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Training Methods of Long-Distance Runners for 5-10 Km Competitions: A Bibliometric Analysis

Métodos de entrenamiento de corredores de larga distancia para competencias de 5 a 10 km: análisis bibliométrico

Métodos de treinamento de corredores de longa distância para competições de 5 a 10 km: análise bibliométrica

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ABSTRACT

This study aimed to map the scientific production on training methods for 5 to 10 km long-distance running by means of a bibliometric analysis. PubMed, SciELO and Lilacs databases were used, and data were collected until December 31, 2019. The analysis included experimental studies with the intervention of training methods in runners. Data were analyzed descriptively. It was found that the first article was published in 1981 and 2018 was the year with the highest number of publications. The United States was the country with the highest number of publications, authors and journals. The most frequently cited methods were continuous execution and interval execution. Consequently, the main results were an increase in running economy, VO_2max and a reduction in time trial.

KEYWORDS: Endurance training, running economy, time trial, training program, VO_2max.

RESUMEN

El objetivo de este estudio fue mapear la producción científica sobre métodos de entrenamiento para carreras de larga distancia de 5 a 10 km, mediante un análisis bibliométrico. Se usaron las bases de datos PubMed, SciELO y Lilacs, y se recolectaron datos hasta el 31 de diciembre de 2019. El análisis incluyó estudios experimentales con la intervención de métodos de entrenamiento en corredores. Los datos se analizaron de forma descriptiva. Se encontró que el primer trabajo fue publicado en 1981 y que 2018 fue el año con mayor número de publicaciones. Estados Unidos tuvo el mayor número de publicaciones, autores y revistas. Los métodos más citados fueron la ejecución continua y la ejecución a intervalos. Por consiguiente, los principales hallazgos fueron un aumento en la economía de carrera, el VO_2max y la reducción de la contrarreloj.

PALABRAS CLAVE: entrenamiento de resistencia, economía de carrera, contrarreloj, programa de entrenamiento, VO_2max.

RESUMO

O objetivo deste estudo foi mapear a produção científica sobre métodos de treinamento para corridas de longa distância de 5 a 10 km por meio de uma análise bibliométrica. Foram utilizadas as bases de dados PubMed, SciELO e Lilacs, e os dados foram coletados até 31 de dezembro de 2019. A análise incluiu estudos experimentais com a intervenção de métodos de treinamento em corredores. Os dados foram analisados de forma descritiva. Verificou-se que o primeiro artigo foi publicado em 1981 e que 2018 foi o ano com o maior número de publicações. Os Estados Unidos foram o país com o maior número de publicações, autores e jornais. Os métodos citados com mais frequência foram a corrida contínua e a corrida intervalada. Consequentemente, os principais resultados foram um aumento na economia de corrida, VO_2max e uma redução no tempo de corrida.

PALAVRAS-CHAVE: treinamento de resistência, economia de corrida, contrarrelógio, programa de treinamento, VO_2max.

INTRODUCTION

Endurance running races attracts millions of recreational and competitive participants around the world (Field et al., 2019). It is evident that maximal oxygen uptake (VO_2max), running economy (RE), running velocity at VO_2max (vVO_2max), limit time at vVO_2max (tlimit), running speed associated with lactate threshold (VLT), maximal speed (V max), and critical speed (CS) are the main parameters used to predict performance during middle and long running distance (Damasceno et al., 2015; Faulkner et al., 2012; Ferley et al., 2014; González-Mohíno et al., 2016;

Hoogkamer et al., 2016; Tota et al., 2015; Zinner et al., 2018), as well as it is determined by aerobic and anaerobic capacities (Enoksen et al., 2011).

The intensity distribution of running exercise is also a relevant factor for sport performance (Damasceno et al., 2015). Therefore, training plays a fundamental role in improving the qualities that determine running performance (Field et al., 2019; Park et al., 2019), since performance in sport depends mainly on the interrelation of physiological, psychological, and environmental factors (Alis et al., 2016; Medina Melo et al., 2022).

Evidence suggests that variations in low-intensity, high-volume running training or high-intensity, low-volume running training have been shown to improve running performance parameters (Enoksen et al., 2011; Ferley et al., 2014; Jarstad & Mamen, 2019; Vesterinen et al., 2016). A recent analysis of the training intensity distribution in 42 recreational runners revealed that both high-intensity, low-intensity and polarized groups –a combination of high and low intensity– improved the 5 km time and VO_{2peak} (Zinner et al., 2018). However, an analysis with elite resistance athletes exposed the predominance of the polarized intensity distribution, inserting 75% of the time in low intensity in zone one, 5% to 10% in zone two and 15% to 20% in zone three (Orie et al., 2014).

Esteve-Lanao et al. (2005), comparing the effect of two training programs that differed in the relative contribution of training volume below versus within the lactate threshold on the performance of 12 sub-elite endurance runners, found that the magnitude of the improvement in running performance was significantly greater in zone than in zone two. According to Muñoz et al. (2014), the two consistent training characteristics of elite athlete are a high total training volume and a high percentage of volume performed at an intensity below the lactate threshold.

Similarly, Jarstad & Mamen (2019) investigated the effects on aerobic endurance performance of high-intensity continuous running (HICR) versus moderate-intensity continuous running (MICR) in 20 recreational athletes, observing an increase in time to exhaustion in the MICR and HICR group, as well as an increase in absolute VO_2max and a tendency to improve ER in the HICR group, while in MICR an increase in VO_2max seems to improve fat oxidation. Accordingly, González-Mohíno et al. (2016) evaluated the difference between intervalic (INT) and continuous (CONT) training methods in 11 runners. After six weeks of training, INT showed a 7.9% improvement in maximal aerobic speed (MAS), stride length and flight and ground contact frequency and time, while CONT showed improvements in RE. In theory, an improvement in RE would allow an athlete to run faster for the same physiological effort and thus improve performance (Hoogkamer et al., 2016).

In this perspective, Silva et al. (2017) found that after four weeks of a HIIT program there was an improvement in physiological variables related to running performance, but these were not accompanied by changes in stimulation strategy or overall 5 km performance in 16 male runners. At the same time, Ferley et al. (2014) evaluated interval and continuous training at the incline and set level in 32 runners. After six weeks, all groups improved in five maximal jumps, VO_2, and blood lactate, but it was insufficient to improve muscle power. It is argued that when the external load of both training groups –CONT and INT– are not equalized and, therefore, do not receive the same stimulus, significant increases in VO_2max occur with INT training compared to CONT (González-Mohíno et al., 2016).

Based on the evidence, it is critical to understand the scientific landscape underpinning the prescription of endurance training and the subsequent selection of training methods. To ensure training quality and excellent performance for professional and recreational runners in running competitions, this study aims to map the scientific output of training methods for endurance runners for 5-10 km competitions.

METHODS

Search strategy

This bibliometric study (Batista Moura et al., 2017) was conducted with information obtained from the electronic databases: SciELO, LILACS and PubMed. The search for articles had no limitation on the initial date, while it was restricted to papers published up to December 31, 2019. However, the survey was updated on June 26, 2020.

