



Psychological variables of CrossFit participants: a systematic review

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Received: 26 March 2020 / Accepted: 30 July 2020 / Published online: 29 August 2020
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Abstract

Objective This study aimed to review the existing literature concerning the psychological variables of CrossFit participants.

Methodology This review followed the PRISMA guidelines and was documented in the PROSPERO registry (CRD42018091177). Six electronic databases (SCOPUS, PubMed, SPORTDiscus, Web of Science, EMBASE, and Cochrane) were searched from their inception through July 2020. The methodological quality of the studies was assessed.

Results Thirty-four studies met the inclusion criteria. We observed an increase in satisfaction, clinical addiction, and enjoyment among participants related to exercise, social improvement, and high intrinsic motivation to participate for the purpose of enjoyment, challenge, and affiliation. Perceptions of effort were high among CrossFit participants. Some studies found that the reaction time was impaired after the CrossFit session, whereas others found no changes in mental health, self-esteem, and well-being after training.

Conclusion Adherence and maintenance of the practice of CrossFit are related to psychological variables such as motivation and satisfaction of basic psychological needs. CrossFit participants demonstrated high perception of effort, intrinsic motivation, and reasons for practice such as enjoyment, challenge, and affiliation. The quality assessment demonstrated the need for more detail in the methods section of future investigations. Additional high-quality studies are needed to investigate the effects of CrossFit training on the mental health of participants.

Keywords Sport psychology · High-intensity interval training · Motivation · Mental health · Mood

Electronic supplementary material The online version of this article (<https://doi.org/10.1007/s11332-020-00685-9>) contains supplementary material, which is available to authorized users.

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Introduction

Extreme conditioning programs (ECPs) are physical exercise programs characterised by high intensity and high volume, with short or no rest periods [1, 2]. ECPs through exercise from gymnastics, weightlifting, calisthenics and others, aim to foster the development of physical fitness in several domains such as cardiorespiratory fitness, strength, flexibility, and power [3].

Among ECPs, some training methods have emerged as registered trademarks, such as Insanity[®], Gym Jones[®], P90X[®], and CrossFit[®], the latter of which has shown greater popularity and growth [2]. CrossFit is characterised by a relatively new method of physical training that includes the performance of functional exercises of constant variation, from running and rowing to Olympic Weightlifting (e.g. Snatch and Clean and Jerk), and gymnastic movements, as well as plyometric and calisthenics, which are performed at a high intensity [4]. CrossFit aims to develop components of physical fitness related to health and motor performance: aerobic capacity, muscular strength and endurance, stamina,

flexibility, speed, coordination, accuracy, agility, balance, and power [3].

CrossFit has been gaining popularity since its inception and implementation about 20 years ago, with significant growth in the number of participants and in the number of gyms offering the practice, called ‘boxes’ [5]. CrossFit boxes are located in 142 countries across all 7 continents, currently totalling more than 14,000 affiliates [6]. Evidence shows that high-intensity modalities have shown significant growth amongst different populations including healthy individuals, obese individuals, and athletes [7–9].

There has been a trend in recent studies to carry out research on psychological factors in sports [10] with respect to the effects of physical exercise on health [11] and the influence of psychological aspects on athletes’ performance [12]. However, review studies on CrossFit [2, 13] have mainly focused on the effects of CrossFit on components of physical fitness focusing on the five domains of physical fitness (cardiovascular/respiratory resistance, endurance, strength, flexibility and power) and on possible injuries in CrossFit participants [14, 15]. In addition to improving the physical conditioning of practitioners, the recent expansion of CrossFit may be associated with psychological variables of participants, such as motivation, which leads people to adhere to and maintain exercise [16]. In this sense, we highlight the study of motivation in the field of Sports and Exercise Psychology [17]. As reported by Dominski et al. [16], CrossFit training is conducted with a great sense of belief and identify, with inherent rewards influencing exercise adherence. However, there is a need to know about other psychological variables that can influence in the participation such as mood states [18]; anxiety [19]; body satisfaction [20]; psychological needs and behavioural regulation [9].

Gathering information on the motivation and psychological needs of participants can contribute to the understanding of growth and interest in CrossFit, their influence on adherence to and maintenance of physical exercise practice [21], and psychological aspects related to recreational performance, athlete performance [22], and injury [15].

The CrossFit training shows peculiar characteristics including the sense of community promoted by the training group mode with a supportive and tight-knit community [23], the functionality and scalability of movements and exercises [24], the motivational and the competition environment including self-challenge not only through breaking of personal fitness records, but also among the pairs [25, 26]. Furthermore, it is recognized that the CrossFit environment emphasizes the body’s function over its appearance [27], differing from traditional resistance training modalities. CrossFit encourages individuals to change their behavior, influencing the adoption of a healthy lifestyle, involving general practitioners of varying levels of fitness and athletes as a sport modality [28].

A comprehensive review of the available literature, considering multiple psychological variables related to health and performance can foster the understanding of this type of training, collaborating for evidence-based practice, and to highlight gaps in the literature and offering directions for future research. In view of the current levels of physical activity around the world, knowledge about the influence of psychological variables on individuals’ participation in CrossFit may be useful to promote exercise interventions that boost long-term adherence. In sum, the aim of the present study is to review the existing literature concerning the psychological variables of CrossFit participants, with a view of distinguishing between short-term (acute) and long-term (chronic) effects.

Methods

Registration and guidelines

This systematic review was conducted according to the recommendations from the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [29]. The review was recorded in the *International Prospective Register of Systematic Review* (PROSPERO) registry (registration number CRD42018091177), prior to completion of formal screening of search results based on eligibility criteria. The PRISMA checklist is provided in the Supplementary material.

Search strategy

Studies were searched using the following electronic databases: SCOPUS (Elsevier), PubMed (*National Library of Medicine and National Institutes of Health*), SPORTDiscus via EBSCO, *Web of Science* (Main collection—*Thomson Reuters Scientific*), EMBASE, and Cochrane Library. The search strategies for each database are provided in the Supplementary material. The search terms used in the databases were “extreme conditioning program*” OR “crossfit” OR “high-intensity functional training” OR “crosstraining” AND “psychology” OR “sport psychology” OR “exercise psychology” in the search fields of the databases. This strategy was permuted in all databases, with integrated searches in the title, abstract, and subject fields. We searched these databases from their inception through July 2020.

