Examining the Psychological Preparation and Management of Performance by Elite and Sub-Elite Endurance Sport Performers: A Systematic Review

by

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Abstract

Background

Successful endurance performance is commonly attributed to the athlete who possesses the right blend of physical and mental capabilities, to cope with the specific demands of an endurance sport, in tough environmental conditions. Sport psychology is important for a variety of sports, especially endurance-based sports, given the mental and physical effort required to effectively train and compete at varying intensities and duration. The growing interest for endurance performance, has resulted in some narrative reviews examining the specific skills that may enhance performance, such as self-talk, attentional control, and active self-regulatory strategies. A systematic review focused on experimental or quasi-experimental studies, with largely non-elite populations, to address the psychological determinants of whole-body endurance performance for which strategies work best. Therefore, the research aim was to systematically review a more diverse range of empirical evidence, focused on elite and sub-elite athletes from a variety of endurance and ultra-endurance sports. The objective was to capture a fuller breadth and depth of evidence, as well as to gain a highly practical and newer understanding, to address the research question of how do endurance athletes psychologically prepare for and manage their performances during training and competition.

Methods

A rigorous screening process was implemented against *a priori* inclusion and exclusion criteria and an operational definition. Six databases were searched to look for peer-reviewed studies in English language and whose samples included elite and sub-elite endurance athletes, aged 16 years or older; the search was also inclusive of gender, nationality, ability and disability. Selected articles were comprehensively appraised for their quality and risk of bias using three critical appraisal tools (Mixed Methods Appraisal Tool; Crowe Critical Appraisal Tool; and Critical Appraisal Skills Programme). Due to the heterogeneity of the results, a data-based convergent synthesis design was applied, whereby thematic analysis was used for simultaneously identifying themes and sub-themes from the results of the qualitative and mixed studies and qualitative open coding of the quantitative studies.

Results

From the 40 studies selected, there were 13 qualitative, 23 quantitative and 4 mixed methods, dating from 1977-2015. Twenty-three (58%) studies were appraised as a low risk of bias, 12 (30%) were deemed as moderate risk and 5 (12%) as high risk. A total of 809 athletes were sampled (487 elites; 322 sub-elites), spanning 11 countries, with age ranging from 16-49 years. The sampling included 100% able-bodied endurance athletes and studies used a variety of endurance and ultra-endurance sports.

Based on the thematic analysis, two overarching themes actively emerged: Mind-Body Dualism and Mastery, which embodied four sub-themes: Psychological Strategies and Skills; Pain Management; Psychological, Psychosocial and Other Factors that Require Monitoring; and Management of Perceptions. Overall, the review reports a similar positive use of self-regulatory and cognitive based strategies by athletes from different endurance sports. For example, a combination of pacing, visualization, self-talk, attentional focus and thought control were employed to psychologically prepare for and manage endurance performance, in both competition and training. However, the differences lay in how or when these were applied, following the dynamic assessment by the athlete on their somatic symptoms and the cognitive requirements, arousal or anxiety levels. Similarly, as each sport may present its own inherent risks, hazardous situations and contextualized experiences, athletes utilized strategies for dealing with them as they arose. The review found psychological, psychosocial and other related factors that required individual monitoring, regardless of the chosen sport.

Conclusions

This review has elucidated that effective psychological preparation and management of performance by endurance athletes is dependent on the complexities of the individual athletes' and their chosen sports. Therefore, it is recommended that an individualized, holistic and multidisciplinary approach, taking account of the individual athlete's psychological, psycho-social and other related factors, is adopted by the coach and sports organization when monitoring and facilitating the right learning environment for athletes. Although the mastery in their chosen sport is as an initial guarantor for successful performance, athletes need to maintain a healthy, symbiotic balance between their mind and body to prevent deficits in performance and preparation. Athletes need to be autonomous, independently learning from experiences and evaluating themselves in training or competition, to develop the most effective psychological strategies specific to them and their contextualized situations. Finally,

the review recommends more research conducted over a longitudinal period, within a naturalistic setting, to gain more insightful empirical evidence of the psychological preparation and management of performance from a variety of different sports, especially ultra-endurance, as well as sampling more female athletes and athletes with a disability.

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Introduction

Successful endurance performance is commonly attributed to the athlete who possesses the right blend of physical and mental capabilities to cope with the specific demands of an endurance sport, in tough environmental conditions. Sport performance is influenced by numerous variables, for example, according to Tuffey (2000), the three main factors impacting on performance are physical, technical and psychological. From a physical standpoint, endurance performance depends on an ability to supply the active muscle fibres with adequate amounts of oxygen and essential nutrients, to eliminate metabolic heat, carbon dioxide and other waste products and to sustain homeostasis in the body (Shephard, 2000). The technical aspects will be specific to the individual sport and by nature some will have more technical or cognitive requirements than others. From a psychological standpoint, competitive success is dependent on the psychological preparedness of the athlete and the psychological make-up of the individual (Shephard, 2000).

Previous research, conducted in a variety of sports to explore the psychological preparation of performance, identified different elements for success and superior athletic performance. For example, quality mental preparation for competition (Orlick & Partington, 1988), a feeling of control over the performance, a high level of self-confidence, an ability to concentrate effectively and self-regulation of arousal (Williams & Krane, 1998). The mental skills, most often used by elite performers, were highlighted by Williams and Krane (1998) as goal setting, imagery-use, thought control tactics, arousal control techniques, well-developed competition plans and coping strategies, and pre-competition mental readying plans. Hence, there appears to be a consensus for the importance of psychological preparation for competition. For that reason, it is pertinent to focus on how, when and why sport psychology is important specifically for endurance sports.

The many challenges faced by endurance athletes are pointed out by Tuffey (2000) stating that maintaining motivation and intensity is important for each long, repetitive training session, such as in open water swimming, distance running or road racing with goal setting proposed as potentially helpful. Similarly, endurance athletes will need to be able to endure the discomfort, fatigue and pain associated with the arduous training and tough competition conditions. This indicates that using some cognitive control strategies may assist the management of these sensations; additionally, maintaining a sharp focus whilst conserving physical and mental energy is important during competition (Tuffey, 2000). Samson, Otten, and Virgien (2013) described endurance sport, especially distance running, as

a domain in which being able to cope with pain and persevere through setbacks is especially important. Psychological fatigue, although reported as hard to pinpoint, is also a real risk to the endurance athlete (Shephard, 2000).

Thus, to become an elite or sub-elite endurance performer, consistent physical and mental effort is required to maintain the high-performance levels required. The combination of physical and mental effort can be measured or explained in different ways. For example, the Borg scale has been widely used for measuring the rate of perceived exertion (RPE), a psychophysiological scale calling upon the mind and body to subjectively rate one's perception of effort, and is still used in clinical and sports settings. Noble and Noble (2000) described perception as an active process in which internal and external inputs are organized in the cerebral cortex and these perceptions allow the performer to subjectively assess the intensity of muscular effort selectively. Situational psychological factors that may be linked to effort perception during endurance activity are expected duration, self-presentation, and attentional focus; psychological contributions appear to decline as physiological signals increase at the higher exercise intensities (Noble & Noble, 2000). It is believed that people can differentiate their perception of effort from other exercise-related sensations, such as pain and discomfort (Hamilton, Killian, Summers, & Jones, 1996) and perception of pain and effort are based on different neurophysiological pathways (Marcora, 2009; Smirmaul, 2012), thus perceived exertion reflects the interaction between the mind and body.

