, which was a recurring fact throughout remote teaching, mentioned by all the teachers interviewed.

The second part of the second question was related to the difficulties encountered by the interviewees in using the platforms they mentioned:

> The difficulties encountered depend on the first answer or question: several times, I had to search YouTube, for example, to find out how to record a lesson, I didn't even know the Google platform, so I had to learn how to create questionnaires, reports and forms, which wasn't very common in my day-to-day life. And so, I remember that the tests, the activities, were supposed to be done like this, like this, and I wasn't very used to it. And then, several times, we had to study these tools on our own to learn how to use them (Interviewee no. 1, 2023).

This statement, "several times, I had to search YouTube, for example, to find out how to record the lesson, I didn't even know the Google platform, so I had to learn how to create questionnaires, reports, forms, which wasn't very common in my day-to-day life," makes us reflect on how this lack of preparation on the part of the teacher may have reflected on the content that reached the students. Despite all the difficulties, did it arrive in a clear and accessible way? This brings us back to the problems of Brazilian education, which does not train its teachers to perform their duties in the best possible way

Question 3: Have you had connection problems? Did the students have connection problems? How was this resolved?

In this question, we observed that there was a big difference between teachers and a significant part of the students, given that the interviewees only had connection problems due to a failure in the internet providers or for natural reasons, such as a power outage in the city due to heavy rain, for example:

> Ah! I've had very few problems, my internet, let's put it in context, in my town there isn't very good internet. The internet in the city isn't the best, but it works. I had good internet at home and a few times I had problems. I think there was only one time when I really couldn't access it, but it wasn't just me. Kind of a generalized problem (Interviewee 5, 2023).

In the fragment, "but it wasn't just me. Like, a kind of generalized problem," it became clear that it wasn't a problem that only she faced, other teachers also faced it, the students faced it, the campus faced it. Here, a dynamic of solidarity is created by suggesting that the teacher was not alone in facing specific difficulties. This perception of a shared problem can influence the way technological issues are perceived socially, since everyone involved in the education process during the pandemic was affected.

> Many of the children didn't have access to the internet, at home, for example! (Interviewee no. 5, 2023).
>
> Some students did have problems, getting connected and everything (Interviewee no. 4,

2023).

When asked what had been done to solve the problems of students not having access to the internet, the answers were very diverse, but unanimous in pointing out that, despite all the difficulties, almost all campuses had taken steps to try to minimize and circumvent this situation.

> The campus, I think the whole institute, had a call for proposals for support, equipment loans, aid for students to have access, but I don't know exactly what the issues were at my institute, because this wasn't communicated much either, it was resolved between the management and student assistance. And this wasn't very publicized, but I believe it was through these criteria (Interviewee no. 5, 2023).
>
> And those who didn't, I'd send them the recording after class. I don't know if they watched it afterwards too. I created some forms of evaluation, I asked questions afterwards, but it was very precarious, very difficult (Interviewee no. 3, 2023).

This passage draws our attention: "I don't know if they watched it afterwards too". Did the students watch the lessons that were recorded on the platforms? Did they really watch it in order to answer the evaluation questionnaires? Or did they go to their classmates, who had already done the activities and attended the lesson that day, to get the ready-made answers to copy down?

Question 4: What methodologies or resources were used during this period?

Following on from the interview, question number 4 (four) shows us the reality of what the classes were like and what methodologies the interviewees used to pass on their content. From the perspective of remote teaching, the use of such methods can contribute to more dynamic proposals, in order to motivate and involve students in the subject to be worked on, thus favoring meaningful learning (Piffero, Soares, Coelho & Roehrs, 2020).

> Each one used a different methodology, and at first I thought: how was I going to get it across to the students? Because I knew about this difficulty and another issue, they needed physical activity. That's why they were closed, something they were going to do. And this question of timetables, right! So you have to keep a timetable, because sometimes the child uses his father's or mother's equipment, and if you were to set a timetable it could be difficult. I thought! I put the activities in the Classroom described how they should do them, thinking that they could have a very small environment, an apartment, a small house that they could do. So I paid a lot of attention to exercise (Interviewee no. 8, 2023).