The Web of Science database was prioritised in decisions regarding duplicate articles, and such searches were carried out in the Core Collection in the basic research field with the terms for the topic item and the time stipulated as all years. The supplementary material contains the search strategies used in each database.

Manual search and grey literature

References lists of all identified studies were searched for further relevant articles [30]. Eight additional studies were identified from the manual search. Besides that, the search strategy was complemented with a comprehensive search of the ‘grey’ literature, including publications not published in indexed peer-reviewed journals.

Eligibility criteria

We included only original articles that investigated psychological variables of CrossFit participants. A CrossFit participant was defined as a person who practices CrossFit as an athlete or common participant at least three times a week. We included studies that investigated the following topics related to the psychology of CrossFit participants for the analysis: attention, activation, cohesion, cooperation, cognition, concentration, coping, feedback, flow-feeling, leadership, motivation, satisfaction, self-determination, sense of community, decision making, mental health, perfectionism, personality, mental training, and visualisation (related to participation), abandonment, addiction, aggression, anxiety, burnout, dependence, dropout, mood, body image, perception of competence, self-confidence, self-efficacy, self-esteem, depression, emotions, stress, reaction time (related to psychological effects of participating).

Only quantitative and qualitative studies (or mixed method) with an abstract and full text available online until July 2020 and in the English, Spanish or Portuguese languages were included. We did not restrict the search by starting date. We excluded review articles, case studies, conference papers, editorials, and letters.

Eligibility criteria for this systematic review were based on the Population, Intervention, Comparator, Outcome, Study design (PICOS) statement [31] (Table 1).

Study selection and data extraction

Two reviewers (FHD and TTS) independently performed the search and assessed the eligibility of each article. Discrepancies were solved by a third researcher (TCS). We screened all included titles and abstracts and reviewed the full text of articles that met our predetermined inclusion and exclusion criteria. The authors (FHD and TTS) independently extracted the data from all included studies.

Our search identified 646 articles; the full text of 34 was reviewed, and 26 were selected, besides 8 further studies identified by reference checking, totalling 34 studies included in the narrative review. A PRISMA flowchart of the search is presented in Fig. 1. Full references of included studies are provided in the Supplementary material.

After study selection and data extraction, analyses were carried out regarding the study design: cross-sectional, experimental, and qualitative. We extracted the following data: title, authors, journal, year of publication, objective of the studies, sample (number of subjects, gender, age, and level), study design, type of intervention, and main study results. Because our objective focused on a broad range of psychological factors, we have divided the discussion section according the prevalence of psychological variables studied. If findings related to a variable appeared in at least two studies, then this was considered to be a specific topic in the discussion, and the variables in a topic were grouped.

Quality assessment

Quality assessment of the 34 studies that met the inclusion criteria was performed using three established scales (STROBE, SRQR, and TESTEX) according to the study design (cross-sectional, qualitative, and experimental, respectively). Two independent reviewers (FHD and TTS) evaluated each of the 34 studies using the three established scales, and the assessment of each study is described in supplementary material (Tables S6, S7, and S8).

To assess the methodological quality of the studies, the recommendations of STROBE (Strengthening the

Table 1 Eligibility criteria for inclusion of studies in a systematic review

		Inclusion	Exclusion
P	Participate	Any CrossFit participant	Participants of other types of physical exercise
I	Intervention	CrossFit	Massages, manual therapy, stretching, alternative therapies, weight training, walking or running, high-intensity interval training (HIIT)
C	Comparision	With healthy individuals or not, with groups of other physical exercises or control group without intervention	–
O	Outcome	Psychological aspects	–
S	Study	Cross-sectional, randomized and non-randomized	Case studies, review, meta-analysis

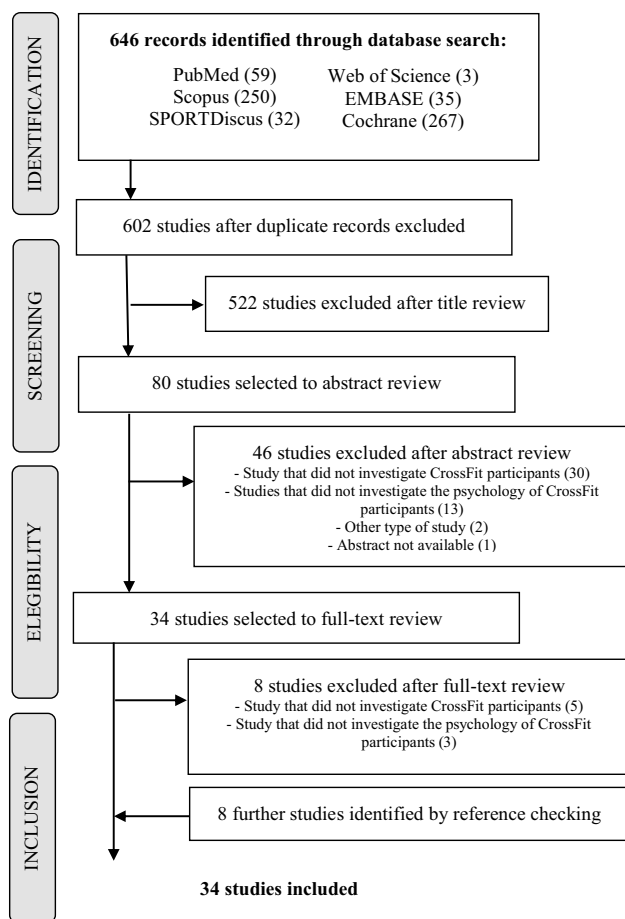


Fig. 1 Flow diagram illustrating literature research and selection process

Reporting of Observational Studies in Epidemiology) were followed, by means of the STROBE statement Checklist of Items That Should Be Included in Reports of Cross-sectional Studies [32]. This checklist includes 22 items that received a score from 0 (does not meet) to 1 (meets), where total adherence is expressed as a percentage of the items present.