This mind-body interaction is an important consideration for the elite and sub-elite endurance athlete as they need to train and compete sub-maximally, at varying duration and intensities, whilst simultaneously maintaining the highest levels of skilled performance. Some detailed explanations of how the athlete can maximize this potential can be observed from two different standpoints. The first is the central governor model which was proposed to explain brain regulation of exercise performance (Noakes & Tucker, 2008). This complex system integrates afferent (feedback) sensory information with anticipatory feedforward control that, at the beginning of exercise, is based on the pre-exercise expectations of task duration and intensity. It is argued that the integration of this information generates a conscious perception of effort, measured as the rating of RPE. Whereas, the second is based on motivational intensity theory using a psychobiological model (Marcora, 2010a). This theory proposes that during the performance of physical tasks the only possible form of self-regulation is to disengage from the task (i.e. stop at a maximal level or lower the intensity to a more sub-maximal level), or to keep going. In physical tasks where the workload is not fixed (time trials), a higher level of self-regulation (pacing) is possible which enables the athlete to

complete the activity in the best possible performance. According to Marcora's (2010) psychobiological model of exercise performance, pacing is based on five psychological factors: (1) perception of effort; (2) potential motivation; (3) knowledge of the distance/duration to cover; (4) knowledge of the distance/duration covered/remaining; (5) previous experience of perceived exertion during exercise of varying intensity and duration. Thus, the critical decision of choosing which underpinning model to use by endurance sport researchers, is which best aligns with their world view and reflects their belief in either the conscious or subconscious brain controlling the athlete's decision-making during their training or performances.

The debate over a dual interaction of physical and mental effort required for performance resulted in pacing and decision-making being reviewed by Smits, Pepping, and Hettinga (2014) and Renfree, Martin, Micklewright, and St Clair Gibson (2014). Smits et al. explored the affordance competition hypothesis, suggesting that new insights on pacing and optimal performance could be further investigated using the consideration of pacing as a behavioural expression of continuous decision-making. This process of pacing has been associated with the goal-directed regulation of exercise intensity across an exercise bout (Smits et al., 2014). This ecological approach can offer additional means for the individual differences, perception and action. Renfree et al. applied four models of decision-making to the regulation of muscular work rate during self-paced competitive endurance activity looking at heuristic or rational and small or large world explanations. If an athlete relied solely on a rational and small world approach they may appear robot-like in their pacing and decision-making. Hence, Renfree et al. acknowledged the need to look at other influencing factors and they present seven categories of individual characteristics that could influence decision-making: attitudes to risk, cognitive ability, intelligence, motivation, personality, mood, and emotions.

The importance and benefits of sport psychology is illuminated for endurance sports performers by some narrative reviews that explored the sole use of a specific skill or strategy employed to enhance performance and reporting was underpinned by either the parallel processing theory, dual process theory and/or elements of a mindfulness-based approach. These include, for example, the use of a mindfulness-based conceptual model and associative/dissociative cognitive strategies in sustained activity (Salmon, Hanneman, & Harwood, 2010), active self-regulatory strategies and a proposed working model for inward and external monitoring (Brick, MacIntyre, & Campbell, 2014), the use of association and dissociation in performance (Masters & Ogles, 1998), reviewing endurance performance,

attentional focus and metacognitive strategies and experiences appraising pain signals (Brewer & Buman, 2006) and the concept of automaticity being utilized by long distance runners as a cognitive strategy (Laasch, 1995). Additionally, St Clair Gibson and Foster (2007) reviewed the role of self-talk in the awareness of physiological state and physical performance. Similarly, Van Raalte, Vincent, and Brewer (2015) explored the implications of a sport-specific model of system 1 and 2 self-talk, using some reference to endurance athletes as part of their discussion. Finally, Lind et al. (2009) reviewed whether mind over muscle strategies work, such as attentional focus, whilst also referring to the parallel processing model and a social psychophysiological model, whereby they added environmental and task related variables to the athlete perceptions, and reporting them as an active process.

Yet, although these narrative reviews were clearly insightful in assessing how specific skills can potentially improve endurance performance, none of them specifically addressed the exact phenomenon of interest that the author wished to explore. Nor has there been a systematic review conducted to date that has specifically addressed the research question of how do elite and sub-elite performers psychologically prepare for and compete in their chosen endurance sport. However, one systematic review, conducted by McCormick, Meijen, and Marcora (2015), did provide some insightful knowledge as a useful starting point by addressing endurance performance and its psychological determinants of whole-body endurance performance for which strategies work best.

Their systematic review focused on experimental or quasi-experimental research designs, whose sampling was composed largely of non-elite competitive standard. Their range of endurance sports studied included gymnasium triathlon, swimming 100m-1000yds, running 1-5km, cycling 1.5-20km, rowing and walking. Of the 24 included studies, 22 reported that at least one intervention improved performance, such as association or dissociation, goal setting, hypnosis, imagery, pre-performance statements, self-talk, and a psychological skills training package. It was proposed that psychological skills training could benefit an endurance athlete and there was more to learn about how (i.e., mediating variables) and for whom (i.e., moderating variables) these interventions work (McCormick, Meijen, & Marcora, 2015).

Consequently, the aim of this research was to systematically review a diverse range of evidence, based on elite and sub-elite athletes from a variety of endurance and ultra-endurance sports. The objective was to elucidate a greater breadth, depth and highly practical insights to contribute to a newer understanding of how they psychologically prepare for and manage their performance during training and competition. Accordingly, endurance

performance was operationally defined as an activity involving sustained, repetitive sub-maximal physical exertion, mental effort and technical skill in which an individual competes against at least one other individual, and obtains his or her energy predominantly from aerobic metabolism.

The traditional view of the three energy systems is helpful as a starting point for defining endurance such as to state that exercise lasting longer than 1 minute can be powered mostly by the aerobic system (Gollnick, 1988). However, a more applicable and detailed approach was sought for the clarification on the inclusion of sports, by referring to Hawley and Hopkins (1995) who proposed two functionally separate aerobic power systems for two qualitatively different kinds of prolonged, maximal event. That is those events lasting less than about 4 hours, performed at greater than 70% maximal oxygen uptake (VO2max) and powered by the aerobic glycolysis; and the longer, lower-intensity events powered by aerobic lipolysis. Thus, for this systematic review, all endurance sports had to be continuous in duration, intensity and powered predominantly by the aerobic energy pathway. For distance running, the 800m was set as the minimum distance to be included as evidence reported it is still predominantly powered by the aerobic system in elite and sub-elite athletes (Spencer & Gastin, 2001).

Additionally, any studies involving muscular endurance tasks, such as a hand grip or sit-up tests, were excluded. When categorizing the studied sports, ultra-endurance was defined as any performance with a duration of 6 hours or over, and endurance as under 6 hours (Zaryski & Smith, 2005). Single sports were considered as well as any multi-discipline sports and multi-day events. Therefore, sports that used a transition in between each discipline, such as aquathlon, duathlon, biathlon and triathlon would be included alongside any multi-day endurance event, such as the Tour de France. Finally, the competition level for sub-elite performance was set at national standard and elite performance levels were set above national standard.

