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Psychological traits of extreme sport participants: a scoping review

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Abstract

Background Extreme sports have increased in popularity, particularly over the past two decades. Theories explaining participation in extreme sports tend to focus on risk. Consequently, extreme sports participants are often characterized by an accentuated desire for risk and abnormal personal traits, but the positive aspects of extreme sports are often neglected in the literature. This scoping review summarizes extreme sport motives, emotions and personal characteristics.

Methods Following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) Checklist, three databases were searched (PubMed, Web of Science, Scopus, SportDiscus and, PsycInfo) on 20th April 2023. Studies were included if they were originally articles written in English and examined psychology traits in extreme sport participants.

Results In total, 39 manuscripts met the inclusion criteria and were analyzed in the present review. There is no unique profile for individuals involved in extreme sports. Risk and fear are considered natural characteristic of participation, and many positive aspects are associated with involvement in extreme sports (e.g., organization, planning, confidence). The quality of experience is often reported to justify extreme sport participation.

Conclusion Changes in emotions and motives characterized the reversal theory, which in combination with the flow approach, could explain the participation in extreme activities. A dynamic ecological approach considering the interaction between individuals and the environment should be adopted to understand individual motives, behaviour and emotions.

Keywords Motivation, Emotion, Personal characteristics, Risk, Environment

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Background

The definition of extreme sports in academic literature remains equivocal, with terms such as "adventure sports" [1], "alternative sports" [2] or "action or adventuring sports" [3] used interchangeably. Extreme sports are often described as non-competitive, leisure activities, adventure experiences or activities requiring less skill or knowledge [4, 5]. The imprecision of extreme sports definition is associated with the development of inaccurate theories and concepts which reflect the experiences of participants involved in extreme sports. According to Brymer [6] extreme sports are defined as "independent adventures activities where a mismanaged mistake or accident is most likely to result in death". Examples of extreme sports are building, antenna, span, earth (BASE) jumping, big wave surfing, mountaineering, extreme skiing and free solo climbing [5]. Although there are variations in BASE jumping (i.e., wingsuit, tracksuit), participants normally attain 250 $km.h^{-1}$ and cover approximately distances equal to or less than 150 m [7, 8]. In big wave surfing, surfers face waves in excess of five meters [9]. Participants enrolled in high-altitude climbing attain extreme altitudes (i.e., > 8000 m) and be exposed to adverse physiological and psychological conditions [10].

Over recent years, extreme sports have grown in popularity, and the number of participants is above traditional sports [11, 12]. In fact, green spaces, typically associated with some extreme sports, seem more effective for increasing and promoting physical activity, which in turn relates to benefits on cognitive performance and self-reported well-being, compared with indoor practices [13]. Limited evidence suggests a synergic effect between the practice of physical activity and time passed in contact with nature to improve mental health [14]. Qualitative data in extreme sports highlighted that participants described the contact with nature as central, more significant and powerful [15]. Participation in extreme sports seems to affect well-being, physical and psychological traits positively [1, 13, 15].

The scientific literature on extreme sports has focused on specific theories that identified personal traits and explained the motives for participation [16]. Classic theories explaining participation in extreme sports are, for example, sensation-seeking [17], edgework [18] or type T personality [19]. These explanations are limited since they were based on the association between risk and sport participation and have ignored individual reports that considered the benefits of extreme sports. The reversal theory is a model that combines motives, emotions and personality traits [20, 21]. The conceptual framework of reversal theory considers four pairs of metamotivational states (i.e., high-order motivational levels), which explains changes in motives, emotions and mood on specific occasions. The persistence of specific motivational states across the life span can be identified as personality traits but are modified with environmental stimuli. The theory also considered emotions grouped into two main categories: somatic and transactional. Somatic emotions are defined considering the experience of body arousal (e.g. excitement, anxiety etc.), whilst transactional emotions are related to the final output (e.g. pride, humiliation etc.). The theory explains why arousal can be perceived as excitement and anxiety in an identical external situation [21]. Numerous motives beyond risk-seeking theory or surpassing personal boundaries could explain participation in extreme sports. Given the positive impact on participation and different theories to explain the characteristics of participants (motives, experiences and personal characteristics), a review summarizing this topic is lacking.

Therefore, the present scoping review aims to present an overview of relevant literature investigating the motives, emotions and personal characteristics of participation in extreme sports. In addition, theoretical background and methodologies used in studies were also collected to interpret the main findings associated with the characteristics of experiences in extreme sports. It is proposed that this review is required to facilitate the mapping of future research agendas on extreme sports, and potentially give rise to new theoretical and interdisciplinary knowledge relating to extreme sport participation.

Methods

The current review followed guidelines proposed by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) Checklist (Tricco et al., 2018). The protocol was pre-registered on the Open Science Framework – DOI: https://doi.org/10.17605/OSF.IO/J2Q57.

Eligibility criteria, information source and search

Studies were considered in the current review if the following three criteria were met: (1) participants were involved in extreme sports, (2) studies examined psychology traits (i.e., motivation, personality, emotions), and (3) studies were original manuscripts written in English. Qualitative and quantitative studies involving psychology in extreme sports were included. Studies were mainly excluded if they combined extreme sport participants with other types of sports and/or did not cover specific psychology topics. No restrictions were applied relating to the year of publication. The search strategy was organized into three phases [22]. The preliminary phase involved research *via* reading a book chapter about extreme sports [5]. Secondly, the searches were conducted using the following search terms: *motiv** OR *beha** OR *self-determination* OR *achievement-goal* OR

*interest** OR *personality* OR *characteristic** OR *emotion** AND *extreme sport** OR *BASE jump** OR *extreme skiing* OR *waterfall kayaking* OR *big-wave surf** OR *high-level mountaineering* OR *free solo climb**. Literature searches were conducted in PubMed, Web of Science, Scopus, SportDiscus and PsycInfo. The final search results were exported into a reference manager software (EndNote X9; Thomson Reuters©, New York, NY, USA), and duplicates were automatically removed. The searches for the present scoping review were conducted on 20/4/2023.

Selection of sources of evidence

Two independent and experienced authors (DVM/HS) screened the study titles and abstracts. Full-texts were then examined for their suitability for the inclusion criteria. If there were any discrepancies between the authors, then a third author (EG) arbitrated the disagreement.

Data charting process, data items and synthesis

The relevant data of each study was extracted and summarized on a Microsoft Excel Sheet. The following details were individually collected and summarized for each manuscript: author, sample characteristics, country within which the research was conducted, study aims, methods, and main findings. The authors also briefly described the theoretically background which formed the basis for the research question in each study. The first author (DVM) collected the initial information, which was then checked by two separate researchers (HS/AF).

Results

Sources of evidence

A total of 1493 studies were identified following the search of databases. Following the omission of 332 duplicates, the remaining 1661 manuscripts were screened by title and abstract. A further 1110 were excluded, and 51 full texts were screened. Twelve studies did not meet the inclusion and were excluded for the following reasons: (1) not an original paper ($n=8$), (2) did not consider solely extreme sport participants ($n=2$), (3) studies centered on methodological instruments ($n=2$). Thirty-nine studies were included in the present scoping review (Fig. 1).