The Standards for Reporting Qualitative Research (SRQR) recommendations [33] were used to evaluate the qualitative studies. This scale has 21 items, and each study was given a score from 0 to 21 and was coded as being of low (score of 0–7), medium (score of 8–14), or high quality (score of 14–21).

The TESTEX (Tool for the assessment of Study quality and reporting in Exercise) [34] scale was used to evaluate the quality of experimental studies. This scale was designed specifically for use in exercise training studies, and it uses a 15-point scale (5 points for study quality and 10 points for reporting).

Results

Exercise psychology themes such as motivation, adherence, self-esteem, attention, well-being, body awareness, exercise addiction, effort, mood, anxiety, social identity, athletic identity, sense of community, enjoyment, personality, perception of body competence, satisfaction with body image, and mental health were identified.

Overview of the research

In total, the 34 studies included 7101 participants, comprising 6122 (86.21%) CrossFit participants and 979 (13.79%) participants of other types of exercise, who composed the control group. The sample comprised 3749 (52.79%) men and 3352 (47.21%) women. Two studies analysed athletes ($n=94$) of CrossFit [19, 35].

Four studies (11.77%) used a qualitative (semi-structured interview and focus group) design, and the remaining 30 studies (88.23%) used a quantitative design (cross-sectional $n=20$, experimental $n=10$). One study used a mixed method (quantitative and qualitative design), but the study was classified as quantitative due to the predominance of this design. Regarding cross-sectional studies, the adherence to the STROBE criteria varied between 36.3 and 83.3%. The median TESTEX score for experimental studies was assessed as 6 (min. 1; max. 14).

Tables 2 and 3 present the sample characterisation and results found in the studies with a cross-sectional design (20 studies), experimental (10 studies), and qualitative design (4 studies), respectively.

Cross-sectional studies

The results of cross-sectional studies revealed an increase in satisfaction [9, 36], addiction [3] from exercise, social enhancement [9] and sense of community [26], and high intrinsic motives for practice to gain enjoyment, challenge, and affiliation [7, 37, 38]. The studies showed that the perception of effort was high among CrossFit participants [36, 39, 40] and that competence-related goals were higher among more experienced individuals [41]. Weekly training frequency was also related to greater social capital and a greater feeling of community [23], as well as with body image [42]. The length of participation was positively related to relatedness and enjoyment [43], and negatively associated with disordered eating [38]. There is no link between CrossFit participation and self-esteem [38, 49]. Studies have noted that men have more performance-related goals [41] and that they are more motivated by factors associated with challenge, social recognition, competition, strength, endurance,

Table 2 Cross-sectional studies analyzing psychological variables of CrossFit participants ($n = 20$)

References	Theme	Sample		Results	Adherence to the STROBE Criteria (total/%)	
		<i>n</i>	Caract./Gender			
Partridge, Knapp and Massengale [41]	Motivacional climate	144	Participants 56 men and 88 women	34.4	Males reported higher levels of performance approach goals and females reported higher levels of master avoidance goals (Mav). Participants who reported shorter membership times were found to have significantly higher mastery-related goals than individuals who reported longer membership times. Participants who reported shorter membership times (less than 6 months) were found to have significantly higher mastery-related goals than individuals who reported longer membership times (more than 6 months)	13/59.1
Martínez and Marmól [39]	Effort, enjoyment and learning	104	Adolescents 62 boys and 42 girls	14.7	High effort perception in CrossFit classes. Adolescents showed high levels of enjoyment and learning perception after CrossFit practice. Boys perceive higher enjoyment and intensity than girls	13/59.1
Fisher et al. [7]	Motivation	314	Participants 132 men and 182 women	36	CrossFit participants ($n = 68$) were more likely to report higher levels of intrinsic motives (enjoyment, challenge and affiliation), whereas personal training clients (66) reported higher values for health-related motives such as positive health, ill-health avoidance and weight management	15/68.1
Lichtenstein and Jensen [3]	Exercise addiction	598	Participants 328 men and 270 women	Do not report	5% of exercise addiction in CrossFit and young males showed a higher risk	18/81.8
Kóteles, Kollsete, Kollsete [49]	Well-being, self-esteem, body awareness, satisfaction with body image, and perceived body competence	186	Participants 57.5% Women	28.9	CrossFit training was not connected with higher levels of psychological functioning (well-being, affect, body awareness, and self-esteem) and satisfaction with body image	15/68.1

Table 2 (continued)

References	Theme	Sample		Results	Adherence to the STROBE Criteria (total/%)
		<i>n</i>	Age		
Davies, Coleman, and Stellino [36]	Motivation	206 Participants 58% Women	37.6	Participants who attended CrossFit more frequently had significantly higher levels of basic need satisfaction across all three needs (autonomy, relatedness and competency). The sample reported high satisfaction in the relatedness and autonomy needs. Regarding the motivational regulations, the participants presented high autonomous regulation. 59.3% participants reported a 15 to 17 on Borg's Rate of Perceived Exertion	12/54.5
Pickett et al. [26]	Sense of Community	276 Participants 157 women and 117 men	33.5	The results indicated that sense of community was significantly different for the CrossFit group only. The CrossFit group rated their context higher across the dimensions of administrative consideration, equity in decision making, and social spaces. The CrossFit context did enable strong sense of community perceptions	12/54.4
Whiteman-Sandland, Hawkins, and Clayton [23]	Social capital and Community belongingness	100 Participants 52 men and 48 women	Do not report	Social capital was found to be significantly higher in the CrossFit gym sample than in the Traditional gym sample. It was observed the same result to feelings of community belongingness	19/83.3
Bycura, Feito, and Prather [37]	Motivation	737 Participants 388 men and 344 women	32.4	Revitalization, enjoyment, affiliation, and competition were all significantly correlated with both duration and frequency of participation in CrossFit training. Women were more likely to place greater emphasis on factors related to stress, weight management, and appearance compared to men, who placed greater importance on factors associated with challenge, social recognition, competition, strength and endurance, and nimbleness	16/72.7

Table 2 (continued)

