DEVELOPMENT AND VALIDATION OF THE COOPER-PRO APPLICATION FOR THE ASSESSMENT AND PRESCRIPTION OF TRAINING FOR ROAD RUNNERS

DESENVOLVIMENTO E VALIDAÇÃO DO APLICATIVO COOPER-PRO, PARA AVALIAÇÃO E PRESCRIÇÃO DO TREINAMENTO PARA CORREDORES DE RUA

DESARROLLO Y VALIDACIÓN DE LA APLICACIÓN COOPER-PRO PARA LA EVALUACIÓN Y PRESCRIPCIÓN DEL ENTRENAMIENTO DE CORREDORES DE CARRETERA

https://doi.org/10.56238/sevened2026.008-157

Moisés Simão Santa Rosa de Sousa[1], Luiguy Xavier de Lima[2], Tatyana Pinheiro Magalhães[3], Divaldo Martins de Souza[4], Alaan Ubaiara Brito[5]

ABSTRACT

Introduction: Technology has been utilized by coaches and road runners in the pursuit of better results, without neglecting scientific aspects of training, and the use of applications for this purpose can make the process more efficient.

Objective: The objective was to develop and validate a technological tool through an application to assist in the evaluation and prescription of training for road runners.

Method: The tool was developed by a multidisciplinary team combining expertise in Physical Education and software development. The system was implemented using Next.js 15 (App Router), React 19, and TypeScript, with a responsive interface built with Tailwind CSS. For authentication and data persistence, Supabase was used, including Supabase Auth and a PostgreSQL database, with security policies (RLS) for access control. Data from 20 amateur runners with an average age of 63.4 years were used to test functionality. Usability was evaluated by 18 physical education professionals using the SUS instrument (System Usability Scale).

Results: There was no statistical difference between measurements taken manually and via the application. The SUS scale showed a mean value of 97.08 points. Conclusion: The

[1] Dr. in Sport Sciences. Universidade do Estado do Pará (UEPA). E-mail: moises.sousa@uepa.br
Orcid: https://orcid.org/0000-0002-0684-2079
[2] Specialist in Business Management and Market Intelligence. Instituto de Estudos Superiores da Amazônia (IESAM). E-mail: xavierluiguy@gmail.com Orcid: https://orcid.org/0000-0003-1339-4777
[3] Dr. in Ecology and Conservation. Universidade Federal do Pará (UFPA). E-mail: tatyanapinheiro@yahoo.com.br
Orcid: https://orcid.org/0000-0001-8327-4047
[4] Dr. in Sport Sciences. Universidade do Estado do Pará (UEPA). E-mail: divaldozouza21@gmail.com
Orcid: https://orcid.org/0000-0001-9621-3470
[5] Dr. in Energy. Universidade Federal do Amapá (UNIFAP). E-mail: aubrito@unifap.br
Orcid: https://orcid.org/0000-0002-3850-2298

Cooper Pro application is an efficient technological tool with good usability to assist in the prescription of road running training.

Keywords: Road Running. Training. Application.

RESUMO
Introdução: A tecnologia tem sido utilizada por treinadores e corredores de rua na busca por melhores resultados, sem negligenciar aspectos científicos do treinamento, e o uso de aplicativos para esta finalidade pode tornar este processo mais otimizado.

Objetivo: O objetivo foi desenvolver e validar uma ferramenta tecnológica através de aplicativo para auxiliar na avaliação e prescrição do treinamento para corredores de rua.

Método: A ferramenta foi desenvolvida por uma equipe multidisciplinar unindo conhecimentos da Educação Física e do desenvolvimento de software. O sistema foi implementado com Next.js 15 (App Router), React 19 e TypeScript, com interface responsiva construída com Tailwind CSS. Para autenticação e persistência de dados, utilizou-se o Supabase, incluindo Supabase Auth e banco de dados PostgreSQL, com políticas de segurança (RLS) para controle de acesso. Dados de 20 corredores amadores com idade média de 63,4 anos foram utilizados para testar a funcionalidade. A usabilidade foi avaliada por 18 educadores físicos através do instrumento SUS (Systema Usability Scale).