Characteristics of source of evidence

Table 1 summarizes the main characteristics (sample, country, aim, methods and main findings) of the studies included in the current review. Research involving examinations of psychological traits in extreme sports ranged from 2000 to 2022. Both male and female participants were included in 68% of the studies [5, 23–45]. Most studies were conducted in Europe (38%) with 31% involving participants from different countries. Five studies

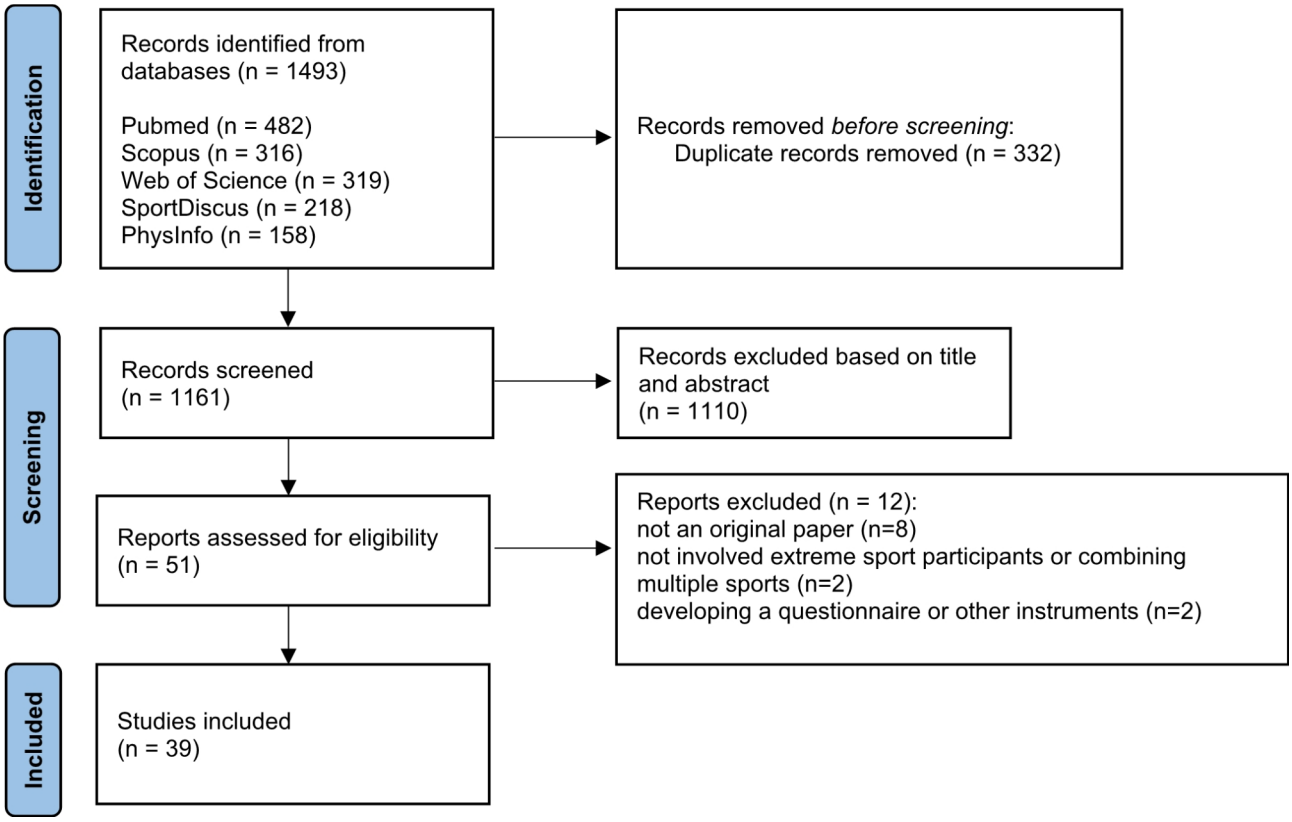

Fig. 1 Flow chart diagram identifying the screening process and the studies including in the present scoping review

Table 1 Characteristics, objectives, methods used and, main findings of studies that included extreme sports

Study	Sample	Country	Aim	Methods	Main findings
Florenthal [23]	*N* = 116 male and female Risk sport *N* = 39 age: 24.6 ± 2.0 yrs *specific-risk sports were not reported Non-risk sport age: 23.5 ± 2.9 yrs	Israel	Explore the motivation to participate in extreme sports.	List of values	Risky sports are associated with pleasurable sensations and excitement. Of note, participants perceived security and self-respect as less important in risk sports.
Fave et al. [46]	*N* = 6 male rock climbers age: 29.3 ± 3.9 yrs	Italy	Investigate the quality of experience and risk perception.	Interview	The quality of experience (i.e., the flow) is an important factor in participating in a risk expedition, confirming a goal-directed approach.
Katjna et al. [53]	*N* = 38 male top level high-risk sports (alpinists, skydrivers, paragliders, divers, white-waker kayakers, downhill bikers, motocross riders, downhill skiers, ski jumpers) age: 24.8 ± 4.5 yrs *N* = 38 male non-risk sport athletes (swimmers, track athletes, slalom and giant slalom skiers, flat-water kayakers, rowers, sailors, Nordic skiers, sport climbers, karatekas, badminton) age: 23.6 ± 4.0 yrs *N* = 76 male non-athletes age: 24.8 ± 4.3 yrs	Slovenia	Compare personality structure.	Big Five Observer Scale	High-risk sports tend to obtain high scores in emotional stability, conscientiousness and energy. In contrast, openness followed the gradient: high-risk sport < non-athletes < non-risk sports.
Cazenave et al. [56]	*N* = 180 female *N* = 37 professional risk-sports (two different groups: French of School and Alpinism, specific-sports – rally driving, parachuting, skiing, snowboarding) age: 38.2 ± 6.4 yrs *N* = 53 non-professional risk sports (mountaineering, base jumping, parachuting, downhill, skill and snowboarding, downhill mountain biking) age: 26.6 ± 8.2 yrs *N* = 90 non-risk sports (swimming, dancing, table tennis, golf, athletics) age: 20.4 ± 2.4 yrs	France	Examine psychological profile and emotional characteristics.	Bem Sex Role Inventory, Barrant Impulsiveness Scale, Sensation Seeking Scale, Risk and Excitement Inventory, Toronto Alexithymia Scale	Differences between professional and non-professional risk sports were noted. The profile of non-professional risk sports was characterized by escape, masculine identity, sensation seeking, impulsivity and alexithymia, whilst professional risk sports showed a compensation profile and androgynous gender identity.