An search strategy was used in English: ("Running" OR "Trained Runners") AND ("Resistence Training" OR "Physical Endurance" OR "Physical Endurances" OR "Training Loads" OR "Training Indices") AND ("Oxygen Consumption" OR "Oxygen Consumptions" OR "Anaerobic Threshold" OR "Maximal Oxygen Uptake" OR "Lactate Thereshold" OR "Treshold") AND NOT ("Systematic Review" OR "Meta-Analysis" OR "Review" OR "Soccer" OR "Volleyball" OR "Basketball" OR "Mountaing" OR "Swimming" OR "Cross-Country Skiers" OR "Triathletes" OR "Football" OR "Water Polo" OR "Swimmers").

Similarly, a search strategy was used in Spanish: ("Carrera") AND ("Cargas de Entrenamiento") AND ("Cosumo Máximo de Oxígeno" OR "Consumo de Oxígeno") AND NOT ("Revisión Sistemática" OR "Metaanálisis"). Titles, abstracts and keywords terms were searched in Portuguese, English and Spanish.

Eligibility criteria

The study included (a) full text, (b) open-access articles in Portuguese, English or Spanish, (c) unrestricted as to publication date in which (d) the target audience was an amateur / recreational or elite / professional road athlete; (e) was experimental with the intervention of running training methods; and (f) did not receive ergogenic support.

Extracted data

For bibliometric analysis and discussion, the following aspects were taken into account: (a) year of publication; (b) lead authors; (c) journal of publication; (d) country of the journal; (e) country of the study; (f) country of the author; (g) number of subjects and age group; (h) training protocol; and (i) main findings. The selection criterion for item (e) country of the study, was that submitted by the Ethics Committee Institution, while for item (f) country of the author, was the country of the corresponding author.

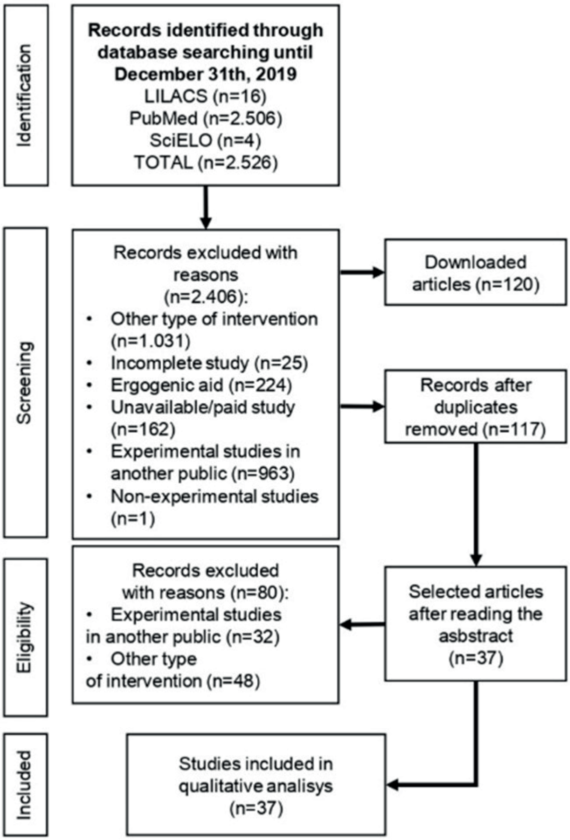
Data analysis

The data were analyzed descriptively and presented in graphs, tables and maps prepared in Excel® for Windows version 365 ProPlus.

RESULTS

Preliminary search result traced 2,526 articles related to the topic, while the search and selection steps (applying filters in databases, reading titles and abstracts, excluding duplicates and applying eligibility criteria) identified 37 studies for qualitative analysis, between 1979 (date of the first article) and December 31, 2019 (figure 1).

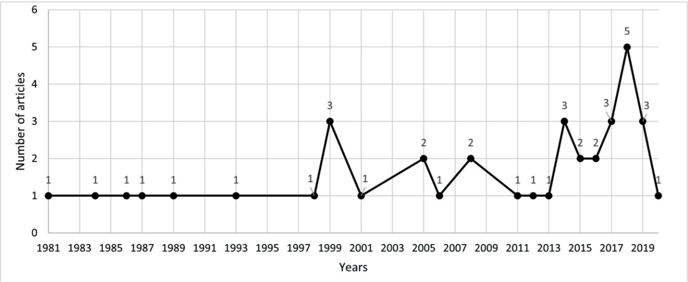
Figure 1. Flowchart for identifying, screening, selecting and including articles



Source: Own elaboration.

Figure 2 highlights the first publications presented in 1981; in particular 1999 shows an increase in production. Likewise, 2018 shows the largest dissemination of studies.

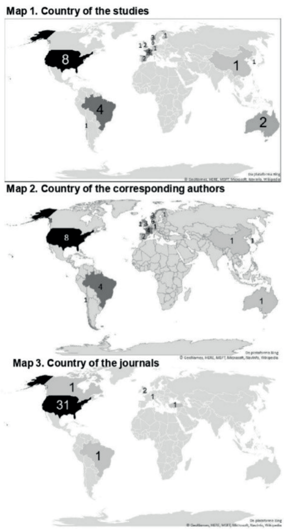
Figure 2. Distribution of published research by year



Source: Own elaboration.
Note. 1981: first publication. 2018: largest number of publications (5 in total).

Geographically, Figure 3 shows that Europe has the largest number of journals, studies and corresponding authors. In contrast, in the Americas, the United States has the largest number of studies, authors and journals selected for publication.

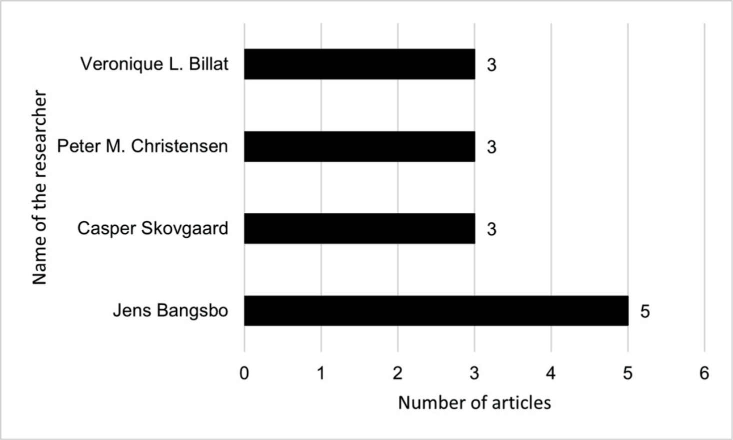
Figure 3. Distribution of studies



Source: Own elaboration.
Note. Map 1: Distribution of studies by country. Map 2: Distribution by corresponding author. Map 3: Distribution by journal.

Among the authors, only Jens Bangsbo has the largest number of studies, with five published articles (figure 4). The remaining authors not shown in the figure have only one (n=139) or two (n=16) publications.