References	Theme	Sample		Results	Adherence to the STROBE Criteria (total/%)
		<i>n</i>	Age		
Sibley and Bergman [9]	Motivation	322 Participants 65.2% Men	33.9	Results showed that CrossFit participants primarily strive for goals related to health management and skill development, with physique enhancement and social affiliation being of secondary importance. The most frequent participants in CrossFit had significantly higher levels of basic needs satisfaction (autonomy, relatedness and competency)	13/59.1
Feito et al. [50]	Motivation	732 Participants 388 men and 344 women	32.3	The results showed that individuals training < 3 days/week scored lowest on enjoyment, affiliation, and competition motives. Those training > 5 days/week scored highest on challenge, social recognition, strength and endurance, and nimbleness motives, but lowest on weight management	18/81.8
Ayar [51]	Motivation	200 Participants 161 men and 39 women	Do not report	Differences have been found between motivational factors that affect individuals to participate in recreative sports and some of the demographic parameters in some variables of REMM's health, rivalry, physical appearance, social/entertainment and skill development sub-dimensions Male participants attend to exercises in CrossFit centers with competitive reasons more than female participants	8/36.3
Marin et al. [52]	Motivation	493 Participants 351 men and 148 women	30.3	Participants: 365 traditional resistance training and 128 CrossFit CrossFit participants presented higher levels of enjoyment, stress management, social recognition, affiliation, competition, and weight management. CrossFit participants showed higher intrinsic motivation and higher levels of perception of relatedness than resistance training participants	16/72.7

Table 2 (continued)

References	Theme	Sample		Results	Adherence to the STROBE Criteria (total/%)	
		<i>n</i>	Caract./Gender			Age
Box et al. [53]	Motivation and Personality	403	Participants 148 men and 255 women	36.3	Participants: 89 CrossFit, 127 Resistance training, 97 Aerobic training, 59 Group exercise, 31 Sport It seemed that those who selected CrossFit training as their primary mode of physical activity reported stronger motivation across the majority of participatory motives in comparison to the other modes. CrossFit training participants reported the greatest levels of intrinsic motivation	17/77.3
Box et al. [54]	Motivation	735	Participants 53.1% men	32.4	Older participants (> 50 years) scored higher on health-related motives, while younger participants (25–32 years) scored higher on social motives relative to their counterparts	18/81.8
Box et al. [43]	Motivation	722	Participants 46.8% women	32.4	Those who had greater length of participation reported more motives associated with relatedness (i.e., affiliation, competition) and enjoyment, while those with less HIIT participation were more motivated by body-related variables (i.e., weight management)	17/77.3
Coyne, Sarah, Woodruff [38]	Body image, self-esteem, and eating behaviours, motivation and reasons for practice CrossFit	149	Participants 149 women	34.9	CrossFit skill was positively associated with overall body image and evaluative body image. CrossFit length participation was negatively associated with disordered eating. No CrossFit variables were associated with global self-esteem. The most commonly mentioned motivations were improving/main-taining physical abilities, challenge, community, and mental health. The reasons most commonly mentioned to practice CrossFit were the community, sense of inclusion, programming, and challenge	15/68.1%

Table 2 (continued)

References	Theme	Sample		Results	Adherence to the STROBE Criteria (total/%)
		<i>n</i>	Caract./Gender Age		
Swami [42]	Body Image	63	Participants 34 men and 29 women 26.1	The scores on body and functionality appreciation, and on body acceptance were significantly higher at the second testing session (after 3 months of CrossFit training compared with baseline). The largest improvements in body appreciation and functionality appreciation were achieved by participants who attended CrossFit classes regularly, ≥ 4 days a week compared to ≤ 3 days a week	14/63.6%
Wilke, Pfarr, Moller [19]	Anxiety and Coping	79	Athletes 36 men and 43 women 32.7	The results indicated substantial levels of anxiety, particularly regarding the somatic dimension of the competition fear index. The most pronounced coping skill was freedom of worry. Women reported higher competition fears and lower coping skill levels than men. Age or level of competition showed no/very small associations	15/68.1%
Freire et al. [20]	Body dissatisfaction, addiction to exercise, and eating disorders	60	Participants 22 men and 38 women 26.5	Individuals dissatisfied with their bodies showed higher level of addiction to exercise and risk behavior for EDs, women showed higher presence of body dissatisfaction than men. Fitness participants ($n = 44$) reported higher presence of addiction to exercise than Crossfit practitioners ($n = 16$)	18/81.8

Table 3 Psychological effects of CrossFit practice investigated in experimental ($n = 10$) and qualitative studies ($n = 4$)

References	Objective	Sample		Intervention	Results	Overall Testex	
		n	Caract./gender				
Heimrich et al. [8]	To examine effects of HIFT as compared to moderate-intensity aerobic and resistance training (ART) on exercise initiation, enjoyment, adherence, and intentions	23	Sedentary 56.5% women	26.8	8 weeks. Two groups: ART (moderate aerobic exercise each session and full-body resistance training on two sessions per week) and HIFT (CrossFit 60 min—WOD 5–30 min)	HIFT participants spent significantly less time exercising per week, yet were able to maintain exercise enjoyment and were more likely to intend to continue	7
Perciavalle et al. [35]	To analyze the influences of blood lactate produced during a specific session of CrossFit® on intensity and selectivity of attention	15	Athletes Men	Do not report	WOD 15.5: 27–21–15–9 repetitions in term of Row (calories) and Thrusters	Reaction time, execution time, number of errors and number of omissions exhibited a significant worsening concomitantly with the increase in blood lactate	3
Eather, Morgan, Lubans [44]	To investigate the effectiveness of the CrossFit™ Teens resistance training program for improving mental health outcomes in adolescents	96	Adolescents 51.5% women	15	Twice a week for 8 weeks. A typical session of CrossFit included: a dynamic warm-up (10 min), a technique-based skill session (10 min), a Workout of the Day (WOD = 10–20 min) and a stretching session (5 min)	There were no significant effects of the intervention on mental health in the full study sample	14
Drake et al. [45]	To examine the magnitude and direction of the effects of short-term CrossFit participation on measures of health and fitness	6	Participants men	25	4 weeks of CrossFit training (5 days for week with 1 h each session)	The effects on mood states of CrossFit practice were ranged from unclear to possibly harmful Possibly harmful small effects on overall Total Mood Disturbance	8
Woolf and Lawrence [55]	To explore CrossFit participants' social identity and athletic identity before and after members participated in CrossFit Open	34	Participants 62% women 38% men	31.3	CrossFit Open 2015	The results indicated that participants strongly identify themselves as part of CrossFit	4
Box et al. [56]	To observe whether any changes in six specific mood states occurred across a 5-week CrossFit Open competition or in response to each individual workout challenge	8	Participants 5 women and 3 men	34.3	CrossFit Open 2016	No differences were observed between baseline and pre-workout mood states across the five weeks, indicating little effect of the unique competition design	1