Table 1 (continued)

Study	Sample	Country	Aim	Methods	Main findings
Allman et al. [47]	*N* = 54 male BASE jumpers	US	Explore the motivation to participate in extreme sports.	Interview	Motives to participate in risk sports were: to acquire skill, accomplishment, adrenaline, control, and overcome fear.
Sanchez et al. [57]	*N* = 19 elite male climbers age: 24.6 ± 4.0 yrs	Belgium	Examine the relationship between psychological states and performance.	Competitive State Anxiety Inventory-2, Positive and Negative Affect Schedule	Successful climbing was related to levels of somatic anxiety. Also, it is important to note that successful climbers performed the most challenging route more slowly than non-successful participants.
Monasterio et al. [24]	*N* = 68 male and female BASE jumpers age: 34.0 ± 7.6 yrs	Not specified	Compare the temperament and character of BASE jumpers with the general population. The study also examined the relationship between these characteristics and accidents (i.e. frequency and severity).	Abbreviated injury scale, Cloninger Temperament and Character Inventory	Novelty-seeking and self-directedness were higher for BASE jumpers than the average population. In opposition, BASE jumpers scored lower values for harm avoidance, reward dependence, and self-transcendence. No relationship between temperament and character traits and accident occasions was noted. Overall, the profile of BASE jumpers tends to be comparable to the control group.
Hetland and Vitterso [25]	*N* = 31 male and femake (BASE jumpers, skydivers) age: 28.5 yrs	Norway	Investigate the emotions during and after the jump. The same procedure was conducted for the jumping film 24-h later.	Basic Emotions State Test; Visually Reported Emotions; Heart rate	Hedonic emotions (i.e., pleasure, happiness) were comparable before and during both jumping and film. Differences in eudemonic feelings (i.e., engagement, interest) were noted across conditions. During the jump, values for pleasure varied, while stable values for interest were noted.
Dean [26]	*N* = 73 male and female off-road motorcycling age: 18–24 yrs	Mexico	Examine the relationship between perceived risk and self-control.	Questionnaire about perceived physical risk to themselves, level of experience in the sport, relative skill, expected fun, level of self-control, and estimated risk for an average other participant*	Self-control was negatively associated with perceived risk.
Brymer and Schweitzer [27]	*N* = 15 male and female (base-jumping, big wave surfing, extreme skiing, waterfall kayaking, extreme mountaineering, solo rope-free climbing) age: 30–70 yrs	Different countries	Investigate fear associated with participation in extreme sports.	Interview considering four themes: experience and relationship with fear, management of fear, fear and self-transformation	Fear is part of extreme sports and could lead to achieving a personal sense of mastery and losing the sense of self and identity.
Brymer and Schweitzer [28]	*N* = 15 male and female (BASE jumping, big wave surfing, extreme skiing, waterfall kayaking, extreme mountaineering, solo rope-free climbing) age: 30–70 yrs	Different countries	Study one aspect of motivation in extreme sports (i.e., search for freedom).	Interview	Among high-risk sports participants, freedom was associated with constrains, movement, control, releasing fear, being at one, choice and responsibility. Other motivations than risk-taking are apparent in extreme sports.
Heirene et al. [58]	*N* = 8 male rock climbers high-ability (age: 24.8 ± 2.3 yrs) average-ability (age: 23.8 ± 2.3 yrs)	UK	Investigate the withdrawal states (craving, anhedonia and adverse effects) related to participation in rock climbing.	Interview	Anhedonia, craving and negative effect are evident among rock climbers. Variation by competitive level was noted, with the high-ability rock climbers having more frequent experiences of craving and adverse effects than average-ability participants.

Table 1 (continued)

Study	Sample	Country	Aim	Methods	Main findings
Chang [29]	*N* = 225 male and female (skateboards, extreme blade, bicycle) *age was not detailed	China	This study investigated the relationship between high-risk sports and flow experience. In parallel, it examined sex influence on the relationship between involvement in high-risk sports and flow experience.	Flow experience was obtained by a questionnaire focused on the level of mood and concentration when participants are involved in high-risk sports	The current study found that participation in high-risk sports was related to the flow experience. In addition, the relationship was affected by sex. Attrition was significant among male participants. In opposition, centrality and self-expression were robust predictors among females.
Monasterio et al. [30]	*N* = 79 male and female BASE jumpers age: 37.3 ± 13.7 yrs	Different countries	The present study focuses on psychobiology. In other words, whether salivary cortisol was associated with temperament (emotional style) and whether alpha-amylase predicted persistence and character (goal-setting) was tested.	Temperament and Character Inventory; salivary samples were collected before and after the competition	Generally, BASE jumping participants were resilient (highly self-directed, persistent and risk-taking). Three different classes of jumpers were identified: masterful: self-directedness (+), experience (+), alpha-amylase (-), cortisol (±); trustful: cooperative, social support, cortisol (-); courageous: anxiety, inexperience, cortisol (+).
Brymer and Schweitzer [5]	*N* = 15 male and female (BASE jumping, big wafe surfing, extreme skiing, waterfall kayaking, extreme mountaineering, solo rope-free climbing) age: 10–30 yrs	Different countries	Examine the experience of extreme-sport participants.	Interview	Three main themes emerged as possible motives for participation in high-risk sports: invigorating experience, inadequate words to capture the experience and transcendence.
Fruhauf et al. [31]	*N* = 40 male and female freerides age: 27.5 ± 4.4 yrs	Not specified	Understand the motivation for the participation of freeride athletes and how they perceive associated risk with participation in high-risk sports.	Interview: questions were focused on the experience, motivations and personal risk-taking	From the interviews, different topics emerged as motives to participate in freeriding: challenge, experiencing nature, the counterbalance to everyday life, and moving from restrictions and friends. Freerides did not participate in seeking out dangerous situations. Participants reported different factors to manage the risk: planning, investigating the conditions, knowledge and experience.
Bekaroglu and Bozo [32]	*N* = 202 male and female (base jumping, cave diving, 40 m deep dive, kitesurfing, high-level mountaineering, mountain biking, paragliding, rallying, rafting, rock climbing, skydiving, and snowboarding) age: 24.8 ± 4.8 yrs	Turkey	Examine the association between attachment styles and emotion regulation strategies, which affect health behaviours, by comparing participants involved in high-risk sports and a control group.	Experiences in Close Relationships; Difficulty of Emotion Regulation Health Promoting Lifestyle Profile	Lack of awareness about emotions and lack of goals while dealing with negative emotions impact the relationship between anxious attachment style and health-promoting behaviours. Also, the lack of goals mediated the association between avoidance style and health-promoting behaviours. Meantime, high-risk sports participants tended to have more health-promoting behaviours than nonextreme sports participants.

Table 1 (continued)