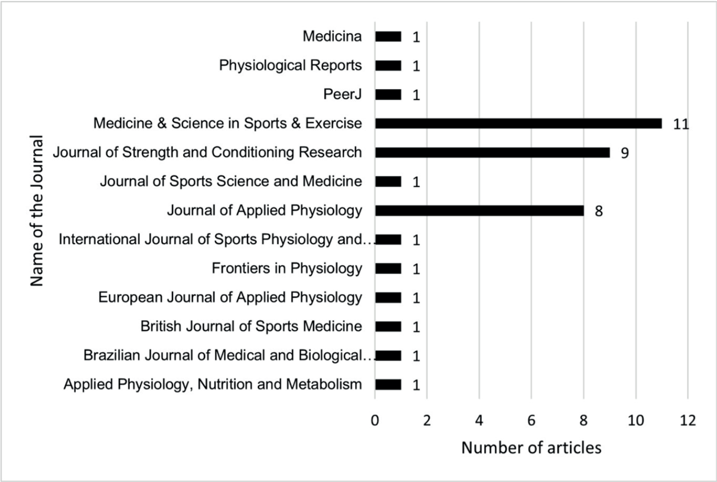
Figure 4. Top 4 authors with the highest scientific production



Source: Own elaboration.

Figure 5 shows that the journal with the highest number of publications on the subject is *Medicine & Science in Sports & Exercise*, with 11 articles, followed by *Journal of Strength and Conditioning Research*, 9 publications, and *Journal of Applied Physiology*, 8 publications.

Figure 5. Journals and number of scientific publications



Source: Own elaboration.

Table 1 shows the data regarding the participants, the training protocol and the main results of each article included in this study. The most commonly used training methods were continuous (n=21) and intervallic (n=24), but they are presented differently in each study. As for the main results, an improvement in running economy (n=12), in VO_2max (n=9) and reduction in time trial (n=17) were observed.

Table 1. Descriptive matrix of the articles selected for bibliometric analysis

Author and journal	Number of subjects and age range	Training protocol	Main results
(Hickson & Rosenkoetter, 1981) *Medicine & Science in Sports & Exercise*	21 subjects of both sexes. Between 19 and 33 years old.	10 weeks of running training, running continuously as fast as possible for 30 minutes the 1st week, 35 minutes the 2nd week and 40 minutes the following week.	When the weekly training frequency is reduced to 3 or 4 days a week, VO_2max is maintained, but if the frequency is reduced to two, VO_2max is not maintained.
(Mikesell & Dudley, 1984) *Medicine & Science in Sports & Exercise*	7 individuals with a mean age of 23.6 SD 3.5 years.	6 days for 6 weeks with alternate days of running and cycling. 3 days with 40 min of continuous hard running and 1 day with running on varied ground.	Intense aerobic training, both running and cycling, induces a significant linear improvement in peak VO_2 and a significant reduction in 10 km time.
(Freund et al., 1986) *Medicine & Science in Sports & Exercise*	Male subjects divided into Experimental Group (n=12) mean age 22.5 SD 2.5 years and Control Group (n=10) 20.3 SD 2.5 years.	12 weeks of training. The running program consisted of 4 weekly sessions of approximately 35 minutes of 9 to 14 ramps, incremented with interval or continuous training within the 35 minutes of that session.	There were no differences in VO_2max between groups or protocols. The finding supports the concept of training specificity and suggests training type and ground considerations in test selection.
(Priest & Hagan, 1987) *British Journal of Sports Medicine*	Male subjects divided into two groups: Experienced (n=6) mean age of 19.3 SD 0.52 years; Beginners (n=6) 22.2 SD 4.1 years; and Combined (n=6) 20.6 SD 3.1 years.	7 weeks of protocol of four different cross-country courses (varied terrain), from 4 to 16 km. During the first weeks, training consisted of 400-meter distances run at MMS (Maximum Steady State). Subsequent training sessions progressed to distances between 1.6 and 5 km at MSS pace. After each day of training at MSS pace on the track, runners performed additional training at or near 100% MSS pace on cross-country courses.	During the 7 weeks of training, the MSS training pace increased significantly from 3.76 to 4.19 m.s-1. MSS training significantly improved maximal anaerobic power capacity and VO_2max, as well as the performance times in the 15 m, 600 m, 3.22 km and 10 km races.

Author and journal	Number of subjects and age range	Training protocol	Main results
(Acevedo & Goldfarb, 1989) *Medicine & Science in Sports & Exercise*	7 male subjects with a mean age of 22.4 SD 1.3 years.	8 weeks of training. 3 days of intensity running and the other days continuous running 5-12 m. Among the 3 interval running days, one was between 90-95% HR_{max} with HR interval up to 120 bpm. The other two fartlek sessions of 6-10 m.	Previously trained runners can improve performance and reduce the amount of blood lactate at their highest training intensities, independent of changes in VO_2max and ventilatory threshold.
(Mutton et al., 1993) *Medicine & Science in Sports & Exercise*	12 male individuals aged between 19 and 35 years divided into: Running Group (n=6) or Cross Training Group (n=6).	5 weeks of training, with 4 days of intensity in week 1 at 80-85% HR_{max}, in weeks 2-5 increase to 85-90%. Weeks 3-5 high intensity above 95% HR_{max}. All sessions were 45 minutes in duration.	Aerobic capacity, 5 km and 1 m performance, submaximal test showed improvements after the intervention, but were not different between running and cross-training.
(Franch et al., 1998) *Medicine & Science in Sports & Exercise*	36 male subjects with a mean age of 30.4 SD 4.8 years.	3 days a week for a period of 6 weeks. The training programs were: continuous distance training (TD); long interval training (LIT) with 4min / 2min pause repeated four to six times; or short interval training (SIT) with 15s run / 15s pause, 30-40 repetitions. The initial duration of the training sessions (running plus pauses for intermittent training) was 20min on average in all three groups; the duration was increased midway to 30min. In addition to the intensified training, participants performed one to three individual training sessions per week at their slowest, normal pace (≤65% of HR_{max}).	Amateur runners can improve running economy and other measures of aerobic performance in a relatively short period. Improvements after short interval training were generally minor and not significant relative to running economy. Reduced pulmonary ventilation after training was significantly correlated with improved running economy. Other potential factors, such as the percentage of type I fibers in the vastus lateralis muscle, stride length, stride frequency, and/or respiratory exchange rate during exercise did not change with training.