Table 3 (continued)

References	Objective	Sample		Intervention	Results	Overall Testex	
		n	Caract./gender				
Stawińska, Stolarski, Jankowski [57]	To test whether impact of physical exercise on mood depends on time of day and chronotype	94	Participants 32 women and 62 men	32	A natural experimental. Two experimental conditions were distinguished—morning and evening hours	Participation in CrossFit training resulted in mood improvement consisting of increase in energetic arousal and hedonic tone and reduction of tense arousal. CrossFit training during morning hours boosted mood in the intermediate/evening chronotype group to the levels observed in morning chronotypes	8
Heinrich et al. [40]	To compare the affective responses between HIIT and two commonly studied exercise modalities, HIIT and moderate continuous aerobic training (MCT)	7	Participants 5 women and 2 men	20.6	3 randomly groups: MCT, HIIT, or HIIT. Nine total exercise sessions per group were scheduled across 3 consecutive weeks on Mondays, Wednesdays, and Fridays	Perceived exertion increased across each modality but remained elevated following the cooldown period for only HIIT and HIIT. Inspection of the circumplex model of affect indicated that HIIT and HIIT shifted participants from a state of calmness to energy, whereas during MCT they remained in the calmness quadrant. The slope of the affective response to HIIT continued to increase in pleasure and arousal until the end of the workouts	8
Kolomitseva et al. [58]	To evaluate the effectiveness of using the CrossFit program as a physical activity based on a motivated choice in the process of physical education of students	92	Students and cadets Men	17–18	Two experimental (12 weeks with several WODs considering the rule more exercises—less rounds, less exercises—more rounds) and two control groups	The following motives for choosing CrossFit were pointed out: to adjust the body shape, make me more courageous and athletic, increase muscle; to increase my activity and vitality; to improve my endurance, performance, reduce fatigue during physical loads	5

Table 3 (continued)

Experimental studies		Overall Testex					
References	Objective	Sample	Intervention	Results	Overall Testex		
		<i>n</i>	Caract./gender	Age			
Pereira et al. [18]	To evaluate the mood states of individuals trained and not trained in ECT, submitted to a training session of a high degree of physical effort	20	Participants men	20–40	Two groups: Trained (<i>n</i> = 10); Individuals practicing regular extreme conditioning training (<i>n</i> = 10); running athletes that never practiced extreme conditioning training. Assessments at baseline, immediately after and 30 min after the end of the session	Trained group induced a significant reduction of the depression variable, in both moments. The trained group significantly increased vigor immediately after the end of the training session compared to the baseline. However, the conditioned group significantly reduced its vigor 30 min after the end, in comparison to the baseline	4
Qualitative studies		Overall Testex					
References	Study design	Sample	Results	SRQR			
	<i>n</i>	Caract./Gender	Age				
Nielsen et al. [47]	Qualitative Focus groups	28	Participants Men	Group 1: 68 Group 2: 56 Group 3: 67	The participants mentioned feelings of well-being, improved mood, and calmer behavior during the intervention period. In CrossFit, writing up their individual performance and comparing them to the others was a motivating factor for some	16–High	
Simpson et al. [46]	Qualitative Semi-structured interviews	17	Participants 12 men and 5 women	34.9	The participants expressed that CrossFit is a demanding and rigorous workout regimen and felt as though they needed to embrace the challenge. Participants viewed their commitment as the integral aspect of their success. All the participants expressed CrossFit improving their mood. All participants expressed a strong commitment to CrossFit, as a primary motivation to continuing CrossFit in some cases	14–High	
Bailey, Benson and Bruner [48]	Qualitative Focus groups	17	Participants 10 men and 7 women	33.7	Espoused beliefs and values identified included pride in the gym and their workouts, inclusivity, and a strong sense of community that extended beyond the gym. The common goal of improving their health and well-being was observed in the participants	17–High	
Podmore and Ogle [27]	Qualitative semi-structured face-to-face interviews	16	Participants 16 women	31.8	The results were reported in categories such as body/appearance ideals, bodily appraisals, appetites and diets, physical fitness ideologies, appearance management routines, perspectives on gender, and identity development Several participants experienced the CrossFit box as inclusive, while others felt that the community was rather exclusive. Participants experienced the culture of the CrossFit box as supporting varied ideologies about diet—in order to see results members needed to follow specific dietary regimens to support their CrossFit workouts	15–High	

and agility [37] than women. Such goals relate to avoiding incompetence in tasks [41], and they are motivated by factors related to stress, weight control, and appearance [37].

Experimental studies

Experimental studies have found no changes in mental health [44] and well-being after CrossFit training. Concerning the consequences of CrossFit training, in an acute effect, some studies have found that reaction time was impaired, and that there are mood changes after a CrossFit session [18, 35]. Regarding chronic effects, a study showed that mood may be impaired [45]. The objective, sample characteristics, intervention, results, and score in quality assessment of the experimental studies are presented in Table 3.

Qualitative studies

Qualitative studies were conducted through semi-structured interviews and focus groups to investigate the factors that encourage individuals to adopt CrossFit as an exercise program [46], the motives that lead individuals to continue or discontinue a physical exercise program such as CrossFit [47], and the organisational culture of CrossFit [48]. In addition, the development of women's body image and appearance management practices was investigated [27]. Qualitative studies have demonstrated high methodological quality, as assessed by the SRQR. The theme, sample, and results of the studies are presented in Table 3.

Implications from the results of the investigated studies can be generated to collaborate the utility of CrossFit practice, mainly with respect to factors related to motivation, adherence, and maintenance regarding training (Table 4).