Methods

There are many methods to review material and the term 'literature review' is a common catch-all term for any study that assimilates and synthesizes, or describes, the findings of more than one study (Boland, Cherry, & Dickson, 2014). Narrative reviews are used to provide an overview of a topic, to raise issues or identify any gaps; however, they do not require explicit or rigorous methodology or protocol, nor a clear method of synthesis (Boland et al., 2014). A meta-analysis will focus purely on the quantitative data and provide effect sizes to report the conclusions for its specific research aim. There are also other types such as a meta-study, a critical review, an integrative review and a systematic review. Systematic reviews have a clearly defined focus with explicit and rigorous methodology which uses eligibility criteria to select papers and specifies the study design type; the papers require a quality assessment and a clear method of analysis and synthesis. Integrative reviews were a response to the criticisms of systematic reviews implying that they were mostly using evidence from Randomly Controlled Trials, and so it was recommended that qualitative and quantitative evidence should also be considered (Sandelowski, Barroso, & Voils, 2007). This integrative approach is new and methods for use are evolving (Boland et al., 2014). Support for conducting such an integrative method is highlighted by Forsdyke, Smith, Jones, and Gledhill (2016) and Dixon-Woods et al. (2006), who argued that there is a growing call for systematic mixed study reviews, within the healthcare sector, to address the perceived divergence between research and practice.

Thus, in the context of the outlined research question, aim and objective, a systematic review was chosen over an integrative review as this was most applicable to the researchers aim. That is that it would include a rigorous and explicit methodology, quality assessment and synthesis; plus, specify the inclusion of empirical evidence from all types of study research design to capture the full breadth and depth of evidence and reduce the potential risk of denying valuable insights. This would also contribute to the interpretation of the specific phenomenon set out within the *a priori* research question (Booth, 2001); and gain a rich and highly practical and newer understanding on how endurance athletes psychologically prepare for and manage their performances.

Eligibility Criteria

All article titles and abstracts, followed by the method and results sections, were rigorously screened for relevance. This was achieved by using the inclusion and exclusion criteria set out in Table 1, and the operational definition of endurance: 'an activity involving

sustained, repetitive sub-maximal physical exertion, mental effort and technical skill in which an individual competes against at least one other individual and obtains his or her energy predominantly from aerobic metabolism'. The clarification of information was sought by emailing the authors of twenty potential articles, resulting in the inclusion of six and exclusion of fourteen (Meade & Richardson, 1997; Torgerson, 2003).

Sources and Search Strategy

A cursory electronic search provided an estimate of the size of relevant literature and check of relevance of key words and phrases (Torgerson, 2003). Following this preliminary stage, a combination of thesaurus terms, free text terms and broad-based terms (Dixon-Woods et al., 2006) were adapted, in different combinations, to identify empirical studies that were high in sensitivity to the research objective (Meade & Richardson, 1997). Each search produced a variety of initial 'returns' ranging between for example 9 to 1546, with an approximate sum of possible 10,409 articles. Therefore, the next stage was to request peer reviewed articles which reduced the range further, for example, 7 to 244. At this stage, a necessary process of screening all article titles and abstracts took place, followed by method sections, looking for relevant demographic details and sifting out obvious duplicates. The next stage was assessing a full-text printed copy of all potential articles to assess them in detail for their possible inclusion.

Six electronic databases were searched between October 2014 and November 2015: MEDLINE (Ebesco), Physical Education Index (CSA) (ProQuest XML), PsychARTICLES, PsychINFO (Ebesco), ScienceDirect and Sport Discus (Ebesco); an example of an online search is found in Appendix 1. The reference lists of screened articles and reviews were also scrutinized for any further articles, alongside a hand search of the International Journal of Sport and Exercise Psychology (2003-2015), International Journal of Sport Psychology (1995-2015), Journal of Applied Sport Psychology (1995-2007), Journal of Clinical Psychology (2009-2012), Journal of Sport and Exercise Psychology (1995-2015), and Journal of Sports Sciences (2000-2007).

Table 1 Inclusion and Exclusion Criteria

	Inclusion Criteria	Exclusion Criteria
Study Design	Qualitative, quantitative, intervention and mixed method peer-reviewed journal articles, written in English, published in full print before end of November 2015; specifically exploring or investigating how endurance athletes manage their performance during training and/or competition; includes any psychological or psychosocial factors that affect endurance performance.	Non-peer-reviewed articles; review articles, book chapters, abstracts or conference papers. Papers not in English text; articles that do not include psychological or psychosocial factors and does not consider the preparation and management of endurance performance.
Population Sample	Regularly competing elite (above National level) and sub-elite (National level) athletes**,** or equivalent where specific entry qualification points are required to compete; if retired, <10yrs. Age is >16 years old, male/female; inclusive of able-bodied/disabled athletes, and all ethnicity/nationality backgrounds.	Non-elite participants below national standard; < 16 years old; not competing or training on a regular basis. When there is a mixed population sample of competitive standard, and elite/sub-elite athletes cannot be clearly separated out from non-elite populations.
Study Outcomes	Study results specifically report on how the athletes psychologically prepare and/or manage their performance during preparation for training and/or competition; and reports on how any psychological or psycho-social factors may affect or should be monitored during elite/sub-elite endurance performance.	The study does not specifically report the use of any psychological preparation for training and/or competition; and does not report on psychological or psychosocial factors that may affect elite/sub-elite endurance performance.
Classification of Competitive Endurance Based Sports	All endurance sports/events that predominantly use the aerobic pathway. Sports classified within the continuous, medium-very high intensity continuum. Single and multi-stage sport(s), that are a single or multi-discipline sport; there is an official competitive set up for these sports and events.	Any activity/sport/event that does not predominantly use the aerobic energy pathway; any sports classified as intermittent duration, low-very low intensity. Studies that use muscular endurance tests.

Data Extraction

An assessment of relevant full printed text copies was conducted, after duplicates were removed and ineligible articles were excluded. The study characteristics and descriptive statistics were extracted and compiled into Tables 2-13. Details included author, year, study design type, factors explored, outcomes, demographical information about the sample population, sport type, the risk of bias result and any funding information.

Quality Appraisal

When conducting a systematic mixed studies review, a consideration of how to review the quality of quantitative, qualitative and mixed-methods studies can be a challenge, as noted by Bélanger, Rodríguez, and Groleau (2011), because the study designs constitute distinct traditions with unresolved ontological and epistemological differences. Consequently, for this review, the author identified three critical appraisal tools, each with its own user manual, that were deemed to be the most appropriate for assessing the quality of all sections in the selected mixed studies. The rationale for choosing three was to allow the author to cross-check between the consistency of the appraisal results, and to ensure a rigorous and unbiased appraisal process.

The first appraisal tool was the Mixed Methods Appraisal Tool (MMAT) which contains 19 methodological quality criteria for appraising qualitative studies; randomized controlled trial; non-randomized quantitative studies; quantitative descriptive studies; and mixed methods research. Studies were scored on a nominal scale (Yes/No/Can't tell) so that the overall quality score for each study was based on the methodological domain using a percentage based calculation. Mixed methods studies were quality assessed within their own domain plus the domain/s used by its quantitative and qualitative components whereby the overall research quality cannot exceed the quality of its weakest component (Pluye, Gagnon, Griffiths, & Johnson-Lafleur, 2009). The MMAT measurement properties had a clear origin and content validation of criteria, with an inter-rater reliability of .72 global score (Pace et al., 2012).