Resultados: Não houve diferença estatística entre medidas realizadas de forma manual e através do aplicativo. A escala SUS apontou valor médio de 97,08 pontos. Conclusão: O aplicativo Cooper Pro constitui-se em uma ferramenta tecnológica eficiente, com boa usabilidade para auxiliar na prescrição do treinamento de corrida de rua.

Palavras-chave: Corrida de Rua. Treinamento. Aplicativo.

RESUMEN
Introducción: La tecnología ha sido utilizada por entrenadores y corredores de ruta en la búsqueda de mejores resultados, sin descuidar los aspectos científicos del entrenamiento, y el uso de aplicaciones con este propósito puede hacer que este proceso sea más eficiente.

Objetivo: El objetivo fue desarrollar y validar una herramienta tecnológica a través de una aplicación para ayudar en la evaluación y prescripción del entrenamiento de corredores de ruta.

Método: La herramienta fue desarrollada por un equipo multidisciplinario que unió conocimientos de Educación Física y desarrollo de software. El sistema se implementó con Next.js 15 (App Router), React 19 y TypeScript, con una interfaz responsiva construida con Tailwind CSS. Para la autenticación y persistencia de datos, se utilizó Supabase, incluyendo Supabase Auth y la base de datos PostgreSQL, con políticas de seguridad (RLS) para el control de acceso. Se utilizaron datos de 20 corredores aficionados con una edad promedio de 63,4 años para probar la funcionalidad. La usabilidad fue evaluada por 18 educadores físicos a través del instrumento SUS (System Usability Scale).

Resultados: No hubo diferencia estadística entre las mediciones realizadas de forma manual y a través de la aplicación. La escala SUS arrojó un valor promedio de 97,08 puntos. Conclusión: La aplicación Cooper Pro se configura como una herramienta tecnológica eficiente, con buena usabilidad para ayudar en la prescripción del entrenamiento de running en ruta.

Palabras clave: Running en Ruta. Entrenamiento. Aplicación.

1 INTRODUCTION

Street running is a current reality, and the number of followers of its practice is growing day by day for various reasons, especially when it comes to the search for health and quality of life, and have been understood as one of the main strategies to increase the practice and levels of physical activity at the population level (Bauman et al., 2021). The number of street races held in the country in the last year grew 29% compared to 2023. In all, in 2024, there were 2,827 official races, involving experienced runners or beginners, men and women, surpassing the mark of 2,186 events of this kind in the previous year (Sponchiato, 2025).

As it is an accessible and low-cost practice, street running has been gaining more and more space in the routine of the Brazilian population. In addition to its accessibility, street running also promotes benefits to the health and quality of life of its practitioners, being responsible for the increase of approximately 10% in the levels of physical activity of the Brazilian population in general, and has been used as an important tool present in action plans, at the government level, to promote physical activity. in different countries (Costa et.al. 2023; Rojo, 2017; Bauman et al., 2021).

The traditional image of the runner, who simply puts on a pair of sneakers and goes out to run through the streets, does not represent the complexity and care that this modality requires. In addition to the act of running, street running requires physical preparation, technical knowledge and, above all, an approach based on scientific bases to ensure safety, efficiency and longevity in sports practice (Borges et al., 2015; Brazil, 2020).

It is common to see beginners disregard essential aspects, such as medical evaluation, training planning, proper choice of equipment, nutrition, and injury prevention. This negligence can bring health risks, limit performance and, in many cases, remove the practitioner from the sport early (Brasil, 2020; Nascimento; Santana, 2016).

Planning and individualization of training are key aspects for success in road running. It is not enough to follow generic spreadsheets found on the internet; It is necessary to consider factors such as age, sports history, fitness level, personal goals and time availability. The guidance of qualified professionals, such as physical educators and physiotherapists, is essential to structure a safe and efficient program. The elaboration of an individualized running training, based on recent scientific bases, is essential for the athlete to reach his full potential (Jones; Carter, 2000; Midgley et al., 2007).