Discussion

This is the first systematic review that has synthesised comprehensively and deepening the current state of scientific production on the psychological variables of CrossFit participants. We analysed the motivation for participation and determined the effects of CrossFit on the psychological variables of participants. Knowledge production on the psychological variables of CrossFit participants is recent. Due to the greater number of studies investigating the themes motivation and mood, we analysed and discussed these variables separately, while psychological factors assessed relating to psychological health and performance were incorporated into the remaining sections of the discussion. Furthermore, the practical implications of the studies were described based on the results. The 34 selected studies were not suitable for quantitative synthesis through meta-analysis, owing to the lack of homogeneity regarding study design and data

analysis. Consequently, we performed a qualitative synthesis to summarise and explain the characteristics and findings of the selected studies.

Motivation for participation

Based on the results of their study, Fisher et al. [7] suggested that the reasons (intrinsic reasons and reasons related to enjoyment, challenge, and affiliation) for participants to join CrossFit resemble those related to sports. Such factors may influence participants to keep the practice in the long-term in comparison with other modalities of resistance exercise [59]. However, attention should be paid to the inverse relationship observed in environments characterised by high-intensity activities in which engagement in this type of activity is likely to reduce pleasure [60]. Due to the lack of studies on dropouts of CrossFit [17], we point out the urgency of studies specifically on the motivational characteristics that lead the participants to dropout versus continue; this may improve the understanding of physical exercise behaviours related to high-intensity functional training modalities. According to meta-analysis of Reljic et al. [61] in high-intensity interval training (HIIT), the exercise intensity was not related to dropout, with lower dropout rates than commonly reported for traditional exercise programs—moderate-intensity continuous training.

Self-determination theory (SDT) has been proposed to account for motivation in physical activity and sports [59, 62] and it was the dominant theory in the studies we reviewed. Basic psychological needs theory (BPNT), a sub-theory of SDT, suggests that we have three psychological needs: autonomy, competence, and relatedness. The satisfaction of these needs is related to the motivation of the individual to practice physical exercises [63]. Two studies have shown that CrossFit frequency is related to significantly higher levels of basic needs satisfaction with respect to all three needs [9, 36]. On the other hand, Köteles et al. [49] found that a high frequency of CrossFit training was not related to well-being, affection, body awareness, self-esteem, and body satisfaction.

In the case of CrossFit, relatedness is clearly fostered by the sense of community promoted by CrossFit, as this sense of belonging to group favours participation [23, 36, 45, 55]. In this regard, one of the characteristics of the modality is group training, so everyone can perform the exercises independently of their physical fitness level—scalability. For this, there are categories, called Scale (exercises performed with the least intensity of adapted form, usually destined to beginners) [55] and RX (exercises with a higher level of difficulty, usually destined to experienced participants). The social characteristics of CrossFit, which refer to affiliation and relatedness which arguably have contributed to its growth in popularity [7].

Table 4 Psychological variables, summary findings, and implications of the studies

Psychological variable	Study	Summary findings	Implications*
Motivation	Partridge, Knapp and Massengale [41]	Males reported higher levels of performance approach goals and females reported higher levels of master avoidance goals	Men and women; older and younger participants presented different goals related to the practice of CrossFit. Gender and other socio-demographic variables should be taken into account by coaches
	Box et al. [54]	Older participants scored higher on health motives while youngsters on social motives	Aspects such as challenge and enjoyment of participants should be emphasized in CrossFit training, aiming for greater adherence and maintenance
	Box et al. [43]	Relatedness and enjoyment pointed by those who had a greater length of participation as motives for practice	
	Fisher et al. [7]; Marin et al. [52]; Box et al. [53]; Heinrich et al. [8]	CrossFit participants presented intrinsic reasons for the practice	
	Ayar [51]	Males reported more competitive reasons than female	
	Davies, Coleman, Stellino [36]	CrossFit participants presented high autonomous regulation for the practice	
	Bycura, Feito, Prather [37]	Revitalization, enjoyment, affiliation, and competition positively related to adherence and maintenance of the participants	
	Sibley and Bergman [9]	Participants with higher frequency had higher levels of BPN satisfaction	
	Simpson et al. [46]	Challenge, high intensity and community sense were pointed out as motivational factors	
	Enjoyment and learning	Martínez and Marmól [39]	High levels of enjoyment and learning perception in adolescents who practiced CrossFit
Kolomitseva et al. [58]		A significant improvement in the physical condition of the students and cadets was observed after CrossFit training	
Effort	Davies, Coleman, Stellino [36]	Participants evaluate CrossFit as a modality with high perception of effort	Possibility of using subjective perception of effort scale for evaluation of effort and optimization of training planning, also through knowledge of the internal training load
	Drake et al. [45]		
Exercise addiction	Heinrich et al. [40]		Attention should be given to exercise addiction in CrossFit
	Lichtenstein and Jensen [3]	5% of prevalence of exercise addiction to CrossFit	
	Freire et al. [20]	80% of participants had low degree of addiction to exercise	

Table 4 (continued)