The second tool was the Crowe Critical Appraisal Tool (CCAT) containing 54 reporting items in eight categories: preamble, introduction, design, sampling, data collection, ethical matters, results, and discussion. All categories must be scored; the lowest score for a category is 0, the highest score is 5 and the score for each category must be reported; the total score (out of 40 or as a percent) is reported in addition to each category score. The measurement properties had a clear origin of criteria and construct validation (Crowe,

Sheppard, & Campbell, 2011), with an inter-rater reliability of .74 for its total score (Crowe, Sheppard, & Campbell, 2012).

The third tool was the Critical Appraisal Skills Programme (CASP) qualitative research appraisal checklist which is used by clinicians to assess the rigor, research methods, credibility, and relevance of qualitative evidence. The tool comprised 10 items, with the response options being yes (1), no (0), and unable to tell (0). Item scores were summed to produce an overall quality score out of 10 for each qualitative article (CASP, 2014).

An aggregative approach was adopted for presenting the overall results and their quality rating, like Ardern, Taylor, Feller, and Webster (2013) and Forsdyke et al. (2016). The rating for a low risk of bias was set at 75% or higher, a moderate risk was between 51-74% and a high risk was 50% and less. No articles were excluded if rated as high risk because, as stated by Pope, Mays, and Popay (2007), all studies have weaknesses – the question is whether they matter and how much in the circumstances of the review.

Data Synthesis

Due to the heterogeneity of all the results, a data-based convergent synthesis design was applied meaning that the integration of the results occurred at the data extraction level (Pluye, Hong, & Vedel, 2016) for each qualitative, quantitative and mixed method study. Thematic analysis was implemented manually for conducting this integration of extracted data. This contextualist method was chosen to actively search for and report athlete's experiences, meaning and the reality of the factors relating to endurance preparation and management of performance; additionally, it was employed to examine the ways in which these meanings, events, experiences operate (Braun & Clarke, 2006).

The researcher re-read the articles many times to become immersed in the data corpus. Once very familiar with it, a data extraction process was conducted and data summary tables were compiled, followed by the thematic analysis of all articles. Full and equal attention was accorded to the data-driven coding process, using a hybrid deductive-inductive approach, to identify the data set and subsequent items and extracts. The researcher was also simultaneously looking for any similarities or differences between athletes or types of sports for any reoccurring patterns from the qualitative studies, qualitative elements of the mixed methods studies and qualitative open coding of the variables from the quantitative studies. Thus, data extracts were assimilated for each theme and sub-themes, some of which overlapped due to the nature of the extract or item. Finally, once codes were refined and

reviewed from the thematic mapping process, a conceptual framework was produced to summarize the results of the thematic analysis.

Other systematic reviews have similarly used thematic analysis to effectively combine qualitative and quantitative findings (Baxter, Killoran, Kelly, & Goyer, 2010; Crellin, Orrell, McDermott, & Charlesworth, 2014; Forsdyke et al., 2016; and O'Connell, Bedford, Thiede, & McIntyre, 2015).

Ensuring Rigor

The methodology was informed by The PRISMA checklist (Moher, Liberati, Tetzlaff, & Altman, 2010), and mixed methods review toolkit (Pluye, Hong, & Vedel, 2013) to apply systematic and explicit methods throughout. Furthermore, the author undertook a continual reflective process, to assess how much confidence should be placed in the findings from a qualitative evidence synthesis, using the Confidence in the Evidence from Reviews of Qualitative research (CERQual) approach as a guideline to work with (Lewin et al., 2015).

Table 2 Extracted Data Characteristics of Included Studies (1)

Author/ Year/ID No	Study design Type	Method(s) used	Factors Explored	Effects on Performance Outcome	Gender Age (ave)	Nationality/ Competition Standard	Ability (A-B or Disabled)	Type of Sport	Critical Appraisal Risk of Bias Source of Funding
1. Baker et al. (2005)	Qual Description.	Video montage of competition clips; content analysis.	Cognitive characteristics: attentional control.	Experts have greater cognitive thoughts than mid/back pack. +ve attentional control.	M8 32.5yrs	Unknown (8) Professional (8)	A-B	UE-Triathlon	Moderate Not stated.
2. Barnett et al. (2012)	Quant Descriptive Case Report.	RESTQ, Dynamic Linear Model (DLM), mediating variable analysis, single case study. GPS. Uses Bandura's theory of self-efficacy and Hanin's IZOF model assumptions for mediation analyses to examine dynamic effects. Descriptive stats used: means/SD of regression coefficients.	PBS state, performance and training load. Studying direct (unmediated) and indirect (mediated – *fatigue /lack of energy & being in shape*) short-term associations of total training loads with 'performance related self-efficacy' (PRSE).	RESTQ useful for monitoring training load. Direct relationships of concurrent and lagged TL, independent of the 2 potential mediators, were positive and stable across time (0.17 & 0.09 both 0.00 signif) indicating that in the monitor period, higher TLs were associated with higher levels of SE. The indirect positive effects of TL on SE were larger than total effects due to suppression from fatigue/lack of energy (0.14 & 0.13). The effects of TL on being in shape on SE were stable across time. The effect of lagged TL was positively related to fatigue/lack of energy in the pre-injury period.	F1 22.2yrs	Unknown (1) International (1)	A-B	Triathlon	Low Queensland Academy of Sport Research Grant/CQ University Research Training Scheme Grant.
3. Bergland & Safstrom (1994)	Quant Descriptive Incidence or prevalence study without comparison group.	Swedish version of POMS, administered 2-3 times off-season and weekly with the rating training load (RTL) questionnaire administered weekly May-Aug 1992. VAS at end to evaluate use of POMS.	Monitoring psychological changes during training and racing seasons load using POMS for **mood** & staleness.	Use POMS for monitoring mood detecting staleness during training load. Total mood score was initially 130 and improved ($p<0.05$) to 122 a month later. During heavy training POMS increased to 160 ($P<0.01$. In tapering improvement ($P<0.01$) down to 120 1-week before Olympics. RTL was 9.4, 11.6, and 7.3. VAS was 72 ($P<0.001$). Using POMS results helped to prevent risk of staleness with adjusted TLs by coach.	M9 F5 22.2yrs	Sweden (14) World (14)	A-B	Canoeing	Low Research grants from the Karolinska Institute, the Swedish National Centre for Research in Sports (CIF)/the Centre for Athletic Performance Improvement (CPU).