Study	Sample	Country	Aim	Methods	Main findings
Krokosz and Jochimek [33]	*N* = 144 male and female (parachutes, kitesurfing, windsurfing, wakeboarding, freediving, BMX, roller skating, extreme scooter, skateboarding). male (age: 24.1 ± 4.0 yrs) female (age: 23.9 ± 5.8 yrs)	Poland	Analyze coping strategies used by male and female participants.	Brief COPE questionnaire: Satisfaction with Life Scale	Different coping strategies explained dangerous situations in male and female participants. Among females, significant predictors were: positive reframing, acceptance, and use of instrumental support. Among males, similar analyses indicated that acceptance, use of instrumental support, denial, venting and substance use explained the threat assessment.
Monasterio et al. [34]	*N* = 83 male and female BASE jumpers age: 24.1 ± 4.0 yrs	US, UK, Canada, Israel and South Africa	Compare personality in males and females as well as motivations.	Temperament and Character Inventory	Temperament and character were comparable among male and female participants. The exception was cooperativeness.
Raue et al. [35]	*N* = 57 male and female climbers age: 18–57 yrs	Germany	Test the relationship between climbing activity, error rates and risk perception.	*	The number of perceptions was reduced during the climbing activity. In opposition, during the activity, error rates tend to increase. The experience was inversely related to risk perception and positively associated with the number of errors.
Langseth and Salvesen [59]	Group of climbers *N was not detailed	Norway	Analyze and interpret group values.	Interview	It was found an association between risk-taking and recognition or status.
Hetland et al. [36]	*N* = 53 male and female backcountry skiers age: 27.8 ± 5.7 yrs	Norway, Sweden, US, Canada and Germany	Describe moment-to-moment feelings; compare moment-to-moment feelings with emotional self-reported at the end of practice.	Questionnaire to collect self-report emotions*; GOPro 4 cameras; GPS	Video camera analysis and self-reported emotions were unrelated. Happiness was higher during the breaks. Finally, the facial expression of happiness predicted self-reported interest, while the facial expression of sadness was a determinant of lower levels of pleasure.
Monasterio and Cloninger [54]	BASE jumpers, mountaineers *age and N were not detailed	Different countries	Explore the role of self-transcendence in personality.	Temperament and Character Inventory	The results indicated that participants are adventurous in temperament, self-controlled and organized. The levels of transcendence were below the mean, which indicates the rationalization of controversial behaviours.
Hetland et al. [48]	*N* = 24 male and female bikers age: 27.1 ± 6.8 yrs	Norway, Sweden, Poland	Describe moment-to-moment emotions and examine the relationship with self-reported emotions after the event.	Questionnaire to collect self-report emotions*; GOPro 4 cameras; GPS; heart rate	Happiness was higher before the event. Interest was less intense during the event than in the moments preceding the event. No relationship between facial expressions and self-reported emotions was obtained. Participants experienced levels of anger.
Boyd [49]	*N* = 148 male skateboards age: 22.1 ± 3.2 yrs	US	Examine the associations between goal orientation, risk-taking and intrinsic motivation.	Attitude Toward Risk Questionnaire; Perception of Success Questionnaire; Behavioral Regulation in Sport Questionnaire	Task orientation and risk-taking were associated with intrinsic motivation (intrinsic motivation toward accomplishment and intrinsic motivation). On the other hand, ego orientation was not associated with intrinsic motivation.
Fruhauf et al. [37]	*N* = 93 male and female freeride and slope skiers age: 25.6 ± 6.8 yrs	Germany	Regarding motivation and accident involvement, compare freeride skiers (high-risk sport: professional, recreational) and slope skiers (low-risk sport).	German Sensation Seeking, Emotion Regulation; Agency Scale and the German Accident and Close Calls in Sport Inventory: questions about equipment, safety information and strategies to reduce risks were asked to freeriders	Levels of seek-sensation were higher in freeriders compared to slope skiers. The higher agency was noted after the activity in freeriders compared to slope skiers. Freeriders reported more accidents than slope skiers. However, it was not associated with motives to participate in extreme sports.

Table 1 (continued)

Study	Sample	Country	Aim	Methods	Main findings
Bonstanci et al. [38]	*N* = 1660 male and female (skiing, snowboarding, mountaineering, motor-car, motorbike racing) age: 27.9 ± 10.7 yrs	Turkey	Compare self-confidence in high-risk sports considering gender, sports experience and level of participation as independent variables.	Self-Confidence scale	Women were more self-confident than men. Self-confidence was related to sports level and sports competition.
Fruhauf et al. [39]	*N* = 48 male and female freeriders: *N* = 24 adolescents (age: 14–20 yrs) *N* = 24 adults (age: 26–41 yrs)	Different countries	Compare motivations and risk-related aspects in adolescents and adults.	Interview	Adolescents and adults shared motivations for participation in extreme sports—the main reasons: challenge, freedom/pleasure, friends, and balance. In opposition, nature was the primary motive of adults and less reported in adolescents. Risks and close calls were experienced among adults (79%), contrasting with adolescents (29%).
Kuzikova et al. [50]	*N* = 180 (skydrivers, base jumping, motorcycles) *age was not detailed	Not specified	Analyze the motivations for participation in extreme sports.	Questionnaire for Predisposition to Risk Research; Self-Confidence test questionnaire; Assessment of the level of nervous mental stability; Self-Assessment of Predisposition to Extreme-Risk Behavior*	Extreme sports participants had a predisposition to the risk. Nervous mental stability was considered an essential factor for risk activities, which is affected by experience. Self-confidence and search for thrills were associated with risk-taking.
Green et al. [40]	*N* = 20 male and female BASE jumpers *age was not detailed	Australia, New Zealand, South Africa, US, Canada, UK, Iran, Dutch, India	Understand and interpret the emotions of BASE jumpers.	Interview	Three primary emotions emerged in the present study: fear, flow and thrill. These emotions impact the cognitive evaluation of the risk and behaviors. Emotions could have a negative influence on risk-taking decisions but flow and thrill have an impact on ongoing participation
Frick [51]	*N* = 66 male and female jumpers (cliff jumping, free diving) *age was not detailed	Not specified	Examine sensation-seeking behaviour among male and female participants in extreme sports.	Data used in the current study is available online (https://cliffdiving.redbull.com)	In risk sports, women tended to be underrepresented compared to male participants. Seeking behaviour was similar among males and females. Differences in performance between males and females were negligible in cliff diving.
Gardner et al. [41]	*N* = 1107 male and female (different extreme sport) age: 19.5 ± 2.1 yrs	US	Understand the relationship between sensation seeking, impulsivity, risk compensation and injuries.	Sensation Seeking Personality Type Scale; Barratt Impulsiveness Scale Version 11; Risk Compensation Scale	Sensation-seeking and impulsivity are significantly associated with risk compensation and injuries. In addition, risk compensation was related to injuries in specific sports (mountain biking and snowboarding).
Tostesen and Langseth [60]	*N* = 7 freeriders age: 21–46 yrs	Norway	Understand the social value (i.e., recognition, credibility) of freeriding skiing as a culture.	Interview	Among freeriders, risk-taking and recognition were associated but were affected by the skill level of the participants. In the current study, three dimensions of social risk-taking were proposed: the association between risk-taking and recognition, the limits of this association, and the moral limits of risk-taking.
Weishaar et al. [42]	*N* = 7109 male and female (different extreme sports) age: 19.7 ± 2.3 yrs	US	Investigate the influence of impulsivity and sensation seeking to explain participation in high-risk sports and the risk of injury.	Sensation Seeking Personality Type Scale; The Negative urgency, Lack of premeditation, Lack of perseverance, Sensation Seeking; Positive Urgency Impulsive Behavior scale	Risk and experience-seeking were significant positive predictors of extreme sports participation, while lack of perseverance was negatively associated with sports participation. In addition, risk-seeking and lack of perseverance determined injury risk.