Well, "everyone used a different methodology". Mentioning this fact shows the variety of methodologies used and highlights the plurality of approaches in educational practice. This can be interpreted as an expression of the teacher's freedom to choose teaching methods that suit the needs of the students, or the disorganization of the campuses in being able to adapt a single way to meet everyone's needs. However, in a broad educational system such as the IFTM's, did using one methodology work? Doesn't it get too loose and uncontrolled? This was the only response of this type, all the others answered that they had a more well-defined direction of action in this period.

Question 5: You believe that the use of these resources has been beneficial: In what way? Explain further.

For some of the interviewees, it has been beneficial for teachers, as they have learned to use tools that they were not used to and that can help a lot in post-pandemic teaching. However:

> In general, I think it was worse for the students, because they didn't manage to acquire the content, the knowledge they needed to have acquired during these years of the pandemic (Interviewee no. 4, 2023).

Interviewee No. 4's statement, "it was worse for the student, because he couldn't acquire the content, the knowledge he needed to have acquired during these years of the pandemic", highlights the perceived difficulty in assimilating the necessary information,

which suggests a critical evaluation of the educational process during the pandemic, pointing to possible deficiencies in remote teaching and the use of the term "years" suggests a continuity and worsening of the problems over time, highlighting the complexity and persistence of the difficulties faced by the students.

For the others, the majority of those interviewed, it was beneficial, taking into account that it was the best they had for the moment:

> I think it was beneficial, because we didn't have much choice, right? So, between having the option and not having it, because this student isn't dazzled by any of the content, we had the option of doing nothing, right! It's not developing anything related to teaching, teaching is our flagship. So, I believe that the resource was beneficial both for the teacher, who was able to develop his work, even if it wasn't as good as it used to be, but he did develop, right! And the boys didn't even miss the school year. So I think it was beneficial in that sense. Both for the student and the teacher. (Interviewee no. 6, 2023).

In the passage, "we didn't have much choice", it suggests the existence of limited conditions during the pandemic, historically already mentioned and previously reported the lack of structure, support and knowledge by teachers, which can be interpreted as a context that required routine choices. This highlights the relationship between external circumstances and the decisions made in response to these conditions and the comparison between "having a choice and not having one" highlights the dichotomy between the possibility of choice and the lack of alternatives. The choice between "doing nothing" and adopting remote teaching is presented as a necessary decision, considering the priority given to teaching.

Question 6: What were the biggest disadvantages of using videoconferencing platforms in this process, especially with regard to teaching Physical Education?

In general terms, the interviewees reported social issues, such as socialization, interaction and interaction that Physical Education makes possible for students. This demonstrates the lack of Physical Education being carried out in its usual spaces before the pandemic and, above all, the lack of practice of the activities taught for the discipline:

> In relation to the teaching of Physical Education, it's the lack of contact, because Physical Education is very much about contact, about being close to the student, being with the student, observing what they're doing, what they're feeling and I believe that online we can't do that. It's practically impossible (Interviewee 3, 2023).

In this vein, the fragment, "we can't do this online", highlights the intrinsic limitations of distance learning in the area of Physical Education and suggests an incompatibility between practical needs and the virtual nature of the online environment. By mentioning that "It's practically impossible", it highlights the real complexity of reproducing physical contact and face-to-face interaction in the online modality. This impossibility is presented as a practical barrier and not just a methodological choice, a common occurrence for Physical Education in the remote period.

> [...] nothing replaces practice, right, Arthur! So, the lack of practice, of the interaction between teacher and student, man, it's very difficult. Teaching Physical Education at a distance wasn't easy, so I think that was the main thing (Interviewee no. 2, 2023).

The passage quoted by interviewee no. 2, "nothing replaces practice", mirrors the recognition of practical and corporal experience in the teaching of Physical Education in person. This suggests an appreciation of the physical and experiential dimension of the subject, highlighting the importance of the students' direct involvement in practical activities and the expression "lack of the practical part, of the teacher and student interaction" emphasizes the importance of the personal relationship between teacher and student in Physical Education. This highlights the relational dimension and the need for close contact for effective discipline education. Contrary to this, we have Physical

Education in a remote way, which means that this is lost and cannot be achieved.

Question 7: You found it difficult to deal with these pedagogical practices: Tell us more about it. Could you explain in what sense?