Key: Study design & method coded according to the MMAT template (Pluye et al. 2014): Qual = Qualitative; Quant = Quantitative; Interven = Intervention; Comp = Competition; A-B = Able-Bodied; UE = Ultra-Endurance; TL = training load; Signif = significant; PBS = Psychobiosocial; ID No = Identification number; RESTQ = Recovery-Stress questionnaire; POMS = Profile of Mood States; VAS = Visual Analogue Scale; Yrs = Years; Ave = average; +ve = positive; SD = standard deviation; Stats = statistics

Table 3 Extracted Data Characteristics of Included Studies (2)

Author/ Year/ ID No	Study design	Method(s) used	Factors Explored	Effects on Performance Outcome	Gender Age (ave)	Nationality/ Competition Standard	Ability (A-B or Disabled)	Type of Sport	Critical Appraisal Risk of Bias Source of Funding
4. Bouget et al. (2006)	Quant Descriptive Incidence or prevalence study without comparison group.	RESTQ for 4-day experimental period.	Dose-response relationship between rapid increase in training volume/intensity & stress-recovery, mood, & hormonal responses.	Increase of train load was correlated with hormonal ratio (r=-0.48, P<0.05). Change in rest cortisol concentration was positively related to change in Physical Complaints (r = 0.69, P < 0.01). Suggests a dose response relationship and this ratio could be used as indicator of train status.	F12 21.7yrs	Unknown (12) National (12)	A-B	Cycling	Moderate Not stated.
5. Brick et al. (2015)	Qual Descriptive.	Interviews & content analysis.	Dynamics of attentional focus and cognitive control.	+ve attentional control; active/proactive during performance.	M4 F6 35.6yrs	Unknown (12) Olympic (2) World (4) European (3) Common Wealth (1)	A-B	Running: ultra (2), 10km-marathon (6), 3-10km (2)	Low Not stated.
6. Comotto et al. (2015)	Quant Descriptive Incidence or prevalence study without comparison group.	CR-10RPE 30 mins after each session; POMS start, middle and end of camp.	Monitoring of intra-individual differences during a 5-day training camp.	Internal TL: significant high intra-individual session RPE differences for same external load (F = 23.83, P<0.001); post hoc tests reveal 2/3/4th days perceived as hardest; 1st day (P<0.0001, ES=1.80-2.16) last day (P<0.001, ES=1.48-2.32). POMS: significant differences in fatigue: 1st days: 7.8, 3rd day 10.5, last day 14.2, (F=25.74, P<0.001, ES1.19-2.26; Vigour decreased last day 12, 1st day 15.8, (F=7.478, P<0.01, ES=0.98); Anger decreased (F=2.717, P=0.015, ES=0.58). Individualised programmes best due to different responses.	M10 F6 18yrs	Italy (16) National (16)	A-B	Triathlon	Moderate Not stated.
7. Coutts et al. (2006)	Quant RCT.	RESTQ-76; Intensive Train grp (IT) and Normal Train grp; 3km TT. 4-week overload training for IT group.	Monitoring of performance/psychology /biochemistry during overreaching & recovery.	The RESTQ-76 questionnaire showed an impaired R-S state with increased training load, which improved following the taper in the IT group (p<0.05). Use RESTQ for regular monitoring of performance and psychology.	M16 31.3yrs	Unknown (16) International (10) National (6)	A-B	Triathlon	Moderate Douglass Hanley Moir Pathology (North Ryde, Sidney, Australia)/Faculty of Business Research Grant, University of Technology, Sydney.

Key: TT = Time Trial; RCT = Random Controlled Trial;

Table 4 Extracted Data Characteristics of Included Studies (3)

Author/ Year/ ID No	Study design	Method(s) used	Factors Explored	Effects on Performance Outcome	Gender Age (ave)	Nationality Competition Standard	Ability (A-B or Disabled)	Type of Sport	Critical Appraisal Risk of Bias Source of Funding
8. Dunn & Dishman (2005)	Quant Incidence or prevalence study without comparison group/Case Series.	POMS; STAI; SCQ; during competition.	Anxiety and predicting competition performance.	Generalisability of results supported by the representativeness of the samples for overall rank on tour for M/F. Linear relationship of a pre-race state anxiety (SA) with poor performance observed in males is consistent with a relaxation model i.e. suggesting that interventions designed to relax the athlete prior to the competition might improve performance. This is also due to relations being *independent of their skill level.* High SA was predictive of poor performance independently of trait anxiety, self-confidence (SC), and each athlete's past-anxiety history. For women state anxiety did not predict performance. The larger the departure from the IZOF the poorer the performance, independent of the absolute level of SA. Interventions for M/F may need to be individualised. Limited evidence found for the validity of the inverted U hypothesis. Athletes could predict their own state anxiety levels with some accuracy. For females, effective interventions would need to consider state anxiety of everyone in relation to optimal levels of anxiety based on performance history. High self-confidence paradoxically predicted worse performance and absolute anxiety levels were not associated with performance. Test of IZOF limited to the STAI and findings provide no support for the IZOF model when extended to measures of tension, confusion or fatigue. Trait anxiety was positively related to SA and inversely related to self-confidence in M/F; it was also related to the departure of the IZOF for women. SC not related to SA and departure from IZOF for M/F. Females had less experience despite being elite. Individual assessments for helping psych up.	M16 F24 Unknown	Various stated but number unknown (40) Professional (40)	A-B	UE Cycling (Tour de France)	Low Grant from the Sports Medicine Council of the US Olympic Committee.
9. Eccles et al. (2002)	Qual Grounded theory.	Interviews (type not specified explicitly)	Expert cognition: anticipation; visualisation; decision-making.	+ve anticipation, +ve visualisation, +ve decision-making.	M9 F8 30.1yrs	UK International (16) World (1)	A-B	Orienteer	Low None stated.

Key: STAI = State Trait Anxiety Inventory; SCQ = Self Confidence Questionnaire; SC = Self Confidence; IZOF = Individual Zone of Optimal Functioning; +ve = positive

Table 5 Extracted Data Characteristics of Included Studies (4)

Author/ Year/ID No	Study design	Method(s) used	Factors Explored	Effects on Performance Outcome	Gender Age (ave)	Nationality Competition Standard	Ability (A-B or Disabled)	Type of Sport	Critical Appraisal Risk of Bias Source of Funding
10. Eccles (2006)	Qual Description.	Telephone interviews; content analysis.	Decision-making/ Deliberate practice and anticipation in environment.	+ve deliberate practice, +ve anticipation, +ve decision-making.	M6 F9 28.3yrs	AUS (5); NOR (1); US (3); UK (6) National (15)	A-B	Orienteer	Low None stated.
11. Eccles et al. (2009)	Qual Description.	Interviews; hierarchical content analysis.	Decision-making; deliberate practice.	In prep: +ve Decision making, +ve planning, +ve deliberate practice.	M6 F9 28.3yrs	AUS (5); NOR (1); UK (6); US (3) National (14) World (1)	A-B	Orienteer	Low Grant from Council on Research & Creativity at Florida State University.
12. Filhaire et al. (2004)	Quant Incidence or prevalence study without comparison group.	POMS used at T0/T1/T2/T3 - mood and physiology tests in between training phases. 4-day intensive training camp – increased TL between T0 & T3.	Psychobiological status over 8-month training – Over Training (OT).	Overall mood was 154, 147, 140, and 144 (T0-T3) respectively. 4-days intensive training did not make a significant difference to mood disturbance and longer periods would be required than imposed in this study. No signif change for detecting staleness after the camp or 8-month training. No muscle soreness after the IT camp. Relationships between POMS and MHPG-S concentrations were not signif. Treat results with caution and more research required in this area. Mood variables need longer time for signif results.	M12 19.5yrs	Unknown (12) National (12)	A-B	Cycling	Moderate Not stated.
13. Filho et al. (2013)	Quant Incidence or prevalence study without comparison group/Case Series.	RESTQ during Girobio 2012 competition. RM MANOVA on overall scores between test/retest.	Determine and compare the magnitude of pre-post recovery and stress scores and identify stress/recovery (S/R) balance factors.	Some stability of factors suggested over time; findings reinforce the importance of assessing indicators of S/R balance to establish mental training guidelines to improve self-regulation. Differences between test/re-test, Wilks λ =.30, F (19, 48) = 5.83, P<0.01, η^{2p} = 0.70. Within subjects' follow-up showed differences in 14 of 19 subscales but none for conflict/pressure, success & social recovery, personal accomplishment & self-efficacy. Big drop-out rate 67/170.	M67 21.9yrs	Unknown exactly (67) International (67)	A-B	UE Cycling (Girobio)	Moderate Not stated.