Training is characterized as a repetitive and systematic process, composed of progressive exercises aimed at improving performance. In this sense, physical training can be understood as an organized and systematic process of physical improvement, in its morphological and functional aspects, directly impacting the ability to perform tasks that involve motor demands, whether sports or not (Roschel; Tricoli; Ugrinowitsch, 2011).

The prescription of exercise intensity should be individualized to maximize physiological gains and reduce the risk of injury. The apps facilitate this individualization by adapting the training zones, considering the individuality of the running athlete, something that is difficult to achieve with static spreadsheets (Buxton et al., 2011).

In road running, for a long time, cardiorespiratory capacity (expressed in terms of VO2 max) was considered one of the main predictors of performance in endurance athletes (Joyner, 2018). Traditionally, the assessment of VO2 max requires expensive and difficult-to-access laboratory tests. However, technological advances have allowed the development of indirect methods and the integration of algorithms into applications capable of estimating this crucial variable with good accuracy. VO2 max is widely accepted as the best indicator of cardiorespiratory fitness and endurance capacity, and is essential to direct exercise intensity (Silva, 2007; Buxton et al., 2011).

The 12-minute running test (Cooper test) is widely accepted in the area of Physical Education and Sports Sciences, and is even referenced by important institutions such as the *American College of Sports Medicine* (ACSM) as a valid field method for indirect estimates of VO2 max. The justification for the use of the Cooper test to estimate VO2 max lies primarily in its simplicity of execution in the field and its recognized reliability (reproducibility) in the assessment of cardiorespiratory fitness in large groups (ACSM, 2006).

The test was originally developed by Kenneth Cooper in 1968 based on a high correlation (r=0.90) between the distance covered on the track in 12 minutes and VO2 max measured directly in the laboratory, in a sample of young adults from the US Air Force. The scientific basis of the test lies in the direct correlation between the distance traveled and the maximum volume of oxygen that the body can use at VO2 max. This establishes its validity as a method of indirect prediction. The distance covered directly reflects the ability of the cardiovascular and respiratory system to transport and use oxygen during maximal and prolonged effort, and is a robust indicator of an individual's overall aerobic fitness (Mahseredjian; Barros Neto; Tebexreni, 1999).

The use of VO2 max as a strategy to determine the intensity of training represents an effective, safe approach in line with the best practices of sports science. The personalization of training enhances results, health, motivation and sports longevity of runners. In addition, the monitoring of VO2 max over time makes it possible to make adjustments in the planning, making the training process more dynamic and efficient. This ensures that the athlete is always training in zones that are appropriate to their current goals and conditions, optimizing performance and reducing risks (Bompa; Buzzichelli, 2019).

Considering the complexity of the process of evaluation, prescription and monitoring of a scientifically based training for long-distance runners, and seeking to make this process more practical, faster and more dynamic for coaches, teachers, coaches and athletes, the objective of this study was to develop and validate a tool, through an application, to assist in the evaluation process and in the prescription of training for street runners from the results of the Cooper test.

2 MATERIAL AND METHOD

This research is characterized as applied research, through the development of a technological tool (Cooper Pro application) for practical purposes of evaluation and prescription of training for street runners, using quantitative data from the evaluation of VO2 max, through the Cooper test.

The Cooper Pro was developed by a multidisciplinary team, combining knowledge of Physical Education and software development. The system was implemented with Next.js 15 (*App Router*), *React* 19 and *TypeScript,* with a responsive interface built with *Tailwind CSS.* For authentication and data persistence, *Supabase* was used, including *Supabase Auth* and the *PostgreSQL* database, with security policies (RLS) for access control. The app is structured to work as a PWA (Progressive Web App), with a manifest and *service worker*, allowing installation on mobile and desktop devices. To validate the operation, automated tests (Jest, Testing Library and Playwright) and usage tests were carried out in modern browsers and mobile devices via PWA installation.