Psychological variable	Study	Summary findings	Implications*
Body Image	Coyne, Sarah, Woodruff [38]	CrossFit skill positively predicted women's body image	Self-perceived physical skill and/or fitness training should be promoted. CrossFit's use of strength increasing body image
	Swami [42]	Participating in CrossFit is associated with improvements in body image	CrossFit may be a viable intervention method for promoting positive body image
	Freire et al. [20]	A positive association of body dissatisfaction with risk behavior for eating disorders and addiction to exercise was observed	
Well-being, body awareness, satisfaction with body image, and perceived body competence	Köteles, Kollsete, Kollsete [49]	There was no relationship between the variables and the CrossFit training	Future investigations must be carried out regarding these variables
	Köteles, Kollsete, Kollsete [49] Eather, Morgan, Lubans [44]		
Self-esteem	Coyne, Sarah, Woodruff [38]		
	Wilke, Pfarr, Moller [19]	Competition fears are highly prevalent in athletes of CrossFit	
Anxiety and coping	Eather, Morgan, Lubans [44]	There were no significant CrossFit effects on mental health	
Mental health	Box et al. [53]	The personality dimensions were not different among CrossFit and other groups of exercise	
Personality	Drake et al. [45]	The effects on mood states of CrossFit practice were ranged from unclear to possibly harmful	
Mood	Box et al. [56]	There were no significant changes in mood states across five weeks of CrossFit competition	
Social variables and community belongingness	Stawińska, Stolarski, Jankowski [57]	Physical exercise strongly improves mood and that this effect depends on time of day and morningness–eveningness levels	
	Pereira et al. [18]	Changes in mood states could be promoted by an extreme conditioning training session	
	Whiteman-Sandland, Hawkins, Clayton [23] Pickett et al. [26]	Greater social capital in CrossFit participants CrossFit group showed a higher sense of community	Strong sense of community indicates a motivational factor to adherence of CrossFit regionally
Exercise initiation, enjoyment, adherence	Woolf and Lawrence [55]	Strong identification of participants as part of CrossFit	CrossFit's organizational culture and sense of community can be explored as motivational factors and for greater adherence of participants to training
	Bailey, Benson and Bruner [48]	Strong sense of community by the participants	
	Heinrich et al. [8]	Less time spent in the group that performed CrossFit with maintenance of enjoyment and more likely to continue	Less time spent in physical exercise favors adherence
	Nielsen et al. [47]	Reports of improvement in well-being and mood during intervention with CrossFit	Explore motivational factors such as recording individual performance

Table 4 (continued)

Psychological variable	Study	Summary findings	Implications*
Attention	Perciavalle et al. [35]	Reaction time exhibited a significant worsening concomitantly with the increase in blood lactate	High levels of blood lactate can cause consequences in cognitive domains, caution is recommended in training components such as volume and intensity

*Authors analysis

Competence was the strongest predictor of high levels of identified and intrinsic regulations in the study of Sibley and Bergman [9]. A common practice in CrossFit is to record performance in training and competitions (personal record), which is related to the load performed, as well as the number of repetitions and time. This characteristic fosters competitiveness and progress for each individual, increasing the participant's sense of competence [3, 47].

The goals promoted by the CrossFit boxes environment, related to accomplishing tasks and learning new skills [38, 45] shows that the extrinsic motivation appears in a more autonomous way in the context of CrossFit training. Davies, Coleman, and Stellino [36] noted that for professionals working in the field, it is clear that boosting autonomous aspects and increasing the motivation to practice will foster satisfaction among participants seeking basic psychological needs. In this sense, autonomy is related to the performance of the professional responsible for practice. According to Sibley and Bergman [9], when participants are offered the possibility of choosing exercises and the level of intensity, there is an increased sense of autonomy. Also, the monitoring of each individual's progress and continuous pursuit of performance optimisation may be aspects that promote autonomy [37].

Similar to sports environments, CrossFit training has assumed a social nature, with the creation of communities [26] in which the sense of affiliation is an important characteristic and an elementary condition for the support of the basic psychological needs [7]. We observed that more autonomous forms of motivation appeared in CrossFit training participants, so the motivational characteristics indicated an autonomous form of extrinsic motivation (identified as integrated regulations, and by intrinsic regulation). Therefore, people engaged in CrossFit training may achieve such goals as enhancing their own identities through exercise [7, 50].

Although CrossFit participants demonstrated intrinsic motivation, and reasons for practice such as enjoyment, challenge, and affiliation, this is preliminary evidence. Box et al. [43] found similar results in individuals who actively engage in HIFT, the participants with greater length of participation reported more motives associated with relatedness, as affiliation, compared those with less HIFT participation.

Thus, future investigations should examine the potential role of motivation on psychological health. Considering individuals that are more extrinsically motivated to perform CrossFit, for example, aiming for better physical appearance or improving physical abilities/skills [38], these participants may be more likely to suffer adverse effects on psychological health (e.g., developing body image disorders), when compared to individuals that are intrinsically motivated, according to previous research autonomous motivation has been shown to reinforce positive mental health outcomes [64].

Mood

The effect of physical activity and sport participation on mood state has been extensively researched. Numerous studies have investigated both change in mood states arising from exercise and the relationship between mood and performance [12]. However, there has yet to be a great interest among researchers in CrossFit—five studies addressed the theme, possibly because it is a fairly recent ECP.

Experimental studies showed that the results regarding effects of CrossFit on mood ranged from unclear to possibly harmful, with some of the mood factors showing likely detrimental effects and without differences between baseline and pre-workout, across weeks in the CrossFit Open Competition [45, 56]. The negative mood changes after CrossFit arose from the stimulus generated by both the high volume and intensity of the modality [45, 56]. Similar findings were found in studies with basketball and soccer athletes [65, 66]. On the other hand, two qualitative studies have shown improved mood among participants after CrossFit training [46]. Sławińska, Stolarski, and Jankowski [57] found that CrossFit training performed in the morning boosted mood and that participation in intense physical exercise may compensate for the negative effects on moods of non-optimal time-of-day exercise.

Considering the inconsistencies, and the initial stage of research that the theme is in, this variable lacks new investigations on CrossFit, as variations in mood are associated with sports performance. Some studies have shown that there may be negative changes to mood as a consequence of the intensity of training, participation in competition, or periodization of training [67]. Regarding acute effects, Pereira et al. [18] found that after one session of training, there were significant changes, albeit small and moderate, in mood states in trained and untrained individuals. It was observed a significant increase in vigour immediately after and reduction in fatigue 30 min after the end of the session. In this sense, research should be conducted on the effects of CrossFit practice on mood—both acutely and chronically.

Psychological health

It is clear from the review findings that more studies are needed on the relationship between CrossFit and psychological health. Considering the impact of the COVID-19 pandemic on people's lives, exercise should be promoted as a form of psychological self-care [68, 69], including CrossFit. Few studies were found that investigated mental health and well-being and the differences after CrossFit training [27, 44]. In addition, neither study found effects of CrossFit training on self-esteem [38, 44, 49]. The body image was improved with the CrossFit training, mainly related to the

development of skills, since this modality focuses on body's function over its appearance [38, 42].