Key: RM = Repeated Measures; +ve = positive; signif = significant.

Table 6 Extracted Data Characteristics of Included Studies (5)

Author/ Year//ID No	Study Design Type	Method(s) used	Factors Explored	Effects on Performance Outcome	Gender Age (ave)	Nationality Competition Standard	Ability (A-B or Disabled)	Type of Sport	Critical Appraisal Risk of Bias Source of Funding
14. Geva & Defrin (2013)	Quant Non-randomised	Lab-based. Tests: conditioned pain modulation (CPM); Fear of pain questionnaire.	Pain tolerance/ Threshold/ perceived pain intensity.	Triathletes had higher pain tolerance (P<.0001), lower pain ratings (P<.001), and lower fear of pain values (P<.05) than controls. The magnitude of CPM was greater in triathletes (P<.05), and negatively correlated with fear of pain (P<.05) & with perceived mental stress (P<.05). Pain catastrophising & fear of pain decreased. Could explain why withstand high physical training loads; greater ability to endure or motivated to endure? (17 non-athletes used).	M11 F8 39.6yrs	Unknown (19) National (19)	A-B	(UE) Triathlon	Low No funding sources.
15. Groslambert et al. (2003)	Quant: Interven RCT.	Trenometer test for rifle; standing position; roller skiing 2.1km 90% Vo2max; Heart rate monitor; 6-week training program. Random Control (8) grp Experiment (8) used.	Autogenic training (AT) & imagery (IM) training on shooting performance.	+ve AT & +ve IM (in stand position, increased postural control, & hold stability to control body sway, combined with shooting programme) Estimates 35 second improvement for 10km; 70 seconds in 20km. F (2.28) = 11.245, p<.0003, η^{2p} = .45.	M12 F4 21.5yrs	France National (16)	A-B	Biathlon	Moderate None stated.
16. Gustafsson et al. (2007)	Qual Case study/ Description	Multiple case study; ABQ; semi-structured interview; training log.	Burnout.	-ve effect of high motivation, perceptions of stress and pressure adversely affect athletes & OT.	M1 F2 20.6yrs	Sweden National (3)	A-B	XC-Skiing	Low Not stated.
17. Gustafsson et al. (2008)	Quant: Descriptive Interven.	Form Scale; POMS Day 1, 2, 8, 15 of a training camp.	OT-OR; Recovery monitoring physiology, biochemical, psychological; multi-disciplinary sport science approach useful.	+ve Mood improvement. Rest is good for recovery. POMS - Vigour was baseline 22, Day 1 (Pre) 11, Day 8 (mid) 20, Day 15 (post) 22. Fatigue: Baseline 7, Day 1 (pre) 8, Day 8 (mid) 2, Day 15 (post) 2. Important to have baseline values as athletes will have better scores than population norms for POMS and may still appear healthy despite mood disturbance.	M1 17yrs	Sweden National (1)	A-B	XC-Ski; Ski-Orienteer; Orienteer	Low Not stated.

Key: ABQ = Athlete Burnout Questionnaire; AT = autogenic training; IM = imagery; +ve = positive; OT-OR = overtraining – overreaching;

Table 7 Extracted Data Characteristics of Included Studies (6)

Author/ Year/ID No	Study Design Type	Method(s) used	Factors Explored	Effects on Performance Outcome	Gender Age (ave)	Nationality Competition Standard	Ability (A-B or Disabled)	Type of Sport	Critical Appraisal Risk of Bias Source of Funding
18. Hurdiel et al. (2015)	Quant Case Report.	Questionnaire; day before race and shortly after finish 10 min serial response time cognitive test. Cohen's d for ES	Combined effects of sleep deprivation and decision making/ cognitive performance.	-ve effect severe sleep deprivation/fatigue can affect decision-making. Number of reaction time lapses >500ms p=0.005, d=1.39; mean response time increased after race p=0.001, d=1.68; number of errors of commission (false starts <100ms) p=0.02, d=0.9; no correlation between cognitive performance & either amount of rest obtained or time into the race. Longer time in race = longer sleep duration R_2=0.68; results affected whatever sleep taken. Safety compromised.	M16 F1 43.4yrs	Various (not specified) unknown (17) National (17)	A-B	UM (UTMB)	Moderate None stated.
19. Kellman et al. (2001)	Quant Case Series.	RESTQ/POMS completed 6x during training and preliminaries. During training camp, an RM MANOVA.	Monitoring stress and recovery during world champ training camp. Lactate concentrations.	A close relationship exists between the selected RESTQ-Sport & POMS scales. However, use of RESTQ helps monitor training load – instead of POMS. The test-retest reliability assessment good for up to 48 hours prior to competition to intervene on stress-recovery state.	M 30 F24 17.6yrs	Germany International (54)	A-B	Rowing	Low Bundeinstitut fur Sportwissenschaft.
20. Kress & Statler (2007)	Qual Naturalistic grounded theory/Pheno menology.	Semi-structure interviews.	Pain and coping with it during competition.	+ve Self Talk, +ve Goal Setting, +ve Imagery during comp to lessen intensity of pain.	M9 37.8yrs	US Olympic (9)	A-B	Cycling	Low None stated.
21. Laaksonen et al. (2011)	Quant: RCT Interven .	Lab-based; 10-week combined relaxation (ATR) and specific shoot program. Experimental & control group used.	Use of relaxation to improve shooting precision.	+ve effect for ATR & specific shooting program improves overall shooting accuracy at 75% of Vo2max for EXP group and closest to actual biathlon competition.	M13 F7 19.5yrs (20)	Sweden National (20)	A-B	Biathlon	High Swedish National Centre for Research in Sports/ Jamtland-Harjedalen's Sport Association.