The population involved in the tool's efficiency test was made up of individuals of both sexes who were members of the physical conditioning class of the Sports Center project of the Sports and Leisure Center of the State Department of Education of Pará, and a sample composed of 20 randomly chosen individuals was selected, 9 females and 11 males. with a mean age of 63.4 years.

The cardiorespiratory evaluation was performed using a 12-minute run (Cooper test) performed on an official athletics track (400m), where the total distance covered in meters by each subject was obtained. The individual data of the participants, as well as the results obtained in the 12-minute running test, were entered into the interfaces of the Cooper Pro application that calculated the training variables. Then, the same calculations were performed manually, obtaining results similar to those generated by the application.

The validation of the application occurred through the statistical treatment of the data, carried out through the SPSS 25.0 statistical package (IBM), in which descriptive statistics were adopted for the characterization of the sample, through the minimum and maximum values, the arithmetic mean and the standard deviation for the quantitative variables, and the absolute and relative values for the categorical variables.

To verify the differences between the means of the variables performed manually and through the application, the *Student's t-test* for independent variables was performed, adopting a significance level of $p<0.05$.

To test the usability of the application, 18 experienced physical educators, belonging to the Sports and Leisure Center of the Department of Education of the State of Pará, were selected to fill out the questionnaire (SUS) *System Usability Scale,* composed of 10 questions, which evaluate effectiveness (success in using the product), efficiency (effort to use the product) and satisfaction (experience of using the product) on a scale of 1 to 5, 1 being "Strongly disagree" and 5 "Strongly agree".

After the completion of a version without apparent errors, the Cooper Pro application for mobile devices had its registration application submitted to the National Institute of Industrial Property.

3 RESULTS AND DISCUSSIONS

Tables 1 to 3 contain the descriptive data of the sample obtained through the manual measurement and the application, as well as the correlation data between the manual measurements and those obtained by the application, with the objective of verifying the consistency between these measurements.

Table 1

Descriptive characteristics of the sample (minimum and maximum values, arithmetic mean and standard deviation)

Variable	Minimum	Maximum	Arithmetic Mean	Standard Deviation
Age	38,00	80,00	63,40	8,68
Body Mass	35,50	83,50	60,78	11,66

Source: Data Collection

Table 1 shows heterogeneity in relation to the age and body mass of the sample, which may have occurred because the sample was composed of female and male participants.

Table 2

Descriptive characteristics of the sample in both manual and app measurements (arithmetic mean ± standard deviation)

Variable	Manual Measurement	In-App Measurement
Distance measured in the Cooper test	2,146.50 ± 266.03	2,146.50 ± 266.03
VO2 max	36.66 ± 5.94	36.67 ± 5.93
Maximum MET	10.47 ± 1.70	10.47 ± 1.70
Training Fraction	0.80 ± 0.02	0.80 ± 0.02

Training Intensity	8.46 ± 1.54	8.40 ± 1.54
Speed (m/min)	140.94 ± 25.70	140.94 ± 25.70
Distance m/40 minutes)	5,637.76 ± 1,027.83	5,634.60 ± 1,027.55
VO2 in 40 minutes	63.23 ± 17.94	63.23 ± 17.94
Caloric expenditure	316.25 ± 89.72	316.00 ± 89.68
Weight Loss	40.91 ± 11.61	40.89 ± 11.60

Source: Data Collection

Table 2 shows the sample characteristics related to the results verified both in the manual measurement and the measurement obtained through the application.