Table 1 (continued)

Study	Sample	Country	Aim	Methods	Main findings
Bouchat et al. [55]	*N* = 183 Wingsuit: *N* = 61 Others: *N* = 121 *age was not detailed	Not specified	Compare the psychological profile of wingsuit and other BASE jumpers.	Sports Mental Toughness Questionnaire; Sports Mental Training Questionnaire; Temperament and Character Inventory	Regarding the psychological variables analyzed in the current study, negligible differences were obtained between the groups.
Ionel et al. [43]	*N* = 272 male and female rock climbers age: 32.1 ± 10.0 yrs	US, Canada, UK, Austria, Belgium, France, Germany, Italy, Romania, Spain, Australia, Brazil, China, Japan, and New Zealand, South Africa, Thailand	Test if personality trait has an impact on performance.	Big Five Inventory–2 Short Form; Assessment of grit was done using the 12-item inventory	Traits of the five-factor model (i.e., openness and agreeableness) were associated with performance. Grit was also determinant to explain the performance after considering age, sex, experience and personality traits.
Aghedu et al. [44]	*N* = 189 male and female (different sports) age: 33.6 ± 9.19 yrs	Italy	Explore romantic relationships in extreme sports.	Multidimensional Evaluation of Love; Passionate Love Scale; Rosenberg Self-Esteem Scale; Ten-Item Personality Inventory	Extreme sports participants tend to present less intense feelings than non-extreme sports participants. Meantime, sentimental feelings were characterized by positive and stable emotions.
Boudreau et al. [52]	*N* = 13 male and female rock climbers age: 36.5 ± 12.2 yrs	Different countries	Considering an integrated model, the present study investigated the antecedents, characteristics and consequences of psychological states in rock-climbers.	Mixed-method (qualitative and quantitative approach): Core Flow Questionnaire; Semi-structured interview	The optimal state was higher during outdoor climbing than during indoor sessions. Focus on explanatory routes was reported preceding the climbing. In opposition, the preceding clutch states were defined by specific goals and pressure caused by the additional risk. These states were characterized by maximal effort, while flow states were described by enjoyment. After flow state vitality was reported while, after clutch states, exhaustion was reported.
Fruhauf et al. [45]	*N* = 10 female trad climbers age: 26.1 ± 4.3 yrs *N* = 10 soccer players age: 30.6 ± 7.5 yrs	Not specified	Compare traditional and high-risk sports in terms of advantages and disadvantages regarding female participation.	Interview	Generally, female participation in high-risk sports is associated with fewer barriers and more advantages.

* The questionnaire citation was not present

were developed in the US, while one was conducted in China. The extracted studies can be categorized into domains based on motives, emotions or quality of experience [5, 23, 25, 27–29, 31, 35–37, 39–42, 46–51], personality [24, 30, 34, 43, 52–54] or psychological profile [26, 32, 33, 38, 55–57]. One study focused on the affective aspect of extreme sport sports [44], while a single study was centered on gender equity [45]. Two studies investigated the group values of extreme sports using a social approach [58, 59].

Table 2 highlights the theoretical background of each study. The theory of sensation seeking was used as a framework to develop some of the studies included in this review [23, 24, 30, 34, 37, 41, 42, 49, 50]. The quality of the experience explained by the flow theory was also relevant to define the characteristics of participation in extreme sports [29, 36, 40, 47, 51, 60]. Studies included in the current review followed qualitative and quantitative methods, as shown in Supplementary Table 1.

Results of sources of evidence

The studies included in the present review reported two types of approaches: social and individual, as represented in Fig. 2. The social perspective is based on how the values inherent to an extreme sport influence the participant behaviour. Based on group values approach, climbers [58] and freeriders [59] assumed that risk-taking was associated with credibility and peer-recognition. This association is, in turn, mediated by the skill level. In addition, participation in extreme sports tends to offer fewer barriers to women participation [45]. The relationships between extreme sports participants are positive and stable [44]. At the individual level, participants reported motives to participate in extreme sports and also multiple sensations. These are connecting with the flow or quality of experience [29, 40, 51, 60]. Among males, the quality of experience was determined by leisure involvement, whilst, in female participants, centrality and self-expression were decisive for the experience [29]. The reasons and feelings are related to the personality or psychology profile of participants. Overall, extreme sport participants demonstrate emotional stability, conscientiousness, energy, novelty-seeking, self-directness, adventurous profile, self-control, organization, openness, agreeableness and, grit. Studies that examined psychological profiles found compensation, androgynous, somatic anxiety, self-control, health-promoting behaviors, relevant coping strategies such as positive, reframing, acceptance, instrumental support, denial, venting and substance use, anhedonia, craving and self-confidence as predominant in extreme sport participants.

Discussion

This review presents an overview of relevant literature investigating the motives, emotions and personal characteristics of participation in extreme sports. The studies indicated a notable upsurge in academic work in the field of extreme sports since 2000, suggesting a growing interest in the area. At the individual level, multifaceted motives and sensations explained the involvement in extreme sports and related to personal characteristics. The flow or quality of experience was recognized as a key determinant in the way specific situations are perceived. This notion was also influenced by sex. Studies that examined the main characteristics within extreme sports culture (i.e. group level) noted that risk-taking is inherent to these activities, and it is justified as a representation of credibility, social status and peer recognition. Participants also mentioned that risk-taking and skill level are related. Theories about sensation seeking and personality traits were often reported to justify the characteristics of participants. However, this theoretical background tends to explain the motives for participation as an exclusive desire for risk, danger or thrills, ignoring extreme sports benefits or positive issues. Different questionnaires and qualitative approaches were used to examine motives, personality traits and main characteristics of extreme sports.

The results of the current review showed there is no unique profile of extreme sport participants. The studies also show that different motives, personality traits, and sensations explain participation in extreme sports. The sensation-seeking theory assumes that extreme sports individuals constantly explore risk, adverse or novel experiences [61]. Based on this background, different scales were developed to explore the participation of individuals in extreme sport activities [61–63]. The focus on risk-based theories tends to classify participants as unhealthy or with deviant traits and, consequently, ignore the benefits of extreme sports [57, 60]. Other perspectives also mention the association of fear and anxiety with participation in extreme sports [64, 65]. The positive aspects of involvement in extreme sports were also identified in several studies [24, 30, 31, 34]. The emotional style of 79 male and female BASE jumpers was characterized by risk-taking, self-direction and persistence [34]. In a separate investigation involving interviews with 40 freerides, evidence suggests that the main motives to participate in extreme sports were contact with nature, the counterbalance to everyday life, and moving from restrictions and friends [31]. Additionally, the freerides used different strategies to control the risk (e.g. planning the conditions of activity) [31]. However, it is argued that risk-taking is an inherent characteristic of extreme sports. It could potentiate numerous benefits, such as emotional stability, conscientiousness, energy [52], pleasure, happiness [25,

