International Platform of Registered Systematic Review and Meta-analysis Protocols

INPLASY

Physical and Physiological aspects in CrossFit®: a scoping review with evidence gap map and meta-correlation

INPLASY202450063

doi: 10.37766/inplasy2024.5.0063

Received: 14 May 2024

Published: 14 May 2024

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ADMINISTRATIVE INFORMATION

Support - N/A.

Review Stage at time of this submission - Preliminary searches.

Conflicts of interest - None declared.

INPLASY registration number: INPLASY202450063

Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 14 May 2024 and was last updated on 14 May 2024.

INTRODUCTION

Review question / Objective The present scoping review aims to summarize: (1) the physical and physiological demands in CrossFit® including the effects of CrossFit® practice in comparison with other fitness activities or variation by competition level; (2) interpret the literature that explains different activity profiles within the CrossFit® context; (3) identify literature gaps and point suggestions for further research.

Condition being studied CrossFit® is a high-intensity fitness program that integrates elements from various disciplines including weightlifting (e.g., snatch, clean and jerk), gymnastics (e.g., handstand walk, ring muscle-ups), and cardiovascular activities (e.g., running, rowing, cycling). The training sessions are designed to enhance multiple components of fitness such as strength, stamina, flexibility, and coordination through varied and functional movements. CrossFit® workouts are often structured as high-intensity circuits that aim to maximize performance in minimal time, involving formats like rounds for time (RFT), as many rounds as possible (AMRAP), and every minute on the minute (EMOM). Given its complex and diverse nature, CrossFit® impacts a range of physical and physiological parameters. These include measures of physical performance (e.g., body composition, strength), physiological outputs (e.g., VO2 max, heart rate), and the acute and chronic effects of various workout routines.

METHODS

Participant or population This review focuses on adult CrossFit® participants who meet the following criteria:

a. Training Experience: Participants must have prior CrossFit® training experience. The studies included must explicitly describe the minimum training experience required or report training practices as descriptive data. This ensures that the participants have a foundational understanding and capability in performing CrossFit® workouts.
b. Age: Only adult participants (18 years and older) will be included in the review. This is to ensure the relevance of the findings to an adult population, given the physiological and physical differences compared to younger individuals.
c. Competitive Level: The review will cover participants across different competitive levels, from recreational practitioners to elite athletes. This includes those who participate casually, as well as those involved in structured competitions like the CrossFit® Open, quarterfinals, semifinals, and the CrossFit® Games.
d. Health Status: The review will include studies that involve healthy participants. Individuals with specific health conditions or injuries that might influence their performance or physiological responses to CrossFit® training will not be the primary focus, unless the study explicitly relates to the typical CrossFit® population.
e. Gender: Both male and female participants will be included to provide a comprehensive overview of CrossFit®'s impact across genders.

Intervention The interventions evaluated in this review encompass a broad range of CrossFit® training activities and their associated outcomes. Specifically, the review focuses on the following:
1. CrossFit® Workouts: These are high-intensity functional training sessions that include a variety of exercises combining weightlifting, gymnastics, and cardiovascular activities. The workouts are often categorized into different formats:
a. Rounds for Time (RFT): Participants complete a set number of exercise rounds as quickly as possible.
b. As Many Rounds As Possible (AMRAP): Participants perform as many rounds of a given set of exercises within a specified time limit.
c. Every Minute on the Minute (EMOM): Participants perform a specific set of exercises at the start of each minute for a predetermined number of minutes.
d. Named Workouts: Specific workouts such as "Angie," "Chelsea," and "Nate," which are standardized routines known within the CrossFit® community.

2. Training Load Variability: The review examines how varying the number of repetitions, sets, load lifted, rest periods, and types of exercises in different CrossFit® sessions influences physical and physiological outcomes. This includes acute and chronic adaptations to these training variables.

3. Comparative Interventions:
a. Other Fitness Activities: Studies comparing CrossFit® with other forms of physical training such as traditional resistance training, aerobic exercise, or other high-intensity interval training (HIIT) protocols.
b. Competitive Levels: Interventions that compare the effects of CrossFit® training among participants at different competitive levels (e.g., recreational vs. elite athletes).

4. Performance Metrics: Evaluating performance outcomes related to CrossFit® training, including improvements in physical fitness parameters (e.g., strength, endurance, body composition) and physiological measures (e.g., VO2 max, heart rate response, lactate threshold).

5. Recovery and Adaptation: Studies assessing the recovery processes and adaptations resulting from CrossFit® workouts, including metrics like heart rate variability, muscle soreness, and hormonal responses..

Comparator In this review, the comparative interventions applied to the target population of adult CrossFit® participants with prior training experience include:

1. Traditional Resistance Training: Studies comparing CrossFit® participants to those engaging in conventional resistance training programs, which typically involve structured weightlifting exercises with predetermined sets, repetitions, and rest periods.

2. Aerobic Exercise: Comparisons between CrossFit® and traditional aerobic exercise regimens such as running, cycling, or swimming, which focus primarily on cardiovascular endurance.

3. High-Intensity Interval Training (HIIT): Evaluating the differences and similarities between CrossFit® and other forms of HIIT that involve short bursts of intense exercise followed by rest or low-intensity exercise.

4. Sedentary or Inactive Individuals: Comparing physical and physiological outcomes of CrossFit® participants with those of sedentary or inactive individuals to highlight the effects of high-intensity functional training on health and fitness markers.