Key: ES = effect size

Table 8 Extracted Data Characteristics of Included Studies (7)

Author/ Year/ID No	Study Design Type	Method(s) Used	Factors Explored	Effects on Performance Outcome	Gender Age (ave)	Nationality Competition Standard	Ability (A-B or Disabled)	Type of Sport	Critical Appraisal Risk of Bias Source of Funding
22. Lundqvist & Sandin (2014)	Qual Phenomen-ology/ Description	Semi-structured interviews; deductive/ inductive analysis.	Wellbeing in elite sport at a global and sport-specific level.	Wellbeing +ve; coach-athlete relations +ve.	M4 F6 20.4yrs	Sweden National (10)	A-B	Orienteering	Low Swedish National Centre for Sports Research.
23. Macquet et al. (2012)	Qual Case Study	Head cam, 2 self-confrontation interviews.	Cognitive activity during 2 international competitions; anticipation; pacing; decision-making.	+ve decision-making, +ve imagery in competition, +ve pacing for efficiency.	M1 29yrs	Unknown (1) International (1)	A-B	Orienteering	Low Grant from French Ministry of Sports.
24. Morgan & Pollock (1977)	Mixed: Triangulation Design, Qual: Descriptive Quant: Case Series	Psychometric tests: SPQ; STAI; DACL; EPI; POMS; PEAS; HST; individual interviews.	Psychological characterisation of elite distance runners; Association/dissociation.	Elites associate in competition, don't encounter pain zone, closely attend to bodily inputs, pace governed by reading their bodies/ closely linked with perception of effort which is greater in non-elites during sub-max tests. Trait anxiety less in elite runners ($p<0.05$).	Unknown (19) Unknown (19)	Unknown (19) World (19)	A-B	Marathon (8) Middle-long distance (11)	High Not stated.
25. Morgan et al. (1987)	Mixed: Triangulation Design, Qual Descriptive Quant: Case Series	Psychometric tests: STAI, POMS, EPQ BAS; structured interview: race / cognitive strategy, motivation, training volume, staleness, pre-comp arousal.	Psychological characterisation of female athlete.	Cognitive strategies: During competition association (56%) v's dissociation (22%) ($Z=2.52$, $P<0.05$) and during training dissociation /non-association (56%) ($Z=4.56$, $P<0.001$). Psychometric test results: POMS: ANOVA shows significantly higher on vigour $P<0.009$; for 5k and 10k distances i.e. 'iceberg more pronounced for 5/10k. Race strategy: tendency to follow (52%) significantly higher ($Z=2.29$, $P<0.05$) than leading (22%), combo (26%) ($Z=1.96$, $P<0.05$). Pre-comp arousal RM-ANOVA results support Hanin's ZOF. Staleness elite (60%) v's non-elite (33%) but not statistically significant ($Z=1.40$, $P>0.05$). Intrinsic motivation responsible for involvement/adherence.	F15 Unknown (15)	Unknown (15) National (15)	A-B	Running: 1500m 10km, marathon.	Moderate Not stated.

Key: SPQ = Somatic Perception Questionnaire; STAI = State Trait Anxiety Inventory; DACL = Depression Adjective Checklist; EPI = Eysenck Personality Inventory; PEAS = Physical Estimation and Attraction Scale; HST = Hidden Shapes Test; EPQ = Eysenck Personality Questionnaire; BAS = Body Awareness Scale

Table 9 Extracted Data Characteristics of Included Studies (8)

Author/ Year/ID No	Study Design Type	Method(s) Used	Factors Explored	Effects on Performance Outcome	Gender Age (ave)	Nationality Competition Standard	Ability (A-B or Disabled)	Type of Sport	Critical Appraisal Risk of Bias Source of Funding
26. Philippe & Seiler (2005)	Mixed Embedded design.	Structured interview; After verification of homogeneity of variances, ANOVA was used to test sex differences / two-tailed T-tests to compare among groups.	Sex differences on use of association/dissociation strategy in male female athletes.	Men associate more ($t29=8.25$, $p<.01$) than women ($t27 = 3.15$, $p<.01$), who dissociate more in competition ($F1, 58= 6.00$, $p<.05$) for both. Women dissociate to avoid pain?	M31 F 29 23yrs	France National (60)	A-B	Running, swimming, cycling	High Not stated.
27. Purge et al. (2006)	Quant Incidence or prevalence study without comparison group.	6-month period; tested 7 times before and during preparatory training; RESTQ; blood analysis.	Hormonal & psych adaptation to training; rest & recovery monitoring.	No significant difference for rest and recovery after 24 weeks, overall perceived recovery-stress index related to test/cortisol/gH/creKin act ($R > 0.299$; $P <0.015$). Metabolic and psychological changes should be carefully monitored to avoid negative training effects.	M11 20.2 yrs	Estonia National (11)	A-B	Rowing	Low Not stated.
28. Renfree & St Clair Gibson (2013)	Quant Incidence or prevalence study without comparison group.	Quasi-experimental design; 4 grp split; Pearson product-moment correlation for speed and personal best (PB).	Pacing strategies; decision-making of (un)successful athletes.	+/-ve the right decision-making on pacing makes a difference. Significant differences ($P<.01$) in the percentage of PB speed maintained were observed between groups 1 and 4 and groups 2and 4 in all segments from 20 to 25 km and 30 to 35km. Group 1 athletes achieved better finishing times relative to their PB than other groups, who chose unsustainable initial speeds.	F60 Unknown (60)	Unknown (60) International (60)	A-B	Marathon	Moderate Not stated.

Key: +/-ve = positive/negative

Table 10 Extracted Data Characteristics of Included Studies (9)

Author/ Year/ID No	Study Design Type	Method(s) Used	Factors Explored	Effects on Performance Outcome	Gender Age (ave)	Nationality/ Competition Standard	Ability (A-B or Disabled)	Type of Sport	Critical Appraisal Risk of Bias Source of Funding
29. Ruiz-Tendero & Salinero (2012)	Quant Descriptive Case Series.	Descriptive & comparative design; used SPSS T-tests; Questionnaire interviews. Hotellings T2 test applied to globally analyse the existence of significant differences between coaches and athletes' ratings of positive / negative factors. Where differences found individual analysis via student T test were conducted.	Psycho-social factors determining success coach-athlete perceptions. Based on the Complex Model System.	Coach and athletes work together for perceptions of positive/negative factors on performance. Differences found for pos/neg factors (positive: Hotelling's T2 = 0.70; p = .02) & (Negative: Hotelling's T2 = 2.69; p<0.001). Both in agreement about the top 5 most influential factors related to performance. Top 5 positive factors same for both (motivation, effort and resources – 3 items that Eriksson '93 proposed) five items were dedication, perseverance on training, volitional capacity, coach and family support. Significant differences on negative factors but both had injuries as number 1.	M29 F19 25.5yrs	Spain International (48)	A-B	Triathlon	Moderate Not stated.
30. Rushall et al. (1988)	Interven Quant RCT.	3 experiments: random divided groups into treatment-control or control-treatment repeated twice. Heart Rate recorded; dependent variable time to ski set test track.	Three types of thought content instructions on ski perf: positive Self Talk, Mood words, task-relevant information (independent variables).	Thought content control +ve effect in competition. Reduced RPE. Task relevant statements (TRS) 17 of 18 improved (z=3.77, p<.001); ANCOVA revealed TRS performances significantly different from control (F=24.10; df = 1.12; p=<.01).	M8 F10 Unknown (18)	Canada National (18)	A-B	XC-Ski	Low Grants from Shaklee Canada Incorporated/ Sports Science Associates, Canada.
31. Schneider et al. (2007)	Qual Descriptive Phenomen-ology.	Semi-structured-interviews; bracket interview, reflexive journal, peer reviews, thematic analysis.	Examine experiences and perceptions of risk amongst elite racers and explore social factors that influence perceive and experience risk.	+ve visualisation, relaxation & motivational ST in comp; plus +ve decision-making. Sleep deprivation impairs perf but risk elites take to win.	M5 F5 39yrs	Unknown (10) World (10)	A-B	Adventure racing	Low Not stated.