Table 2 Summary of theoretical background and determinant concept in each study

Study	Theoretical background Determinant concepts	Explanation
Florenthal [23]	Sensation seeking paradigm	This theory was based on different personality traits between individuals. Sensation-seeking mentioned that participants search for thrills, novelty and adventure.
	Optimum stimuli level	The theory explains the association between arousal levels and motivation. Low levels of arousal motivate the participants to find stimulant activities.
Fave et al. [46]	Flow or optimal experience theory	Optimal experience is characterized by challenges (opportunities) and skills (capabilities). To maintain the flow of the experience, participants are constantly looking for challenging situations to refine their skills.
Kajtna et al. [53]	Big Five model	Five factors emerged to define personality based on personality questions: surgency, acceptability, dependency, emotional stability and culture.
Cazenave et al. [56]	Emotional auto-regulation	Participation in high-risk sports was justified to solve psychological conflict states.
	Alexithymia	This concept was associated with difficulties in expressing emotions and feelings. Given the relationship between alexithymia and psychological conflicts, this construct is essential to understand the relationship between high-risk sports and emotional regulation.
	Self-regulation theory	Based on this theory, the Risk and Excitement Inventory questionnaire allows for the discrimination of two profiles in high-risk sports: escape self-awareness and compensatory self-regulation. Briefly, self-awareness was positively associated with depression, anxiety, pessimism, low self-esteem and lack of control during risk-taking occasions. Self-regulation was not associated with the mentioned factors, and it characterized well-balanced individuals who find identity in extreme sports.
Allman et al. [47]	Edgework theory	An edge worker is a person who pushes the boundaries of what was done in the past. Four stages explained edgework theory: initial (characterized by nerves), performance (thinking is not present and the action is natural), aftermath (self-actualized and omnipotent), and redefining or neutralizing feelings. In addition, five dimensions need to be considered to interpret the edgeworkers: the historical and socioeconomic facts, the rules of activity, the combination of emotional level and intuitive reactions, control of the situation and, finally, the meaning of activity.
	Means-end theory	The theory was originally developed in the field of marketing. It is focused on the characteristics, consequences and values of the product. The definition of characteristics or attributes of BASE jumping is social interaction, curiosity, escape from stress, and nature. Effects can be positive or negative. Control, overcoming fear, and adrenaline are examples of positive consequences. In opposition, injury or death are examples of negative consequences. Values are abstract consequences of the desired end states of being: transcendence and freedom. The theory related attributes, consequences and values to understand the motivations of BASE jumping athletes.
Sanchez et al. [57]	Anxiety and self-confidence	Before the competition, anxiety, affect and self-confidence were considered important variables that could affect performance. Anxiety was defined as a negative emotion to a situation of stress, while affect corresponds to adaptive or aversive mood states.
Monasterio et al. [24]	Personality	Studies regarding high-risk sports focused uniquely on one personality indicator (sensation-seeking). Two components of personality were considered: temperament and character. Temperament refers to hereditable, stable, independent emotions (novelty seeking, harm avoidance, reward dependence, character). Character is determined by individual goals and values, which are influenced by learning or social aspects (self-directness, cooperativeness, self-transcendence). It was hypothesized that BASE jumpers had higher levels of novel seeking and low scores of harms avoidance.
Hetland and Vitterso [25]	Psychological aspects of emotions	The emotions can be categorized as hedonic and eudaimonic, commonly referred to as "liking" and "wanting". The eudaimonic emotions are associated with the meaning of life (vitally, interest and engagement).
	Sources of information in self-report emotions	The report of emotions includes four different types of information: experimental knowledge (current emotions), episodic memory (reconstruction of past memories), situation specific-beliefs (emotions expected in a particular context), identity related-beliefs (recordings about the emotions felt).
Dean [26]	Adventure theory	The theory established the relationship between risk, competence and experience. Competence is a multi-factorial concept that covers skill, knowledge, attitude, behaviour, and confidence.
	Self-control	Self-control is the capacity to control impulses, and it is composed of three components: standard (definition of a desired state or a specific goal), monitoring (comparing the actual state with the desired state) and operation (changing the existing state to the desired state). Self-control is negatively correlated with perceived risk.
	Risk in sport	The model proposed combined experience, risk associated with activity, individual risk and outcome. In brief, the experience was inversely related to risk in sport–risk acculturation; experience was positively associated with affect, and positive experiences were positively associated with risk.

Table 2 (continued)

Study	Theoretical background Determinant concepts	Explanation
Brymer and Schweitzer [27]	Fear and extreme sports	Fear is an automatic response between a subject and an object. Among extreme sport participants, fear has been associated with an unhealthy condition.
Brymer and Schweitzer, [28]	Phenomenological and freedom	Freedom is not only associated with the absence of constraints but also with the application of choice and responsibility, which may cause anxiety or fear and, finally, movement.
	Hermeneutic phenomenology in research	This technique focuses on the interpretation of an actual event to examine the nature of a specific experience. Considering the context of extreme sports, six different contexts of freedom were considered: movement, letting go of the need for control, release from fear, choice and personal responsibility being at one.
Heirene et al. [58]	Withdrawal states associated with addiction	States of anhedonia, craving, and negative effects were examined in rock climber participants. Anhedonia is defined as a negative mood state and a diminished interest/pleasure to reward stimulus. Craving corresponds to extreme motivational levels to experiment with the effects of drug. Examples of adverse effects are, for example, stress and unhappiness.
Chang [29]	Flow or optimal experience theory	Optimal experience is characterized by challenges (opportunities) and skills (capabilities). To maintain the flow of the experience, participants are constantly looking for challenging situations to refine their skills. The model proposed establishes the relationship between peak flow experience, plateau flow experience, flow experience and attachment.
Monasterio et al. [30]	Psychobiology profile	This study examined the relationship between traits and situations with stress or decision-making. Stress is associated with two neurobiological systems: Hypothalamic-pituitary-adrenal (responsible for releasing cortisol) and sympathetic-adrenal medullary axis (responsible for releasing norepinephrine. Salivary cortisol and alpha-amylase are indicators commonly associated with the hypothalamic-pituitary-adrenal and sympathetic-adrenal medullary axes, respectively. Higher novelty seeking and low levels of harm avoidance were associated with lower cortisol levels. In contrast, low cortisol levels were apparent in participants dependent on rewards.
Brymer and Schweitzer [5]	Hermeneutic phenomenology in research	This technique focuses on the interpretation of a real event to examine the nature of a specific experience.
Frühauf et al. [31]	Risk-taking behaviour	Risk has two orthogonal factors: risk and preventive behaviours. Both aspects are related to participation in risk sports. Risk-taking is not psychopathology and has four main topics: context, challenge, suffering, and other people.
Bekaroglu and Bozo [32]	Attachment style	Attachment links consistency and persistence between the youth and the caregiver. Insecure attachment (anxious and avoid attachment styles) was associated with health-risk behaviours.
	Emotion regulation strategies	Emotion regulation is modifying emotional reactions and coping strategies to manage the emotional experience.
Krokosz and Jochimek [33]	Emotion regulation strategies	Emotion regulation corresponds to the modification of emotional reactions and coping strategies used to manage the emotional experience.
	Coping strategies	Coping strategies has two main functions: regulatory and instrumental. Regulatory and instrumental parts are associated with concentration on emotions and problems, respectively. After, the avoidance style was also defined as a coping strategy.
Monasterio et al. [34]	Personality	Studies regarding high-risk sports focused uniquely on one personality indicator (sensation-seeking). Two components of personality were considered: temperament and character. Temperament refers to hereditable, stable, independent emotions (novelty seeking, harm avoidance, reward dependence, character). Character is determined by individual goals and values, which are influenced by learning or social aspects (self-directness, cooperativeness, self-transcendence). It was hypothesized that BASE jumpers had higher levels of novel seeking and low harm avoidance scores.