5. Other Functional Fitness Programs: Comparisons with other functional fitness programs or sports that incorporate elements of high-intensity, varied exercises, such as boot camps or military training programs.

6. Different Competitive Levels within CrossFit®: Analyzing differences in physical and physiological outcomes between recreational CrossFit® participants and competitive athletes, including those participating in the CrossFit® Open, quarterfinals, semifinals, and the CrossFit® Games.

7. No Training or Control Groups: Studies that include a no-training control group to assess the baseline changes in fitness and physiological parameters without any intervention.

Study designs to be included No restrictions were applied to the type of studies included in the present review.

Eligibility criteria In addition to the criteria defined in the PICOS framework, the following additional inclusion and exclusion criteria will be applied:

1. Inclusion Criteria:
a. Language: Studies must be published in English, Portuguese, or Spanish.
b. Publication Status: Only peer-reviewed journal articles, including those ahead of print, will be considered. Conference abstracts, dissertations, and unpublished studies will be excluded.
c. Publication Type: Original research articles, systematic reviews, and meta-analyses will be included if they provide relevant data on the physical and physiological demands of CrossFit® training.

2. Exclusion Criteria:
a. Populations: Studies involving participants with specific health conditions or injuries, unless these studies focus on typical CrossFit® populations or training adaptations. Studies focusing solely on novice or inexperienced CrossFit® participants without prior training experience.
b. Interventions: Studies that do not specifically involve CrossFit® training or its typical elements (e.g., weightlifting, gymnastics, cardiovascular activities). Studies focusing solely on nutritional interventions without addressing physical or physiological aspects of CrossFit® training.
c. Outcomes: Studies that do not report on physical performance, physiological measures, or related outcomes (e.g., purely psychological studies). Studies where relevant data on physical and physiological parameters cannot be extracted or are not clearly reported.
d. Study Design: Editorials, opinion pieces, commentaries, and narrative reviews that do not provide empirical data. Case studies or single-subject designs that do not allow for broader generalization of results.

Information sources The review will draw upon a range of information sources to ensure a systematic gathering of relevant literature. The intended sources include:

1. Electronic Databases:
a. PubMed: A comprehensive resource for biomedical and life sciences research, providing access to a vast collection of articles related to health and fitness.
b. Scopus: A multidisciplinary database covering a broad range of subjects, including physical and physiological studies relevant to CrossFit®.
c. Web of Science: An extensive database that includes research across multiple disciplines, ensuring thorough coverage of studies related to CrossFit® training.

2. Citation Manager Software:
a. EndNoteTM 21.0 (ClarivateTM): Used to manage and organize the citations retrieved from the electronic databases. This software will facilitate the removal of duplicates and help streamline the selection process.

Main outcome(s) The review will focus on a comprehensive set of outcomes to evaluate the physical and physiological demands of CrossFit® training. These outcomes will be assessed in terms of both acute (short-term) and chronic (long-term) effects, and relevant effect measures will be detailed as follows:

Primary Outcomes
1. Physical Performance Measures: body composition, strength, endurance, power, and speed.
2. Physiological Outputs: Maximal Oxygen Uptake, Heart Rate, Blood Lactate Levels Hormonal Levels,

Secondary Outcomes
1. Acute Effects of CrossFit® Workouts:
a. Recovery Metrics: Time to recovery, perceived muscle soreness (using scales such as the Visual Analog Scale), and heart rate variability.
b. Performance Metrics Post-Workout: Performance decrements or improvements in subsequent workout sessions.

2. Chronic Effects of CrossFit® Participation:

a. Training Adaptations: Long-term changes in body composition, strength, endurance, power, and speed.
b. Health Indicators: Blood pressure, lipid profiles, glucose levels, and other markers of overall health and fitness.
c. Psychological Outcomes: Measures of motivation, adherence, and psychological well-being associated with regular CrossFit® training.

3. Comparative Outcomes:
a. Comparison with Other Training Modalities: Differences in physical and physiological outcomes when compared to traditional resistance training, aerobic exercise, HIIT, and other fitness programs.
b. Competitive Levels: Variations in outcomes among recreational participants, competitive athletes, and elite CrossFit® competitors.

Effect Measures
1. Descriptive Statistics: Mean, standard deviation, and range for continuous variables; frequencies and percentages for categorical variables.

Quality assessment / Risk of bias analysis N/A.

Strategy of data synthesis
Data Extraction
Data will be extracted using a predefined template to ensure consistency. Information will include study characteristics (e.g., author, year, sample size, study design), participant characteristics (e.g., age, gender, training experience), intervention details (e.g., type of CrossFit® workouts, duration, frequency), and outcomes measured (e.g., body composition, VO2 max, strength, endurance).

Data Verification
Extracted data will be independently verified by a third author to ensure accuracy. Any discrepancies will be resolved through discussion and consensus.

Data Organization
Data will be organized into seven different sheets based on the predefined topics: descriptive data of physical and physiological outputs, acute effects of workouts, chronic effects, comparisons with other training types, differences by competitive level, observational studies, and predictors of CrossFit® performance.

Subgroup analysis Subgroup analyses to explore differences based on participant characteristics (e.g., gender, competitive level), types of CrossFit® workouts, and training protocols.

Sensitivity analysis N/A.

Language restriction Original studies published or ahead of print published in peer-reviewed journals and written in English, Portuguese and Spanish were included in the present review.

Country(ies) involved Portugal; United Kingdom; Brazil.

Keywords CrossFit®; High-Intensity Functional Training; Physiological Demands; Physical Performance; Training Load.

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