Table 3

Descriptive characteristics of the sample in the two procedures, manual and application (arithmetic mean ± standard deviation) and comparison of means (t-test)

	Description		**Comparison**	
Variable	**Manual**	**Application**	**t**	**p**
Cooper's result (mts)	2146.50 ± 266.03	2146.50 ± 266.03	0,00	1,000
VO2max. (ml/Kg/min)	36.66 ± 5.94	36.67 ± 5.93	-0,01	0,996
METmax. (METS)	10.47 ± 1.70	10.47 ± 1.69	0,01	0,991
Training Fraction (FT)	0.80 ± 0.02	0.80 ± 0.02	0.86	0,393
Training Intensity (IT)	8.46 ± 1.54	8.40 ± 1.54	0,11	0,913
Speed (mts/min)	140.94 ± 25.70	140.87 ± 25.69	0,10	0,913
Distance (mts)	5637.76 ± 1027.83	5634.60 ± 1027.55	0,10	0,992
Oxygen Consumption (lts)	63.25 ± 17.94	63.20 ± 17.94	0,01	0,993
Caloric expenditure (Kcal)	316.25 ± 89.72	316.00 ± 89.68	0,01	0,993
Weight Loss (g)	40.91 ± 11.61	40.89 ± 11.60	0,01	0,094

Source: Data Collection

Table 3 shows that when comparing the results obtained in the measurements performed manually and through the application, no statistical difference was observed in any of the variables investigated, showing that the measurements are statistically similar.

VO_2 max is widely considered to be the best physiological indicator of an individual's cardiorespiratory fitness and aerobic capacity. It represents the maximum rate at which the body can capture, transport, and use oxygen for energy production (ATP) aerobically during strenuous exercise. Basset; Howley (2000) define the VO_2 max as a representative index of the amount of oxygen, per unit of time, that the body can extract from the environment and use metabolically.

In the present study, the average distance reached in the time of 12 minutes on the track was 2146.50m, however the literature indicates that beginner runners of both sexes present results that vary significantly according to age, establishing that in the age group of 60 years, distances between 1,400 and 1,700 meters are classified as "medium" or "regular" for sedentary people who start the practice. The reference table proposed by Marins and Giannichi (2003) for the Brazilian population suggests that for men over 60 years of age, exceeding 1,600 meters already signals a level of fitness higher than the sedentary average.

High VO_2 max values are crucial for performance in endurance activities such as long-distance running. Aerobic training produces physiological adaptations, such as an increase in the number and size of mitochondria, which contribute to the improvement of VO_2 max (Silva, 2007).

The Metabolic Equivalent (MET**)** is a physiological unit used to express the energy cost of physical activities as multiples of the resting metabolic rate. 1 MET is defined as the amount of oxygen consumed by an individual at absolute rest (sitting calmly), conventionally corresponding to 3.5 ml of O_2 per kilogram of body weight per minute (3.5 ml/kg/min). Peak MET (or VO_2 max) can be determined by a stress test (ergospirometry or exercise test). If an individual achieves 10 METs on the test, this is their maximum capacity, which is equivalent to a VO_2 max of 35 ml/kg/min. (Sousa et. al., 2015).

In the present study, the estimated mean value for the maximum MET was 10.47 mets. This value corroborates the values found in the literature where they indicate that the maximum MET (METmax) in beginners varies significantly according to age, gender and level of previous activity, but is generally between 8 and 12 METs, where Mendes et.al., (2018) identified vigorous intensity thresholds around 6.8 METs for the general population, suggesting that the peak effort (maximum) for an untrained beginner hardly exceeds 10-11 METs at the beginning of the program.

A study by Heydenreich et.al., (2019) compared beginner and trained endurance athletes and found that while athletes reached high averages, beginners had a VO2 max between 34.4 and 42.8 mL/kg/min, which corresponds to a maximum MET of approximately 9.8 to 12.2 METs (considering 1 MET = 3.5 mL/kg/min).

For beginners, maximum MET is a superior clinical prescribing tool to simple running speed. The transition from sedentary to beginner runner promotes "angiogenesis" (formation of new capillaries) and increased mitochondrial density. Moderate-intensity and continuous training is effective in raising initial VO2 max, but the progressive inclusion of high-intensity intervals (HIIT) has been shown to be more efficient in breaking physiological plateaus in subsequent phases (Ross *et al*. 2016; Scribbans *et al*., 2016).