Table 2 (continued)

Study	Theoretical background Determinant concepts	Explanation
Raue et al. [35]	The role of feelings when judging risks	The decisions of extreme sports participants are affected by two factors: prior experience or specific states during inexperienced situations. In other words, decisions in high-risk sports are based on affective-intuitive states (decisions on experience) and affective, physical states (decisions based on in-moment emotions).
	The role of physical activity when judging risks – embodiment theory	This approach establishes the association between cognitive, affective and physical processes. Participation in physical exercise (i.e., extreme sports) stimulates endorphins, which cause a positive mood and reduce anxiety. Positive mood is associated with lower risk perception and, consequently, more risk-taking behaviour.
Langseth and Salvesen [59]	Risk taking based on a cultural approach	The manuscript focused on symbolic capital – recognition and prestige.
Hetland et al. [36]	The feelings of skill development	The skill development is based on different theories: eudaimonic identity, flow, self-determination and functional wellbeing approaches. According to the eudaimonic theory, people have good feelings when they attain their best. The flow theory highlights three necessary conditions: balance between challenges proposed and skills, clear goals and immediate feedback. Self-determination theory assumes that participants are intrinsically motivated, satisfying three basic needs: competency, self-determination (autonomy) and feeling related. The functional wellbeing approach explains the structural, functional and motivational feelings associated with specific activities.
Monasterio and Cloninger [54]	Self-transcendence theory	Self-transcendence is defined as "*direct perception of participation in something greater than one's self or perhaps even something boundless*". This feeling is related to team-work, cooperation, satisfaction and altruism.
Hetland et al. [48]	Functional wellbeing approach	The manuscript criticizes the flow theory and separates the feelings of pleasure and interest. Pleasure and interest were associated with stability and change, respectively. The functional wellbeing approach distinguished momentary emotions and the overall experience of the flow.
Boyd [49]	Motivation in extreme sports	Participation in extreme sports has been associated with intrinsic motivation, more precisely, self-efficacy. Goal orientation is also a determinant for high-risk sports since it allows for defining competence and success within the sport. Task orientation is associated with task realization, personal improvement and skill development. Ego orientation, individual ability and perceived success is often compared to others.
Fruhauf et al. [37]	Assessment of motivation in extreme sports	The sensation-seeking theory does not solely explain the motivations of extreme sports participants. The Sensation Seeking, Emotion Regulation and Agency Scale was developed and analysed three different constructs (sensation seeking, emotional regulation and agency): need for the activity (between participating), affective experience (during participation) and transference of activity (after participation).
Bonstanci et al. [38]	Motivation in extreme sports	The risk-seeking theory stated high-risk in extreme sports participants. Extreme athletes are characterized as having the ability to defeat the fear of being hurt or dying. Of note, extreme sports participants are also characterized by reporting intense fear.
Fruhauf et al. [39]	Adolescence and risk-taking	The period of adolescence represents a risk-taking occasion, and it is connected with reward sensitivity. Meantime, the relationship between risk behaviours, novelty seeking, and reward seems to predict independence and social acceptance. Consequently, adolescence is a critical period for participation in high-risk sports.
Kuzikova et al. [50]	Definition of risk and motivations	The first theory about the predisposition of risk as a personal characteristic emerged in 1960. Afterwards, Zuckerman suggested that risk is related to personality traits. Participants seem to tend to new and unknown experiences. Participants in extreme sports were characterized by low anxiety, higher mental stability, and adaptive capacities.
Green et al. [40]	Phenomenology of extreme sports	High-risk sports participants should manage their emotions before, during and after the activities. Apparently, fear is felt before the action, intense focus or flow during the move and enthusiasm after the activity. Of note, fear and anxiety help participants to anticipate the threat. Positive feelings were reported: thrill (excitement and pleasure) and flow (focus, concentration and effortlessness). The investigation regarding emotional states is vital since emotions are the standard risk evaluation method.
Frick [51]	Sensation seeking paradigm	This theory was based on different personality traits between individuals. Sensation-seeking mentioned that participants search for thrills, novelty and adventure.

Table 2 (continued)

Study	Theoretical background Determinant concepts	Explanation
Gardner et al. [41]	Summarize the theory of sensation seeking	Sensation-seeking can be conceptualized in two different constructs: risk-seeking and experience-seeking. When both subconstructs are present, they are associated with participation in extreme sports. Meantime, risk-seeking per se is associated with injury risk. Another important concept for this paper was risk compensation, which states that if participants wear protective equipment, they feel more comfortable and, consequently, perform more risk behaviours to maintain an optimal level of stimulation.
Tostesen and Langseth [60]	Risk-sports considering the influence of social group on individual decision	There are two main different perspectives: compensatory and adaptive. It was argued that prestige and recognition are related to risk-taking within risk sports (i.e., symbolic capital). The "cred-zone model" establishes the balance that mediates the relationship between recognition and high-risk activities between skill and risk.
Weishaar et al. [42]	Relationship between high-risk sport participation, sensation seeking and impulsivity	Impulsivity is defined as unplanned reactions focusing on immediate rewards than long-term consequences. Although impulsivity and sensation seeking have been as synonymous, they refer to different terms. Briefly, sensation seeking is associated with participation in extreme sports while, impulsivity is associated with health-risk behaviour engagement and, consequently, related with the risk of injury.
Bouchat et al. [55]	Contextualize mental toughness, personality traits and psychological strategies	Mental toughness is defined as a coping strategy to lead with pressure, adversity, and recovery from failures. Mental training involves skills (attention, emotion regulation and focus) and strategies (self-talk or mental imagery).
Ionel et al. [43]	Personality in sports	Personality traits were related not only to performance outcomes but also to behaviours that impact physical performance. The model used to explain personality in the context of athletic performance focus on the Five Factor Model. The current study also describes the potential impact of grit on sport-outcomes and athlete identity.
Aghedu et al. [44]	Constructs associated with love in terms of risk-sports	Love combines cognitive, emotional processes and personality. In addition, love is a goal mechanism and stimulates positive and negative emotions, idealization attachment, sexual attraction and obsessive thoughts.
Boudreau et al. [52]	Integrated model – combining flow and clutch states	The model presents an alternative to flow theory. In extreme sports, flows are identified according to the attentional focus and goal orientation: telic flow or paratelic flow. In parallel, clutch states are defined as successful performance even psychological pressure increases. According to the integrated model, flow and clutch states present the following characteristics: altered perceptions, absorption and confidence.
Fruhauf et al. [45]	Female participation in high-risk sports	Statistics in high-risk sports tend to favour the participation of male athletes. Of note, the acceptance of female athletes is influenced by their skill level or self-efficacy. Meantime, literature reports different traits of personality in female high-risk sport participants. Extreme sports are an eligible opportunity to defeat gender differences, risk-taking and embodiment.