The significant growth of ECPs such as CrossFit has been driven by the interest of the population as healthy individuals, obese individuals, and athletes. Then, due to more people involved and exposed, there is more chance to some participants have problems arising from excessive practice. In this context, we highlight the study of Lichtenstein and Jensen [3] that reported a prevalence of exercise addiction of 5% related to CrossFit, measured by the Exercise Addiction Inventory. Behavioural indicators were found between addiction and the tendency to exercise despite injuries and feelings of guilt when one is not able to exercise. Attention should be paid to the satisfaction with body image in CrossFit participants, because this variable is recognized as a mediator factor for the development of addiction to exercise [20].

Performance

CrossFit is a high-intensity functional training (HIFT) [70] with short or no time for rest. Such practice implies large variations in effort levels and significantly interferes with the subjective perception of effort [36, 39, 40].

The perception of effort in relation to CrossFit sessions was considered high by participants in some studies [36, 39, 40]. This is closely linked to exercise intensity [71], considered a defining characteristic of ECPs. Compared with moderate-intensity training, CrossFit participants spend less time exercising each week and are more likely to continue exercising. Considering that lack of time is one of the most common reasons given for the physical inactivity [72], the high intensity and consequent reduced time spent in the activity are advantages presented by ECPs such as CrossFit, being well placed to address physical inactivity in the general population, considering this perceived barrier.

As practical implications, the researchers of sport and exercise science could use an instrument to evaluate the subjective perception of effort in the practice of CrossFit, as the monitoring of the perception of effort can allow better control of training load, in order to minimize the risk of injuries [73] and excessive training (overtraining and burnout). We can obtain the internal training load of each individual using the rating of perceived exertion (intensity) multiplying by the total duration of the training session [74]. Such assessment becomes essential in the case of ECPs such as CrossFit, where training intensity is often high.

Regarding performance, the intensity and selectivity of athlete's attention decreased after CrossFit sessions [35]. Concomitant to the increase in blood lactate was an increase in reaction time, number of errors in task execution, and number of omissions.

With the exception of one study, all cross-sectional studies selected for review met 50% or more of the criteria defined by STROBE. Most of the items that did not meet the criteria were related to the methods section—mainly bias and sample size, reporting any efforts to address potential sources of bias and explain how the study size was arrived at, respectively. Of these, only five studies presented high quality, with compliance of items above 80%. These results suggest the need for future investigations to provide additional details in the methods section. On the other hand, such details in methods were observed in the qualitative studies, mainly in relation to the methods for processing and analysing the data, with high methodological quality. In the review by Claudino et al. [13], of the 32 articles selected, only two studies presented a high level of evidence with a low risk of bias. There is thus a need for better quality in some aspects of the experimental studies involving the practice of CrossFit, especially with respect to the specification of randomisation and allocation concealment—characteristics that were absent in most of the studies reviewed.

Practical implications

Several practical implications can be generated from the results of the studies. To increase the adherence and maintenance of the CrossFit practice, we pointed out that emphasis should be placed on some characteristics present in the practice of the modality, such as the challenge that the exercises themselves impose on the participant, the high intensity and thus reduced time spent in physical exercise, the affiliation with CrossFit boxes, and the promotion of a sense of community, as well as the recording of personal records in the exercises and training that stimulate competitiveness. These factors were related to motivation and adherence in the selected studies, and applications from the results must be performed inside the boxes. However, we acknowledge that the listed factors are based on associations through observational studies, thus intervention studies are needed.

Strengths and limitations

We summarized the findings of all the empirical studies on the psychological variables of CrossFit participants to provide an overall examination of the body of knowledge related to the topic, including quality assessment and practical implications. This allows instructors, gym managers, participants, and researchers to consider practical applications and future research directions.

Although there are few studies published to date, growing interest in the psychological consequences of CrossFit participation reflects that in the broader HIFT literature [70]. The number of studies in the present review reveals that the psychological variables have been more investigated more

than other topics on CrossFit. In a review analysing the literature on CrossFit, Claudino et al. [13] found 11 studies on psychosocial behaviour, 7 on the risk of musculoskeletal injury, 4 on body composition, and 4 on aspects of life and health. The comprehensive characteristic of this work allowed the inclusion of 34 studies, while Feito, Brown and Olmos [70] and Gianzina and Kassotaki [25] found only 13 and 3 studies on psychological parameters, respectively.

As limitation of this work, we did not perform a meta-analysis as part of our systematic review, because we felt such an analysis was not warranted given our motivations of the review, and given that our review is not focused on a specific outcome, as well as the heterogeneity (mainly methodological) of the data.

Conclusion

This review aimed to synthesise the literature on the psychological variables of CrossFit participants. The review of the studies showed that the adherence and maintenance of the practice of CrossFit are related to psychological aspects such as motivation and satisfaction of basic psychological needs; however, this is preliminary evidence. In the studies, CrossFit participants demonstrated high perception of effort, intrinsic motivation, and reasons for practice such as enjoyment, challenge, and affiliation. CrossFit has characteristics related to training and competition that seem to satisfy the basic psychological needs of the participants—relatedness, autonomy, and competence, which compose the weekly practice frequency associated with basic psychological needs.

The low number of selected studies that were published before 2014 reveals that research on the psychological variables of CrossFit participants remains at an initial stage. Therefore, although we found relationships mainly between the CrossFit practice and the motivation and basic psychological needs of participants, the findings should be generalised with caution. It is essential for more studies to be published with high methodological quality to allow better analysis of the results and greater power of evidence for future conclusions.

The results have practical implications mainly regarding motivation and adherence of participants. Through the review, we identified the need for more and better quality studies, as well as intervention studies to investigate the effects of CrossFit practice on mental health, mood, stress, self-esteem, and anxiety among participants.

Author contributions All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by FHD, TTS, TCS and AA. The first draft of the manuscript

was written by FHD and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Funding This research was funded by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior—Brazil (CAPES)—Finance Code 001 and FAPESC—Foundation for research and innovation support of the State of Santa Catarina—Grant number 2019031000035 and call number 04.2018.

Compliance with ethical standards

Conflict of interest The authors reported no potential conflict of interest.

Ethical approval Not applicable.

Informed consent Not applicable.

Systematic registration Registration in the International Prospective Register of Systematic Review (PROSPERO registry) was performed prior study initiation (registration number CRD42018091177).

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