Training Fraction (Relative Intensity) typically refers to the relative intensity of exercise, often expressed as a percentage of VO_2 max, maximum heart rate (%HRmax), or relative to training thresholds (aerobic and anaerobic threshold). Intensity is one of the crucial acute variables of training, being a determining factor of physiological adaptations, as higher intensities can generate greater improvements in VO_2 max in trained athletes (Daussin et al, 2008).

In the present study, considering the characteristics of the sample, a training fraction (TF) equivalent to 0.80% of the maximum Met was adopted, which shows an average speed of 140.94 m/min, corresponding to a total distance of 5,637 meters in 40 minutes of training.

According to the ACSM's (2021) guidelines, the training fraction (FT) by the maximum MET is an intensity prescription method that uses the percentage of maximum functional capacity (measured in METs) achieved in a stress test. The ideal intensity for aerobic activities usually varies between 50% and 85% of the maximum MET, corresponding respectively to a Light/Moderate Training with ~50% to 60% of the maximum MET. and an Intense Workout: >70% of max MET.

The speed controlled during aerobic running training is determinant for the intensity of the exercise and, consequently, for the physiological adaptations obtained. Recent studies show that maintaining a constant speed, adjusted to the practitioner's ventilatory threshold, enhances gains in cardiorespiratory capacity and reduces the risk of overload injuries. The prescription based on controlled speed allows for a better individualization of training, promoting more consistent responses in relation to the increase in VO_2 max and overall performance (Silva et al., 2021; Jones et al., 2022).

In the present study, considering the average weight of the subjects and the proposed training fraction, the estimated oxygen consumption for a continuous training of 40 minutes at a speed of 140.94 m/min was 63.25 liters, which corresponds to an average caloric expenditure of 316.25 Kcal, generating an average of 40.91 g of weight loss.

According to the ACSM (2018), more experienced runners have more efficient mechanics, which can reduce the cost of oxygen for the same speed compared to beginners. This means that the actual expenditure may be slightly lower than the generalist formulas, approaching the lower limit of the estimates (about 340-350 kcal).

Oxygen uptake (VO_2) is considered one of the main indicators of aerobic fitness and is directly related to performance in endurance activities. Training performed at controlled speeds close to the anaerobic threshold promotes significant adaptations in VO_2 max, reflecting improvements in metabolic efficiency and the ability to sustain prolonged efforts (Fernandes et al., 2020).

The manipulation of speed directly influences the recruitment of different energy systems, affecting the volume of oxygen consumed during exercise. Recent literature also points out that the gradual progression of speed throughout sessions can result in more robust cardiovascular adaptations, reducing early fatigue and optimizing performance (Pereira et al., 2022; Costa and Souza, 2021).

Fat loss during a 40-minute run at a moderate pace depends primarily on the athlete's total calorie balance and heart rate, with the greatest lipid oxidation occurring at specific intensities. The metabolism of an intermediate athlete is more efficient in mobilizing and oxidizing fat (lipolysis) than that of a sedentary individual, even at higher intensities. The literature suggests that lipolysis provides free fatty acids for direct oxidation in the muscles, and the body begins to burn a significant amount of fat after using rapid energy (glycogen), usually after 20 to 30 minutes of moderate and continuous aerobic activity. The duration of 40 minutes is therefore effective for this purpose (Hetlelid et.al., 2014; Mcardle, Katch, Katch, 2016; Nieman, 2017).

Caloric expenditure during running training is a central component in the process of losing body fat, and the combination of controlled speed with adequate durations of exercise enhances the caloric deficit, promoting significant reductions in fat percentage. In addition, moderate to vigorous intensity, achieved by speed control, is associated with an increase in post-oxygen consumption (EPOC), which increases total energy expenditure after exercise. Speed control allows for better maintenance of the pace throughout the workout, avoiding abrupt drops in intensity and favoring lipid oxidation as the primary source of energy. This mechanism is essential for fat loss, especially in long-term programs, in which the consistency of caloric expenditure is decisive for the success of weight loss (Almeida et al., 2022; Moraes and Lima, 2023).