Author and journal	Number of subjects and age range	Training protocol	Main results
(Smith et al., 1999) *Medicine & Science in Sports & Exercise*	5 men with a mean age of 22.8 SD 4.5 years.	4 weeks consisting of two interval-type sessions of approximately 60 min duration (8 in total: 5 intervals for any set from 60 to 65% and 6 intervals for any set from 70 to 75% at minimum running speed (V_{max}) and a recovery session that was performed for 30 min at 60% of the subject's V_{max}. A total of 12 sessions were performed. All training sessions consisted of a warm-up, which included 5 minutes of running. Subjects stretched for 5 minutes and then returned to running at 60% of their V_{max} for another 5 minutes, after which the warm-up ended and the individuals left the treadmill.	There was a wide variety of pre-training results: 3000 m running time (TT), 550-702s; average speed (V) 18-22.67 km - h; and average time (T), 204-291, as well as post-training results: TT, 537-658 s; average V 19-23.67 km - h; average T 235-387 s. Performance improvements in all subjects, however, were relatively uniform.
(Paavolainen et al., 1999) *Journal of Applied Physiology*	Two groups of men divided into: Experimental (n=12) with a mean age of 23 SD 3 years and Control (n=10) 24 SD 5 years.	9 weeks of training. The total training volume was the same in the GE and CG groups, but 32% of the training hours in the GE and 3% in the CG were replaced by explosive strength training. Explosive strength training sessions lasted 15 to 90 min and consisted of several sprints (5 to 10 or 20 to 100m) and jumping exercises without additional weight or with the barbell over the shoulders and leg press and knee extensor-flexor exercises with low loads at high or maximal movement speeds (30 to 200 contractions/training session and 5 to 20 repetitions/set).	Simultaneous explosive strength training, including running and endurance training, produced a significant improvement in 5km running performance in well-trained endurance athletes, with no changes in VO_2max or other aerobic power variables.

Author and journal	Number of subjects and age range	Training protocol	Main results
		Exercise load ranged from 0 to 40% of one-repetition maximum. Endurance training for both groups consisted of cross-country or road running for 0.5-2.0 h at an intensity below (84%) or above (16%) the individual lactate threshold (LT). Circuit training was similar in both groups; the CG trained more frequently than the GE.	
(Billat et al., 1999) *Medicine & Science in Sports & Exercise*	8 men with a mean age of 24 SD 3.2 years.	6 training sessions during 4 weeks for normal and overload training. The normal training week consisted of one running session with the blood lactate concentration (vOBLA) speed, being twice 20 minutes with 5 minutes rest between the two runs at 40% of the vVO_2max pace. And 4 more sessions slower than vOBLA speed. During the overload training week, the interval training (InTr) with vVO_2max was multiplied by three, adding the two InTr instead of two easy runs at 60-70% $v\ VO_2max$. vOBLA training was the same during the periods.	An overload interval of three interval training sessions (using the same protocol), did not again increase aerobic parameters and did not induce a decrease in performance, although daily logs significantly reported subjective indices of fatigue, muscle soreness and poor sleep quality.
(Demarle et al., 2001) *Journal of Applied Physiology*	6 individuals with a mean age 27.0 SD 2.1 years.	8 weeks including two interval training sessions and three continuous training sessions per week. For interval training, intense running at vΔ50, for 50% time before exhaustion (T_{max}) at vΔ50, and recovery at 50% vVO_2max, for 25% T_{max} at vΔ50 were included. Continuous training runs were performed at 60-70% vVO_2max for 45 to 60 min.	The same absolute rate of supralactate threshold work before and after training, significant adaptations related to VO_2 kinetics can lead to performance improvements in well-trained individuals.

Author and journal	Number of subjects and age range	Training protocol	Main results
(Dufour et al., 2006) *Journal of Applied Physiology*	Male subjects were divided into Groups: Hypoxia 30.3 SD 6.3 years; and Normoxia 30.3 SD 6.1 years of age.	During the 6 weeks of the study, the two groups continued the usual training program (5 sessions/week), including the two weekly sessions at the second ventilatory lactate threshold (TV_2), with 2 periods at TV_2 separated by 5 minutes of recovery at 60% VO_2max. In the 4th week, the training speed was readjusted to maintain a heart rate corresponding to that achieved in the first training session.	Performance improvements were observed in both groups at VO_2max and time to exhaustion (Tlim). In addition, IHT did not significantly modify the VO_2 kinetics, so that Tlim did not correlate with either changes in VO_2 and O_2 adjustment rate or with VO_2max and ventilatory thresholds.
(Esteve-Lanao et al., 2005) *Medicine & Science in Sports & Exercise*	8 subjects with a mean age of 23 SD 2 years.	6 months of intervention consisting of eight 3-week mesocycles, each with a 2:1 load structure (i. e., 2 weeks of high load followed by an "easy" week) and divided into three main periods: preparatory (four first mesocycles (weeks 1 to 12), specific (next two mesocycles (weeks 13 to 18) and competitive (last two mesocycles (weeks 19 to 24). Base or basic training (including mainly low to moderate intensity running and strength training sessions). In the specific period, the strength training sessions were held specifically during actual run and increased running intensity and in the low volume and high intensity competitive period. The 6 months included 1 to 3 training sessions per week of low inten-	There was a relationship between the accumulated training time at low intensities (zone 1) and the resistance performance during the events, which are concluded at very high intensities (i.e., 30 min of continuous exercise in zone 3 or> 85% VO_2max). Performance during these tests does not appear to be associated with total training time spent at medium or high intensities (zones 2 and 3, respectively). Total training time spent at low intensities may be associated with better performance during high-intensity endurance tests, at least if the test duration is 35 min.

Author and journal	Number of subjects and age range	Training protocol	Main results
		sity (zone 1), 1 to 3 sessions per week of low to moderate intensity (zone 1 and zones 1 to 2), 1 to 2 sessions per week with a main part in zone 2 and 2 intense sessions per week, including interval exercises at high intensities (zones 2 to 3 and zone 3). Training generally included 1 to 2 strength training sessions per week.	
(Ponsot et al., 2006) *Journal of Applied Physiology*	Two groups of men were formed: Hypoxia (n=8) age mean 29.9 SD 2.3 years; and Normoxia (n=7) age mean of 31.3 SD 2.3 years.	6 weeks, two weekly treadmill training sessions at the speed of the second ventilatory threshold (vVT2) were performed within their usual training program. The Hypoxia group performed the two laboratory sessions under simulated normobaric hypoxia (Fi O_2=14.5%), whereas the Nor group breathed ambient air. The exercise duration of the vVT2 sessions was increased each week (from 2 × 12 min to 2 × 20 min), and the exercise intensity was readjusted in the fourth week to obtain the same heart rate as in the first vT2 session in the laboratory.	The inclusion of twice weekly sessions of moderate hypoxic training in vVT2 (never more than 80 min/week) in the regular training of endurance runners induces skeletal muscle mitochondrial adaptations that may contribute to the improvement of endurance performance.
(Iaia et al., 2009) *Journal of Applied Physiology*	17 men with a mean age of 33.9 SD 1.5 years. Speed endurance training group (SET) n=9. Control Group (CG) n=8.	The SET replaced their endurance training (205.8 SD 19.3 min/week) with high-intensity intermittent exercise sessions, i.e., each consisting of 8 to 12 30-second running sessions, interspersed by 3 minutes of rest.	4 weeks of SET in individuals already trained in endurance caused a reduction in energy expenditure during submaximal running. These changes were not associated with reduced