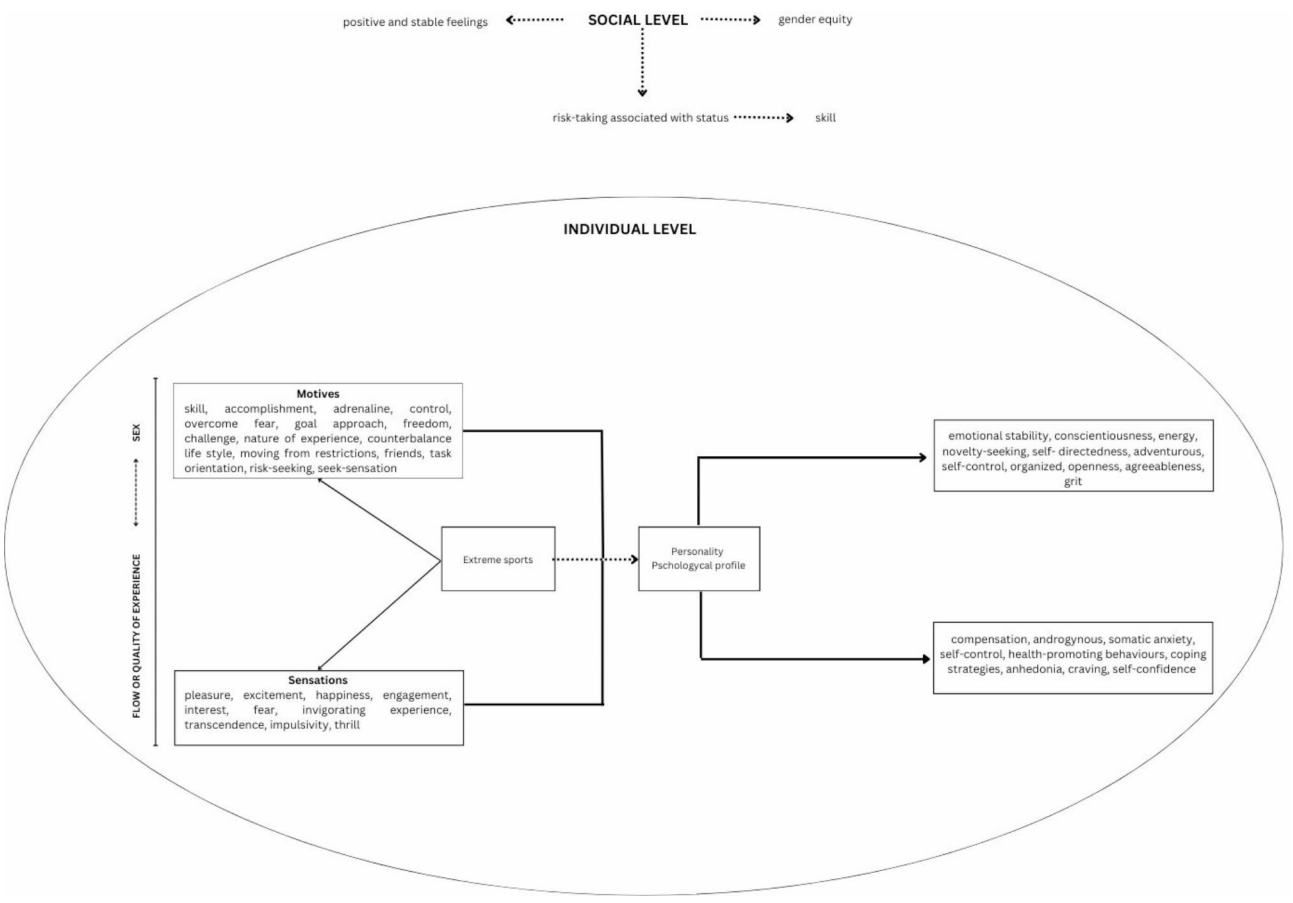

Fig. 2 Scopes of physiological variables in extreme sport participants

47], self-expression [29], resilience [30], experience of nature [31], and self-organization [53]. In addition, interviews conducted in extreme sport participants revealed that fear is a natural characteristic of extreme sports and is related to achieving a personal sense of mastery [27], as opposed to being viewed as a negative consequence of participation in extreme sports.

The reversal theory is based on meta-motivational states, which explains many motives and sensations in the current review. These psychological aspects can vary before, during or after the extreme event [25, 30, 47]. In the context of extreme sports, telic and paramedic states emerged from the reversal theory [5]. Goal-oriented and low arousal levels characterized telic states, whilst paratenic states correspond to arousal-seeking and natural activities. During a telic state, high arousal levels could impact the appearance of anxiety and fear, although fear can potentiate benefits in participation in extreme sports [27]. In contrast, high arousal levels in a paratenic state are synonymous with excitement [5]. The motives and sensations resulting from participation in extreme sports are influenced by the flow or quality of experience [29, 40, 51, 60]. Flow experience is a subjective state when participants are intrinsically committed to the task [66]. During participation in extreme sports, diverse flow states are experienced and are determined by arousal, skill levels, challenge and focus [67]. The convergence between reversal theory and flow experience is that extreme sport individuals reported telic and paratenic flows [67]. Telic flow represents challenging activities, while paratenic flow corresponds to enjoyable and exciting activities [5]. The combination of both theories seem reasonable for understanding the multiple motives, sensations and personality traits of participation in extreme sports.

Recent narrative reviews criticized traditional theories since they interpret individuals and the environment as separate systems [68–70]. Individual behaviours are explained by the interaction between the environment (i.e. social, physical, and cultural) and participants [71]. These behaviours are modelled by decisive individual features that are responsible for perceptions, decision-making, actions and cognitions (i.e. individual, task and environment constraints) as well as the perception of information retrieved from the environment (i.e. affordances) [69]. This dynamic approach also explains the variability of motives and emotions mentioned by extreme sports participants since the constraints and perceptions of the environment determine a particular

behaviour. Nevertheless, changes in meta motivational states postulated by reversal theory are influenced by environmental factors [1]. Future studies that include extreme sport participants and examine motives, emotions and personal characteristics should consider specific situations and contexts.

The current review has limitations that should be recognized. The studies included in the present review were written solely in English. The current review focused exclusively on the motives, emotions and personal characteristics of individuals involved in extreme sports. The studies included also presented limitations, particularly samples of participants involved in different extreme sports. Additional details regarding the characteristics of sports need to be reported. For example, in future studies, it is central to know whether the rock climbers used ropes. The age of the samples was widely variable, which in turn may have an impact on participants' perceptions regarding extreme sports participation. These details need further consideration to generalize the findings for a specific extreme sport.

In summary, extreme sports are often interpreted as unfavorable in terms of personal or social development. Traditional theories interpret extreme sports individuals as an asymmetric organism since they focus exclusively on personal traits or risk-seeking [68, 72]. Consequently, the positive aspects of participation in extreme sports are often neglected. The present review highlights that participants tend to report various emotions, motives and benefits associated with participation in extreme sports. Even aspects related to extreme sports, typically interpreted as harmful, such as fear or risk, could potentiate positive benefits, such as planning the activities or persistence. The practice of extreme sports should not be neglected or discouraged. Although different theoretical approaches have been identified to study extreme sports participation, the reversal theory proposes alternative emotions and motives which are influenced by external variables. This theory explains the multiple motives and sensations extracted in the current review and highlights the ecological dynamic approach, emphasizing the interaction between individuals and the environment.

Supplementary Information

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Supplementary Material 1

Author contributions

DVM, DB, FP, ARebelo, HS conceptualized the manuscript, DVM, AF, AR, ARebelo, NS, HS wrote the original draft; DVM, AR, HS evaluate the bias; DVM, AF, AR, ERG, HS reviewed and edited the manuscript. All authors have read and agreed to the published version of the manuscript.

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The authors confirm that the data supporting the findings of this study are available within the article and its supplementary materials.

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