Most of the interviewees said that they did have many difficulties in using, applying and learning these tools, which were now their means of teaching:

> And my main difficulties were also looking for the main content that I could work on there, because there was content that I didn't think I could explain, or even put into practice for the students, or if I did, it would be something very artificial. So, for me, the main difficulties, apart from having trouble working with the platforms, which was something I had a lot of trouble with, working with tools that could facilitate or even improve the lesson, I took a while to understand some of them (Interviewee no. 1, 2023).

This part of interviewee no. 1, "or if I approached it, it would be something very artificial," is noteworthy, as it brings us back to the precariousness of education and its professionals.

> Too much, I didn't know how to do anything. My business was teaching on the court, my business was practical, my class was 100% practical and then out of the blue it went 100% online. So I had a hard time learning how to use the tools (Interviewee 2, 2023).

"My business was teaching on the court, my business was practical," shows the practical, face-to-face nature of teaching before the transition to the online format. This contrast emphasizes the abrupt and challenging change in the teacher's pedagogical approach and "out of the blue she went 100% online" highlights the lack of preparation or anticipation for the transition from face-to-face teaching to the online format. This highlights the unexpected difficulties faced by teachers when adapting to a completely different teaching method. On the other hand, the passages "my business was practical" and "my classes were 100% practical" suggest an appreciation of face-to-face and practical experience in teaching Physical Education. This emphasis underscores the significant impact of change in the learning environment

Question 8: Do you believe that the remote classes provided the same quality as the face-to-face classes? Why? Can you give examples?

On this question, there was unanimity in saying no, especially when thinking about the specificities of Physical Education, i.e. the need for contact, doing, learning by doing, experiencing what you are learning in practice.

> Well, I don't think it's the same quality under any circumstances. [...] so, for me, this doesn't equal the quality of face-to-face classes in any way. For Physical Education, we see to this day how students have lost these motor skills. So there's no way we can compare, because it was practically two years that these students didn't move, and for Physical Education, it was totally different. So, I think that in terms of quality, it's totally disproportionate (Interviewee no. 1, 2023).

The expression quoted, "I don't think it has the same quality under any circumstances", reflects the perceived inequality between face-to-face and remote learning. This statement indicates a critical evaluation, suggesting that the online format does not meet the quality standards set by face-to-face teaching, and the statement "there's no way we can compare" suggests an intrinsic inequality when comparing the results of face-to-face and remote teaching. The complexity of Physical Education is emphasized, highlighting the unique difficulties faced by this subject during the remote teaching period.

> No. Not at all. [...], what I said, lack of contact, lost socialization, right! For example, you can't tell if the student is doing an activity or not, especially because it's a physical activity (Interviewee no. 3, 2023).

Thus, the absence of the students' bodies in class provoked a variety of emotions, since the teachers, feeling the lack of physical contact, believed that Physical Education

was losing its identity (Varea; González-Calvo, 2020). Identity characterized precisely by bodily experiences and experimentation (Machado et al. 2020; Lazzarotti Filho et al., 2015) of movement.

Question 9: How did you work on practical physical activities? In your view, how much has been lost from these practical activities in remote teaching?

This question helped us understand how creative the teachers tried to be, despite all the setbacks, in order to serve the student in the best possible way:

> For example, in the practical part, I would work on stretching and I would take them on walks, even if these walks were done in their own home, in the backyard and so on. I also passed on a few things about strength exercises, using your own body, calisthenics and so on, but that was it (Interviewee no. 3, 2023).

Regarding the passage "and he would take them for walks, even if they were in their own home, in the backyard and so on", this highlights the importance attributed to movement and attention to the body, central elements in Physical Education. Furthermore, I wonder if the students were able to do these walks at home? After all, did their homes have enough space to go for a walk? Did they have a yard at home? Anyway, obviously the intention was interesting, but we can't know if it was really feasible.

> They no longer had Physical Education, which is a subject that promotes this. So they've lost a lot of this contact with each other, body to body, skin to skin, developing patience, this interaction of laughing. So, it was something that remote teaching couldn't provide, in addition to the practice promoted by Physical Education (Interviewee no. 1, 2023).