Author and journal	Number of subjects and age range	Training protocol	Main results
		The training intensity was 22.4 SD 0.4 km/h, corresponding to 93 SD 0.5% of the speed reached in a 30s run, and was modified according to the duration of the IT period. Subjects trained on alternate days, 3.4 SD 0.1 times per week. In each training session, subjects performed an additional 15.4 SD 0.2 min of warm-up and recovery activities at a speed of 11.3 SD 0.3 km / h (9.9 SD 0.3 km / week).	muscle UCP3 protein expression. Furthermore, despite a two-thirds reduction in the total amount of training, muscle oxidative enzyme levels, capillarization, VO_2max and performance in a 10 km time trial were maintained.
(Støren et al., 2008) *Medicine & Science in Sports & Exercise*	Intervention Group (n=8) 4 men and 4 women with a mean age of 28.6 SD 10.1 years; and Control (n=9) 5 men and 4 women with a mean age of 29.7 SD 7.0 years.	8 weeks of intervention. The groups maintained their normal training by recording the time spent in the different training intensity zones: 60-85%, 85-90% and 90-95% of HR_{max}, the GI had additional maximum strength training (MAS) four series of half squat of 4RM, divided by 3 minutes of rest between each 3 of the weeks.	Heavy endurance training for 8 weeks increased running economy and MAS exhaustion time among well-trained long-distance runners, without a simultaneous increase in maximum oxygen uptake or body weight.
(Enoksen et al., 2011) *Journal of Strength and Conditioning Research*	26 male subjects with a mean age of 19.9 SD 6.1 years. Two groups: HVLI: high volume and low intensity (n=10). HILV: high intensity and low volume (n=9).	10 weeks of training. HILV covered an average of 50 km/week and HVLI an average of 70 km/week. They held 6 training sessions per week. HILV performed 33% of the total training volume at 82-92% of HR_{max}, and 67% was performed at 65-82% of HR_{max}. HVLI accounted for 13% of the total training volume at 82-92% of HR_{max}, and 87% at	Training close to the lactate threshold (HILV group) resulted in a better training effect among male middle distance runners than low intensity training (HVLI group). The HILV group improved markedly in VO_2max and lactate threshold speed, anaerobic capacity and running economy

Author and journal	Number of subjects and age range	Training protocol	Main results
		65-82% of HR_{max}. HILV also performed 3 intensive exercises per week at 82-92% of HR_{max}, and HVLI performed 1 intensive training per week.	(ER). The HVLI group has seen only a noticeable improvement in their RE. As for all parameters measured in this study, there were no marked differences between the two groups before and after the intervention period.
(Gunnarsson & Bangsbo, 2012) *Journal of Applied Physiology*	18 subjects, 12 males and 6 females, with a mean age of 33.8 SD 1.6 years.	7 weeks of intervention. The training concept 10-20-30 consisted of a standardized 1.2 km warm-up at low intensity, followed by 3 to 4 × 5 min of running, interspersed with 2 min of rest. Each 5-minute run period consisted of five consecutive 1 min intervals, divided into 30, 20 and 10 seconds with an intensity corresponding to <30%, <60% and 90 to 100% of the maximum intensity and 3 more weekly training sessions with a volume of 14.0 dp 0.6 km/week.	After the period there was a 50% reduction in the training volume, the VO_2max was increased by 4% and the performance in 1500 m and 5 km improved in 21 and 48 s, respectively. In addition, training 10-20-30 led to a marked reduction in systolic blood pressure, as well as a reduction in total cholesterol and LDL-cholesterol.
(Ferley et al., 2013) *Journal of Strength and Conditioning Research*	32 subjects: n=14 male, n=18 female with a mean age of 27.4 SD 3.8 years. GHill (ramp interval) n=12. GFlat (interval at series level) n=12 or GC n=8.	6 weeks of training. GHill performed 2 high intensity interval sessions and 2 continuous running sessions per week. The high intensity interval sessions consisted of completing 10-14 exercises for 30 seconds on a treadmill adjusted to a 10% rating while running at 100% V_{max} intervals lasted as long as the HR returned to 65% of HR_{max}. On the days when there was continuous training, GHillos	High intensity interval training on ascents and series levels can improve, in well-trained distance runners, the duration of a running session completed at the associated speed in VO_2max. However, of the 2 approaches, the more traditional type of interval training produced greater gains in a test of time until exhaustion.

Author and journal	Number of subjects and age range	Training protocol	Main results
		participants ran on an adjusted treadmill with 1% degree and 75% V_{max} for 45-60 minutes. GFlat also completed 2 high intensity interval sessions and 2 continuous running sessions per week. In GFlat, the high intensity flat sessions consisted of completing 4-6 sessions for a duration equal to 60% T_{max} on a treadmill adjusted to a rating of 1% and 100% V_{max}. GFlat participants also used rest durations between intervals that lasted as long as HR returned to 65% of HR_{max}. During each of the continuous sessions, the GFlat also ran for 45-60 minutes at a speed and a treadmill set at 75% V_{max} and 1%, respectively. GC participants continued their weekly training programs (4.9 SD 0.07 days per week, 270.4 SD 81.6 min per week) far from the training facilities.	
(Skovgaard et al., 2014) *Journal of Applied Physiology*	21 male subjects with a mean age of 31.1 SD 1.58 years. Divided into: Group (HICT) concurrent training of high intensity (n=12) or Group (CG) Control (n=11).	The 8-week training. HICT trained 4 times / week. The resistance speed training (SET) consisted of 30 s runs with 3 min of recovery in the middle and progressed from 4 to 12 repetitions in the intervention. The warm-up before SET consisted of 2 km of running at a self-selected pace. Heavy resistance training (HRT) was performed 15 min after SET and progressed from 3 sets of 8 repetitions with 15 maximum repetitions (RM) to 4 sets of	8 weeks of simultaneous SET and HRT, along with a reduced volume of aerobic training, improved the performance of moderately trained endurance runners during long (10 km), short (1500 m) and intense (Yo-Yo IR2) tests, which was associated with improved running economy and dynamic muscle strength, in addition to greater muscle NHE1 content.

Author and journal	Number of subjects and age range	Training protocol	Main results
		4 repetitions at 4RM in weeks 5-8 with a passive 3min interval. Aerobic training was performed twice a week. One day, unsupervised high intensity aerobic intervals (AHI) were performed, consisting of 4 × 4 minutes of running with a target HR> 85% of HR_{max}, separated by 2 minutes of passive recovery. And one day at the end of the week, the subjects performed a continuous aerobic intensity run (AMI) with a target HR of 75 to 85% of HR_{max} for 40 to 70 minutes.	
(Holliss et al., 2014) *Journal of Strength and Conditioning Research*	12 subjects with a mean age of 19.7 SD 0.8 years. Divided into: IHT Group (n=9) or CONT Group (n=9).	With 2 runs on the anaerobic threshold each week replaced by 40min of running sessions for intermittent training in hypoxia (IHT) (sessions of 16 × 40 min in total during 8 weeks, 2 runs of intense intervals of 60 min and 50 min and 2 easy runs of 30 min and 75 min) or CONT.	8 weeks of IHT resulted in significantly less submaximal HR and a tendency towards reduced oxygen cost in submaximal exercise. Although the incremental run time to exhaustion improved under hypoxic conditions, changes in normoxic test conditions were not apparent.
(Ferley et al., 2014) *Journal of Strength and Conditioning Research*	n=14 male and n=18 female mean 27.4 SD 3.8 years. Divided into: CG (control group) n=8; GHill (interval training group with inclination) n=12; Or GFlat (interval training of series levels).	6 weeks of training. GHill and GFlat used the same maximum and submaximal training intensities while performing 2 high intensity interval sessions and 2 continuous running sessions per week alternately. GHill's high intensity interval sessions involved 10 to 14 sessions for 30 s on a treadmill adjusted to a 10% rating while running at 100% V_{max}.	6 weeks of high-intensity treadmill training with inclined and leveled sets led to significant improvements in VO_2 and blood lactate measurements at 60 and 80% of lactate threshold velocity (LTV), as well as in % VO_2max at LTV, GFlat and GHill. In addition, there were statistically significant