4 CONCLUSION

Recent literature reinforces the importance of speed control in aerobic running training for maximizing oxygen consumption, caloric expenditure, and body fat loss. The use of technological tools through applications capable of assisting tasks related to training prescription, taking into account individualized prescription, based on physiological parameters, as well as continuous monitoring, contributes to the achievement of more significant results among street runners.

The Cooper Pro app proved to be efficient, fast and easy to use for determining important variables for training, such as VO2 max, max MET, training fraction (FT), training intensity (IT), training speed in Km.h-1 and m.min-1, training duration, distance to be covered in training, training oxygen consumption in L.min-1, caloric expenditure from training in kcal, and estimated fat loss in grams per training session. In addition, the application assists in the prescription of interval training based on VO2 max, determining variables such as distance, time, number of repetitions and recovery interval, thus allowing the organization of weekly training.

REFERENCES

Almeida, R. S., et al. (2022). Efeitos do treinamento aeróbico controlado na perda de gordura corporal: Uma revisão sistemática. Revista Brasileira de Medicina do Esporte, 28(2), 145–152.

American College of Sports Medicine. (2006). Manual do ACSM para avaliação da aptidão física relacionada à saúde. Guanabara Koogan.

American College of Sports Medicine. (2018). Diretrizes do ACSM para os testes de esforço e sua prescrição (10ª ed.). Guanabara Koogan.

American College of Sports Medicine. (2021). ACSM's guidelines for exercise testing and prescription (11th ed.). Wolters Kluwer.

Bauman, A. E., et al. (2021). An evidence based assessment of the impact of the Olympic Games on population levels of physical activity. The Lancet, 398(10298), 456–464.

Bassett, D. R., Jr., & Howley, E. T. (2000). Limiting factors for maximum oxygen uptake and determinants of endurance performance. Medicine and Science in Sports and Exercise, 32(1), 70–84.

Bompa, T. O., & Buzzichelli, C. (2019). Periodização: Teoria e metodologia do treinamento (6ª ed.). Phorte.

Borges, J. R., Silva, A. C., & Souza, M. R. (2015). Bases fisiológicas da corrida de rua. Revista Brasileira de Medicina do Esporte, 21(3).

Brasil. Ministério da Saúde. (2020). Atividade física e saúde: Guia para a população. Ministério da Saúde.

Buxton, S. O., et al. (2011). The relationship between VO2max and physical activity in a young adult population. Journal of Sports Science & Medicine.

Costa, G. L., et al. (2023). Corrida de rua e sistema imunológico. In R. A. T. Costa & E. S. Barbosa (Orgs.), Estudos avançados interdisciplinares (Vol. 21). Editora Enterprising.

Costa, M. J., & Souza, L. A. (2021). Velocidade de corrida e adaptações cardiovasculares: Uma análise longitudinal. Journal of Physical Activity and Health, 18(4), 320–328.

Daussin, F. N., et al. (2008). Effect of interval vs. continuous training on cardiorespiratory fitness, maximal oxidative capacity, and peripheral diffusion in humans. American Journal of Physiology-Regulatory, Integrative and Comparative Physiology, 295(1), R266–R272.

Fernandes, T. R., et al. (2020). Consumo de oxigênio e desempenho aeróbico em corredores treinados. Motricidade, 16(3), 211–218.

Hetlelid, K. J., et al. (2014). A three times higher fat oxidation in elite runners compared to non-elite runners during high-intensity exercise. Journal of Sports Science and Medicine, 13, 770–779.

Heydenreich, J., Schutz, Y., Melzer, K., & Kayser, B. (2019). Comparison of conventional and individualized 1-MET values for expressing maximum aerobic metabolic rate and habitual activity related energy expenditure. Nutrients, 11(2), Article 458.

Jones, A. M., & Carter, H. (2000). The effect of endurance training on parameters of aerobic fitness. Sports Medicine, 29(6), 373–386.