With regard to the fragment, "they no longer had Physical Education, which is a subject that promotes this", he referred us to the problem of sedentary lifestyles. The only reason many students don't qualify as sedentary, according to the World Health Organization (WHO), is because they do a few minutes of physical exercise every week in PE classes. Let's remember that a sedentary lifestyle goes hand in hand with illness, such as diabetes, depression, high blood pressure, etc. As a result, the pandemic has not only affected education and the economy, but also our own health.

Conclusion

In light of what has been discussed in the theoretical topics and, above all, in the presentation and discussion of the data obtained in the interviews, it is clear that, despite the efforts made by each IFTM *campus,* it was ultimately up to the teachers to reinvent themselves pedagogically in their daily lives, with the aim of helping students not to miss the school year during the covid-19 pandemic. Especially in the case of Physical Education and its inherently practical nature, with movement as its object, whether through dance, fighting, sport, etc. Not surprisingly, the strategies adopted against this mismatch between the ideal and the real imposed were many, from walks in their own homes, to setting up games, to audio and video assignments.

In this regard, it should be noted that the few training courses that were sometimes offered to teachers were one-off and very quick, and did not provide a truly welcoming and learning environment. Even those focused on technological issues were often limited to teaching mere access, without actually exploring the tools. Thus contributing to the advance of the precariousness of Brazilian education in an uberized contemporary (Silvia, 2020). In an increasingly digital society, not training teachers to work minimally with technological tools is a step backwards. After all, it's not uncommon to find educators with a vast theoretical and didactic background, but who fall short when it comes to videoconferencing platforms, as an example. In this respect, I believe that the roles are

reversed, as students tend to master these technologies more quickly and naturally.

By the way, speaking of students, several of the interviewees made it clear that the institutes' support for them was better planned and applied. It is enough to see that there were, in general terms, loans of electronic equipment, cell phone plans, scholarship notices, printing of handouts, among other actions led by the Student Assistance sector of each *campus*. Obviously, these are more than assertive actions, given the known socio-economic vulnerability of some of our students.

It comes as no surprise, then, that many of the reports brought to light by this investigation are in line with a completely overburdened working class. In the words of one of the interviewees, teachers have suddenly become *youtubers*, since they need to master video recording, editing and posting tools in addition to the theoretical content. Not to mention the stress caused by the new working environment that suddenly invaded our homes, causing us to share classes with parents, children, grandparents and their own demands. There was no longer a clear difference between work and leisure, public and private life. Not dissimilarly, our fragile students sometimes have to share a cell phone screen with their siblings in order to keep up with the content. Both in the face of all the uncertainties and changes caused by the pandemic. A frightening situation which, if not dealt with by professionals, tends to lead to anxiety and depression, for example.

In addition, the interviewees' statements made it clear that, from a methodological point of view, the *Google Meet* and *Classroom*tools, the latter used as an environment for posting asynchronous classes, assessment activities and their corrections, and the latter for teaching synchronous classes, were unanimous among the teachers. Although, as colleagues have commented, many of the students didn't turn on their cameras during lessons using these platforms, making it even more difficult to achieve the closeness that a teaching-learning relationship requires, even to provide feedback, such as in the case of doubts.

It must be said that it was also clear that there was a lack of coordinated general guidance from the IFTM, to the extent that on some *campuses* synchronous classes were compulsory, even following the same days and times as before, while on others they were not, as they considered this model to be exhaustive. Despite the freedom to adapt to the heterogeneous reality of each *campus*, I wonder how this scenario may have echoed in distorted and erroneous internal information. After all, the teachers communicated with each other, even with the aim of exchanging experiences and answering questions, but the formats were different.

Regarding the impact of the pandemic specifically on Physical Education classes, it was evident that, despite the efforts already mentioned by educators, the main areas affected by the lack of frequent physical exercise were: socialization, affectivity and motor development. Consequently, in a nutshell, quality of life has been lost and sedentary lifestyles have been gained, i.e. higher numbers of obesity, depression, high blood pressure, etc. So, at least as far as Physical Education is concerned, we argue that remote teaching can be an additional tool to add to the multifaceted day-to-day of education, however, due to the scope of this discipline, it does not replace face-to-face teaching in any way. This corroborates what was reported in the interviews in this study.

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