Author and journal	Number of subjects and age range	Training protocol	Main results
		GFlat completed 4-6 sessions for a duration equal to 60% T_{max} on a treadmill adjusted to 1% and 100% V_{max}. On continuous running training days, GHill and GFlat ran for 45 to 60 minutes on a treadmill adjusted to 1% and 75% Vmax. The interval for both was 65% of HR_{max}.	improvements in 5 maximal jumps and in various indices of unilateral isokinetic knee extension and flexion in the GHill and GFlat.
(Roschel et al., 2015) *Journal of Strength and Conditioning Research*	n=15 subjects aged between 23 and 40 years. Divided into: RT group (resistance training n=8) with a mean age of 30.8 SD 5.3 years; e Group WBV + RT (resistance training associated with whole body vibration n=7) average 35.0 SD 8.0 years.	Resistance training was performed twice a week and consisted of 3 sets of 8 to 10 RM in the first 2 weeks, 4 sets of 6 to 8 RM in the next 2 weeks (weeks 3 and 4) and 6 sets of 4 RM in the last 2 weeks of training (weeks 5 and 6). The rest interval between sets was 3 minutes during the training period for both groups.	Unexpectedly, none of the training modes (WBV + RT and RT) produced significant improvements in running economy (ER). In addition, the WBV + RT and RT programs induced improvements of 1RM, but no additional effects were observed with the inclusion of WBV.
(Azevedo et al., 2015) *Journal of Strength and Conditioning Research*	n=12 men and n=8 women age of 24.28 SD 2.35 years. Divided into: EG (experimental n=15) and CG (control n=15).	Both groups performed an interval training of 15 weeks; however, only the GE had running exercises added to the interval running training (6 to 16 running runs performed at maximum speed (Smax), ranging between 100 and 600 m) with the active interval consisting of moving between 200 and 600 m at comfortable speed (Scomf). In addition, GE carried out educational running exercises.	The inclusion of running exercises in an interval of 15 weeks of training was not efficient to improve the biomechanical parameters related to performance. However, interval training was really effective in improving performance-related parameters.

Author and journal	Number of subjects and age range	Training protocol	Main results
(Nakamoto et al., 2016) *Journal of Strength and Conditioning Research*	28 subjects of both sexes between 23 and 53 years old. Divided into: IHT + IHE Group (intermittent hypoxic training followed by intermittent hypoxic exposure at rest n=11) 35.2 SD 2.6 years; Group IHT + NE (intermittent hypoxic training followed by normoxic exposure at rest n=10) 33.3 SD 2.7 years; NT + NE group (normoxic training followed by normoxic exposure at rest n=7) 42.4 SD 3.2 years.	2 laboratory training sessions per week for 6 weeks. Each training session started with 10 minutes of warm-up to 60% vVO$_2$max, followed by two periods, at a speed where HR was most of the time at the lactate threshold (hrLT) with an interval of 5% of HRtarget. During weeks 1 and 4, individuals performed 2 12-minute sessions at hrLT; weeks 2 and 5, they performed 2 16min sessions in hrLT; and weeks 3 and 6, they performed 2 sessions of 20min at hrLT. External training with 3 types of training sessions: (a) constant and intense running; (b) high-intensity interval training; and (c) technical practice.	The IHT added to regular training induced further improvements in aerobic capacity than a corresponding NT strategy. These additional adaptations of IHT were maintained for 4 weeks after IHT, regardless of IHE.
(González-Mohíno et al., 2016) *Journal of Strength and Conditioning Research*	n=11 subjects aged 33.1 SD 11.3 years. Divided into: INT group (intervention n=6); and CON Group (control n=5).	3 sessions per week for a period of 6 weeks, totaling 18 sessions. INT performed, on alternate days, repetitions of 1min to 55% maximum aerobic speed (MAS), from 2min to 50% MAS and 3 min to 45% MAS. While ON carried out continuous runs of at least 18 min and at most 48 min with intensity between 70% and 75% MAS. The work / rest ratio was maintained 1:1 in interval training.	Continuous training produced significant improvements in running economy at intensities close to those of the CON training program, without changes in gait kinematics. On the other hand, INT produced significant improvements in MAS and, in the process, the stride length increased significantly more than the stride frequency and the time of contact with the ground decreased at the highest execution speed.

Author and journal	Number of subjects and age range	Training protocol	Main results
(Silva et al., 2017) *Brazilian Journal of Medical and Biological Research*	n=17 men divided into GHIIT (n=8) age 35 dp 6 years; and CG (n=8) age 35 SD 9 years.	HIIT carried out a high intensity interval training program twice a week (separated by 48 h) for 4 weeks, in addition to continuous low intensity aerobic training (50-70% of VO_2max). Interval training was five intervals in vVO_2max for a duration equal to 50% of the time until exhaustion (Tlim), interspersed with an active recovery at 60% of the speed corresponding to vVO_2max for a duration equal to the effort time (recovery of 1:1).	The HIIT program improved physiological variables related to resistance performance, but these changes were not accompanied by changes in the stimulation strategy or in the overall performance.
(Beattie, et al., 2017) *Journal of Strength and Conditioning Research*	n=20 subjects aged 28.2 dp 8.6 years. Divided into: Intervention Group (n=11) age 29.5 dp 10.0 years; Control Group (n=9) age 27.4 dp 7.2 years.	40 weeks of intervention, running training plus maximum strength, explosive and reactive strength training was performed twice a week in the intervention group.	There were no significant differences for any measures of strength between the intervention and control groups at baseline. The change in absolute maximum strength in the intervention group (85.7 SD 14.7 kg → 99.3 SD 19.0 kg) was not significantly different from the change in the control group (100.0 SD 18.4 kg → 101, 6 SD 17.1 kg) over 40 weeks.
(Sharma et al., 2017) *International Journal of Sports Physiology and Performance*	n=13 men and n=6 women with a mean age of 25 SD 5 years. Divided into: Control Group (sea level training n=7); Experiment Group (altitude training n=12).	The same protocol was applied for training at sea level and for altitude. From 4 to 6 weeks, the training sessions included low intensity, runs at lactate threshold, VO_2max and at race pace.	Running speed in elite mid-distance athletes is negatively affected at 2100 m altitude, with levels of impairment dependent on training intensity. However, the perceived effort is increased compared to training at sea level at equivalent running speeds.