Jones, A. M., et al. (2022). Controlled running speed and cardiorespiratory adaptations: Recent findings. European Journal of Applied Physiology, 122(6), 1345–1353.

Joyner, M. J., & Lundby, C. (2018). Concepts about VO2max and oxygen delivery to muscle. The Journal of Physiology, 596(7), 1215–1220.

Mahseredjian, F., Barros Neto, T. L. de, & Tebexreni, A. S. (1999). Estudo comparativo de métodos para a predição do consumo máximo de oxigênio em atletas. Revista Brasileira de Medicina do Esporte, 5(5), 167–172.

Marins, J. C. B., & Giannicchi, R. S. (2003). Avaliação e prescrição de atividade física: Guia prático (3ª ed.). Shape.

Mendes, M. D. A., da Silva, I., Ramires, V. R. R., Reichert, F. F., Martins, R. C. R., et al. (2018). Metabolic equivalent of task (METs) thresholds as an indicator of physical activity intensity. PLoS ONE, 13(7), Article e0200701.

McArdle, W. D., Katch, F. I., & Katch, V. L. (2016). Fisiologia do exercício: Nutrição, energia e desempenho humano (8ª ed.). Guanabara Koogan.

Midgley, A. W., McNaughton, L. R., & Jones, A. M. (2007). Training to enhance the physiological determinants of long-distance running performance. Sports Medicine, 37(10), 857–880.

Moraes, F. P., & Lima, N. S. (2023). Gasto calórico e metabolismo lipídico durante o exercício aeróbico de intensidade controlada. Arquivos de Ciências do Esporte, 41(1), 77–85.

Nascimento, P. H., & Santana, E. A. (2016). Prevenção de lesões na corrida: Uma abordagem baseada em evidências. Fisioterapia & Movimento, 29(1).

Nieman, D. C., et al. (2017). Postexercise serum concentrations of metabolomics biomarkers vary according to exercise intensity and duration. Journal of Applied Physiology, 123(4), 782–790.

Pereira, G. H., et al. (2022). Efeitos da variação de velocidade sobre o consumo de oxigênio em adultos fisicamente ativos. Fisiologia do Exercício, 13(2), 99–107.

Rojo, J. R., et al. (2017). Transformações no modelo de corridas de rua no Brasil: Um estudo na Prova Rústica Tiradentes. Revista Brasileira de Ciência e Movimento, 25(1), 19–28.

Roschel, H., Tricoli, V., & Ugrinowitsch, C. (2011). Treinamento físico: Considerações práticas e científicas. Revista Brasileira de Educação Física e Esporte, 25(spe), 53–65.

Ross, R., et al. (2016). Importance of assessing cardiorespiratory fitness in clinical practice: A case for fitness as a clinical vital sign. Circulation, 134(24), e653–e699.

Scribbans, T. D., et al. (2016). The effect of training intensity on VO2max in young healthy adults: A meta-regression and meta-analysis. Journal of Physical Therapy Science, 28(4), 1311–1320.

Silva, A. E. L. (2007). Consumo máximo de oxigênio durante o exercício físico: Aspectos temporais e ajustes de curvas. Revista Brasileira de Cineantropometria & Desempenho Humano.

Silva, M. A., et al. (2021). Individualização do treinamento aeróbico: O papel da velocidade controlada. Revista Brasileira de Educação Física e Esporte, 35(3), 213–220.

Silva, S. F., et al. (2007). Respostas dos treinamentos aeróbico e de força no VO_2máx. Brazilian Journal of Biomotricity, 1(4), 103–113.

Sousa, N. M. F., et al. (2015). Método indireto de determinação da intensidade de exercício de força. Revista Brasileira de Prescrição e Fisiologia do Exercício.

Sponchiato. (2025). O boom das corridas de rua no Brasil. Veja. https://veja.abril.com.br/saude/o-boom-das-corridas-de-rua-no-brasil/