Author and journal	Number of subjects and age range	Training protocol	Main results
(Skovgaard, Christiansen et al., 2018) *Physiological Reports*	20 individuals, 14 males and 6 females, with a mean age of 28.8 SD 4.8 years and 27.4 SD 3.7 years, respectively.	Eight resistance speed training (SET) sessions, participants completed ten 30 s running sessions. In all sessions, the races were separated by 3.5 minutes of recovery (200 m walk to the starting line) and more moderate-intense aerobic training (AM) was 93 SD 3%, with a weekly duration of 68 SD 5min and with average FC of 83 SD 1% of HR_{max}.	Running economy (ER) was improved after 40 days of intense volume and reduced training. The better running economy can explain the improved performance of 10 km, along with possibly higher anaerobic capacity.
(Skovgaard, Almquist et al., 2018) *Journal of Applied Physiology*	11 subjects, 8 men and 3 women, 29.2 SD 4.5 years old.	For a period of 40 days with high volume sprint interval training (SIT), consisting of four sessions (8 to 12 × 30s running, with 3.5 minutes of rest between sessions) with 12 repetitions days 1 and 5 and 8 repetitions on days 3 and 7, as well as two sessions of moderate-intense aerobic training (AM) being 30-60min with an average HR of 60-85% every 8 days. Then, an 18-day tapering period (TAP) was concluded with the SIT (total run of 4 × 30 s interspersed with 3.5 min rest) being performed on days 3, 6, 11 and 14 and AM (20-40 min with an average HR 60–85%) performed on days 2, 5 and 13.	After 10 and 18 days of gradual reduction in the high-volume period of SIT, the short-term exercise capacity was better than before the high-volume period of SIT. In addition, after the tapering period, the 10km running performance returned to the baseline and the running economy was improved compared to the baseline. The 10km performance was improved by about 3% after 8 days of reduction.
(Andrade et al., 2018) *Frontiers in Physiology*	n=16 men and n=7 women aged 21.3 SD 1.3 years. Divided into: Control group (n=12); Plyometric training group (n=11).	For 4 weeks, 3 days a week, each session lasted 25 minutes. The participants completed jumping exercises with falls from 30 to 50 cm with the same total technique of 60 feet contacts per session (3x10). The rest between repetitions and sets was 15 s to 2 min.	4 weeks of short-term plyometric training at sea level improves the RSI30, 2 km time trial and sea-level running economy, without affecting VO_2max. In addition, after training, both at sea level and at high altitudes,

Author and journal	Number of subjects and age range	Training protocol	Main results
		During the intervention, participants maintained their usual running training (that is, 3 to 4 sessions per week, 30 to 60 minutes per session, at 70 to 80% of HR_{max}). During the intervention, the participants completed a total volume load of 720 hops.	the plyometric training group demonstrated a higher RSI performance and a 2 km time trial compared to the control group.
(Zinner et al., 2018) *Medicine & Science in Sports & Exercise*	n=19 men and n=23 women aged 27 SD 6 years. Divided into: HIGH: high intensity and low volume training; LOW: high volume and low intensity; POL: combination of HIGH and LOW.	HIGH: (low intensity warm-up 10min, high intensity warm-up 4x4 min alternating with a 3min walk and 10min cooling run. From 3 to 5 sessions per week. LOW: (3 to 5 sessions per week of high volume and low intensity, all sessions were between 60 to 90 minutes. POL: (3 to 5 sessions per week, with 4x4 min interval sessions and 60 to 90 min sessions. As a rule, 1 high session followed by 2 low sessions).	It was applied 2 mesocycles, one for 4 weeks with an identical training intensity distribution (TID) and one for 3 weeks with different TID. The 3 groups are equally powerful in improving the 5,000 m time with similar improvements in VO_{2peak}. Only in LOW improvements in running economy.
(Hogg et al., 2018) *European Journal of Applied Physiology*	16 male subjects and 8 female subjects aged 30 SD 9 years. Divided into: STND - standardized; S-P - own rhythm.	Two high-intensity break sessions per week, along with a recovery run and a time run for both groups. This is equivalent to four exercise sessions per week. STND: each interval session, participants completed 6 intervals in vVO_2max with duration determined as 60% of T_{max} interval 2: 1. And the Tempo Run session was 30 min at 50% intensity between the 1st and 2nd threshold. S-P: each interval session was 7x2 min in test speed and 2: 1 recovery. Regenerative run the same as the STND, but intensity of 60% of HR_{max}.	The aerobic aptitude and running performance of recreational runners increased by a similar magnitude, regardless of whether self-paced test (SPV) or exercise test (GXT) data were used to prescribe training. Specifically, VO_2max in the STND improved by 4% and 6% in the S-P group.

Author and journal	Number of subjects and age range	Training protocol	Main results
(Li et al., 2019) *PeerJ*	Two male groups: TC: complex training (n=10) age 20.2 SD 1.03 years; HRT: heavy strength and resistance training (n=9) age 21.22 SD 1.48 years; COM: control (n=9) average 20.78 SD 1.20 years.	9 training sessions per week (six resistance and three strength sessions). The resistance training consisted of 3 road runs between 15-20km (75-85% HR_{max}), 3 intermittent sessions of 5x1,000m (90-95% HR_{max}) 1:1 interval and a 10km road session (20-80% HR_{max}). The total resistance training distance was 77.25 SD 2.33 km per week, and the total resistance and strength training time was 8.75 SD 0.97 and 3.5 SD 0.5 h/week and more. strength training sessions for each group.	Combining 8 weeks of complex training (CT) or heavy resistance training (HRT) with resistance training resulted in improved effects on the strength of 1RM, CMJ height, running economy, maximum sprint speed and 5 km running performance. CT is an efficient method for greater improvements in terms of reactive force, 16 km/h running economy and reduction of blood lactate concentrations at a speed of 16 km/h.
(Park et al., 2019) *Journal of Sports Science and Medicine*	24 men divided into: LLTL: living under training (n=12) age 20.7 SD 1.2 years; LHTL: living high training (n=12) age 20.4 SD 1.4 years.	The daily schedule of the 21-day program: the exercise at dawn consisted of a 20min warm-up to 45-50% of HR_{max}, 60 minutes of running at 70-80% of HR_{max} and a 20 min cool-down at 45-50% of HR_{max}. The morning exercise consisted of a 20 min warm-up at 45–50% of HR_{max}, six high speed running sessions at a distance of 150 m at 90-95% of HR_{max}, four interval sessions that covered a distance of 1,200m 85-95% of HR_{max} and 20min of cool-down to 45-50% of HR_{max}. Finally, the afternoon exercise consisted of a 20min warm-up to 45-50% of HR_{max}, five high-speed sessions over a distance of 300 m to 90-95% of HR_{max}, a 3000 or 5,000 m time trial, and 20 min cool-down to 45–50% of HR_{max}.	The study demonstrated that 21 days of LHTL are very effective in improving exercise performance (VO_2max and 3000 meters of time trial) through improved exercise economy and hemodynamic function compared to LLTL.

Author and journal	Number of subjects and age range	Training protocol	Main results
(Jarstad & Mamen, 2019) *Applied Physiology, Nutrition and Metabolism*	n=7 women and n=13 men age 28 SD 5 years. Divided into: HICR: (n=7): running continues at high intensity; MICR (n=7): running continues moderate-intense; CON (n=6): control.	3 intervention sessions for 10 weeks. After a 10-minute warm-up, the HICR carried out a strenuous run, almost exhaustive, of 20m above the lactate threshold at 83% VO_2max (88% HR_{max} / 91% HR_{peak}), while the MICR performed 40 min in 72% VO_2max (~ 80% HR_{max} / ~ 82% HR_{peak}). The intervention sessions were concluded with a 10-minute run corresponding to 60% -70% of HR_{max}.	Even with substantially lower total energy turnover, HICR can improve as much as MICR. In addition, HICR can increase maximal aerobic power, whereas MICR can increase fat oxidation.

Source: Own elaboration.

DISCUSSION

The methodological diversity of the training protocols, in relation to the differences in intensity, duration and frequency, as well as genotype and phenotype factors (Araujo et al., 2015) may influence the magnitude of aerobic performance capacity adaptations (Schumann et al., 2017). In this perspective, the objective of this study was to map and explore scientific production related to training methods of distance runners for 5 to 10 km competitions.

The results showed that 2018 presented the highest number of publications on the subject, with five published studies. In the analysis by authors, four stood out with the highest number of works, highlighting the Danish professor Jens Bangsbo with five of the six publications produced in Denmark.

Among the training methods used by Danish author Jens Bangsbo interval training predominates, mainly resistance speed training (SET), which is characterized by repeated 30 seconds sprints interspersed with long intervals varying over three minutes, and with a volume of between four to 12 sprints with a frequency of alternate, non-consecutive days.

When observing the distribution of articles in scientific journals, *Medicine & Science in Sports & Exercise* is the journal with the most articles published (29.73%), followed by the *Journal of Strength and Conditioning Research* (24.32%) and by *Journal of Applied Physiology* (21.62%). These journals are based in the United States, which explains why the greatest number of studies have been published in journals from this country (83.78%).

The results showed the majority presence of the European continent, which had the largest number of studies (n=20), however the country with the largest number of studies was the United States with eight (21.62%) articles. Likewise, the distribution of the countries of the corresponding authors is shown, but in Europe the number of authors is 21. Brazil stands out, both in the country of study and in the corresponding author with four (10.81%) investigations, respectively.

Bibliometric analysis of the studies revealed that of the 37 articles, 43.24% (n=16), were with male subjects; 37.84% (n=14) were with subjects of both female and male genders; and 18.92% (n=7) did not provide the information. The age range of the studies varied between 19 and 35 years and included recreational to professional athletes.

Regarding training methods, 21 articles were identified with the continuous running method, 24 with interval running, one with time trial, three with regenerative running, one with tempo running, six with lactate threshold running, one at race pace, one in VO_2max running, three with ramp or slope sessions, two with hypoxia training and one with fartlek. There were differences in applications in each investigation, in relation to the volume of sessions, distribution, forms of prescription and intensity control, as well as the weekly frequency of these training sessions and the period of application of the intervention; however, the methods used were the same.

In addition, training protocols complementary to running were presented, such as one study on plyometric training, two on maximum strength, two on explosive strength, one on reactive strength, three on strength resistance training, two on running technique, and one combining training with cycling. The rationale for the application of these types of training, mostly related to strength training, is due to the erroneous association that strength training would interfere with or inhibit the development of resistance (Støren et al., 2008). Favoring the permanence of the absence of this type of training in the incorporation of physical preparation of runners (Beattie et al., 2017).

However, Paavolainen et al. (1999) already reported an improvement in in 5 km performance time (2.8%), in running economy (7.8%) and running and jumping performance among 10 runners after nine weeks of running and strength training. As

Beattie et al. (2017) found, after 40 weeks of strength training, improvement in the key physiological of performance indicators without significant changes in body composition. Supporting the idea that strength training should be a vital component in the physical preparation of long-distance runners.

The most common findings were found in 12 studies with increases in running economy, nine in VO_2max, two in VO_{2peak}, two in maximal anaerobic power capacity, three in maximal steady state, two in aerobic capacity, one in VO_2 kinetics, one in time to exhaustion at maximal running, one in mitochondrial adaptations, two in lactate threshold velocity, two the dynamic muscle strength; on the other hand, 17 investigations showed a reduction in time between time trials from 15 m to 10 km, three in the amount of blood lactate at training intensities and one in the $HR_{submaximal}$.

The studies that obtained running economy as an outcome have methodological similarities with respect to the mix of continuous running and interval running training, strength training, mainly maximal and explosive strength, high volume and low intensity continuous running only, and endurance speed training. The same was true for studies whose outcome was time trial reduction, in which a four- to eight-week intervention, a mixture of continuous and interval running training, with predominance of the interval method, endurance speed training and strength training, predominated.

There were also articles with negative results. One with no difference in VO_2max, one in aerobic capacity, two in overall performance, one in VO_2 kinetics, one in running economy, one in biomechanical parameters, one in anaerobic performance and one in maximal strength.

The potential of this article is to provide a broad overview of the field of research in training methods for distance runners in 5 to 10 km competitions, demonstrating the relevance of this research, since by mapping data, on the state of the art, compiled scientific subsidies are offered to physical education professionals and coaches for a more efficient and effective training prescription, whatever the level of conditioning and performance of the athlete. In addition to presenting an evolutionary line of methods with their practical applications and results, the study provides various forms of control, prescription and intensity distribution in the different training sessions that make up the preparation of the runners a much-discussed aspect not only in the context of training for running.

To select all relevant articles, literature was consulted, search terms were discussed, research tests were performed with the search strategy until the refinement of this research tactic was obtained, to carry out the final research. However, as in any other bibliometric analysis or systematic review study, the research terms used may have eliminated some eligible articles from this research. Nevertheless, it should be noted that with the screening procedure used and with specific search terms, as was the case here, this limitation can be reduced.

Finally, it should be noted that we did not use gray literature, i. e., conference proceedings, books or other types of publications other than periodical articles. For this reason, it is possible that some of these materials relevant to the research were not included in the search. It is suggested that future studies explore the use of databases such as Scopus.

CONCLUSION

In summary, when analyzing and mapping the scientific production of training methods of distance runners for 5 to 10 km competitions through a bibliometric analysis, it is observed that the European continent is the largest producer of knowledge in relation to the subject, while the United States stands out among the others in addition to having the largest number of articles published by journals in the country.

Lastly, the subject is widely researched and explored, especially with regard to training methods and means for highly trained athletes. The search was vast and the literature presents several paths and possibilities, but still with little certainty as to which would be the best in a given context and population.

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