Key: +ve = Positive; ST = self talk; RPE = rate of perceived exertion

Table 11 Extracted Data Characteristics of Included Studies (10)

Author/ Year/ID No	Study Design Type	Method(s) Used	Factors Explored	Effects on Performance Outcome	Gender Age (ave)	Nationality Competition Standard	Ability (A-B or Disabled)	Type of Sport	Critical Appraisal Risk of Bias Source of Funding
32. Silva & Appelbaum (1989)	Quant Incidence or prevalence study without comparison group.	Running Style Questionnaire & interview night before race. Discriminant function analysis used to place runners in two groups top and bottom group using Wilks's lambda solution.	Association and dissociation during an Olympic Marathon trial race.	Solution identified is significant p= <.01 and questions maximising group separation indicate top 50 placers dissociate towards end of race mile 18+ and when feeling pain, used association more for the rest of race otherwise, and engaged in self talk to help performance in tough parts of race.	Unknown (32) Unknown (32)	US International (32)	A-B	Marathon	High Not stated.
33. Simpson et al. (2007)	Qual Phenomen-ology.	Bracketing & pilot interview; Interviews phenomenological approach/ hermeneutic procedures; thematic analysis.	Examining the training and competition experiences – results separated out for elite (4) from 26 internationals (F7 M19); attention control; goal-setting.	+ve confidence. +ve goal-setting, +ve attentional control, +ve pacing, +ve imagery.	Unknown (4) Unknown (4)	Unknown (4) Professional (4)	A-B	Ultra-marathon	Low Not stated.
34. Skorski et al. (2014)	Quant Incidence or prevalence study without comparison group.	Lab-based flat 3x 40km time trials in between training camp; RESTQ; blood tests; ANOVA. Sleep & nutrition diary	Effects of training-induced fatigue on pacing patterns. DV = pace pattern; IV = fatigue induced; 72hr recovery session;	+ve effect for rest and recovery. Findings support assumption that pacing includes a combination of anticipation and feedback mechanisms. Monitoring helps performance. Performance decreased from TT1 to TT2 (65.7 v's 66.7, P<0.05_and increased T2 to T3 (66.7 v's 65.5, P< 0.01). PP showed a significant difference between TT1 and TT2 (P<0.001) as well as between T2 and T3 (P<0.001). PP difference (P>0.05). TT1 and TT2 showed no significance (P>0.05). RPE no significance & difference btwn trials over whole race P>0.05. Fatigue reversibly changes the PP of cyclists as they chose PP to enable finish of race.	M23 28.8yrs	Germany National (23)	A-B	Cycling	Low German Federal Institute of Sport Science.

Key: PP = pacing pattern; TT = time trial; +ve = positive; DV = dependent variable; IV = independent variable; hr = hour; btwn = between

Table 12 Extracted Data Characteristics of Included Studies (11)

Author/ Year/ ID No	Study Design Type	Method(s) Used	Factors Explored	Effects on Performance Outcome	Gender Age (ave)	Nationality Competition Standard	Ability (A-B or Disabled)	Type of Sport	Critical Appraisal Risk of Bias Funding Source
35. Tammen (1996)	Quant Incidence or prevalence study without comparison group.	Flt track graded exercise test to determine VO2max 1500m; questionnaire Mental Readiness Form after each run & lactate test.	Rating associative and dissociative coping during racing.	+ve Association used more as pace intensity increases. *No p or effect size*.	M4 F4 Unknown (8)	US International (8)	A-B	800m Marathon	Moderate Dept of Sport Science of US Olympic Committee.
36. Tenenbaum et al. (2003)	Mixed Triangulation/ embedded design Quant: case report Qual: case Study.	Case study: 20-week micro/meso/macro cycles; natural setting observation; non-participatory style; interviews, psychometric tests used and evaluation (POMS). Borg scale.	Failure adaptation; stressor situations, perceptions of stressors, responses towards stressors, degree of failure/success adaptation.	-ve effect of stressors; coach-athlete perceptions can be positive and negative depending on perceptions. Support staff need to listen to individuals and understand their requirements. No *p* or effect sizes.	M10 F4 25.5yrs	Unknown (14) National (14)	A-B	Cyclists	Low Not stated.
37. Terry et al. (2012)	Quant-Intervention Non-randomised.	Lab-based, treadmill, BMRI-2, RPE/blood lactate/VO2/running economy. Small sample; no control group. Cohen's d.	Use of synchronous music during training & effects on running economy & O2 consumption; tracks rated as motivational or neutral.	Most +ve effect was use of motivational music in training; depends on athlete and type of music for preference. Compared to no music T1 (d=.49); T2 (d=.60); T3 (d=.45). Run to exhaustion (d=1.08) 18.1% motivational & 19.7% neutral; measured states: RPE lowest for neutral; mood & feeling increased positively with motivational music; motivational qualities perhaps not as important as its tempo.	M6 F5 19.5yrs	Unknown National (10); World (1)	A-B	Triathlon	Low QAS Centre of Excellence for Applied Sport Science Research.
38. Tracey (2011)	Qual Case Study.	Single case study: personal motivational video during preparation & competition season for applied mental imagery.	Perceived usefulness and benefits such as enhanced concentration, anxiety management, motivation, confidence.	+ve applied imagery.	M1 23yrs	Unknown Professional (1)	A-B	MTB	Low Not stated.

Key: MTB = Mountain Biking; O2 = oxygen

Table 13 Extracted Data Characteristics of Included Studies (12)

Author/ Year/ ID No	Study Design Type	Method(s) Used	Factors Explored	Effects on Performance Outcome	Gender Age (ave)	Nationality Competition Standard	Ability (A-B or Disabled)	Type of Sport	Critical Appraisal Risk of Bias Funding Source
39. Van Raalte et al. (2015)	Qual Description.	Survey using analysed open ended question.	Types of self-talk used during a competition race.	+ve effect for self-talk; Means with a common superscript are significantly different from each other $p < .005$. Association for elite: 43.06a (%) 31 (n) v's non-elite: 18.00a (%) 74 (n).	Unknown (72) Unknown (72)	Unknown (72) International (72)	A-B	Marathon	High Not stated.
40. Vickers & Williams (2007)	Quant Non-randomised.	Lab-based; eye tracker; CSAI-2, power output (PO) levels measured in Low Pressure (LP) & High Pressure (HP) conditions after exercising on cycle ergometer at individually prescribed PO levels of 50%, 70%, 85%, and 100% of VO2max.Used regression analysis to determine predictors of accuracy for each HP PO level.	Effects of physiological arousal, cognitive anxiety, and gaze control (dependent variables).	+ve effect of gaze control (QE) duration in high pressure (HP) situation. Three predictors: d-HR, d-RPE, d-QE that accounted for .62 of the adjusted R2 variance. Accuracy was higher when gaze control was lower and d-RPE and d-HR were higher. At highest PO level directing visual attention externally to critical task info appeared to insulate the athletes from choking under HP. Different individuals perceive external pressure of coaches and selectors differently.	M10 23.3yrs	Canada National (10)	A-B	Biathlon	Low Biathlon Canada.

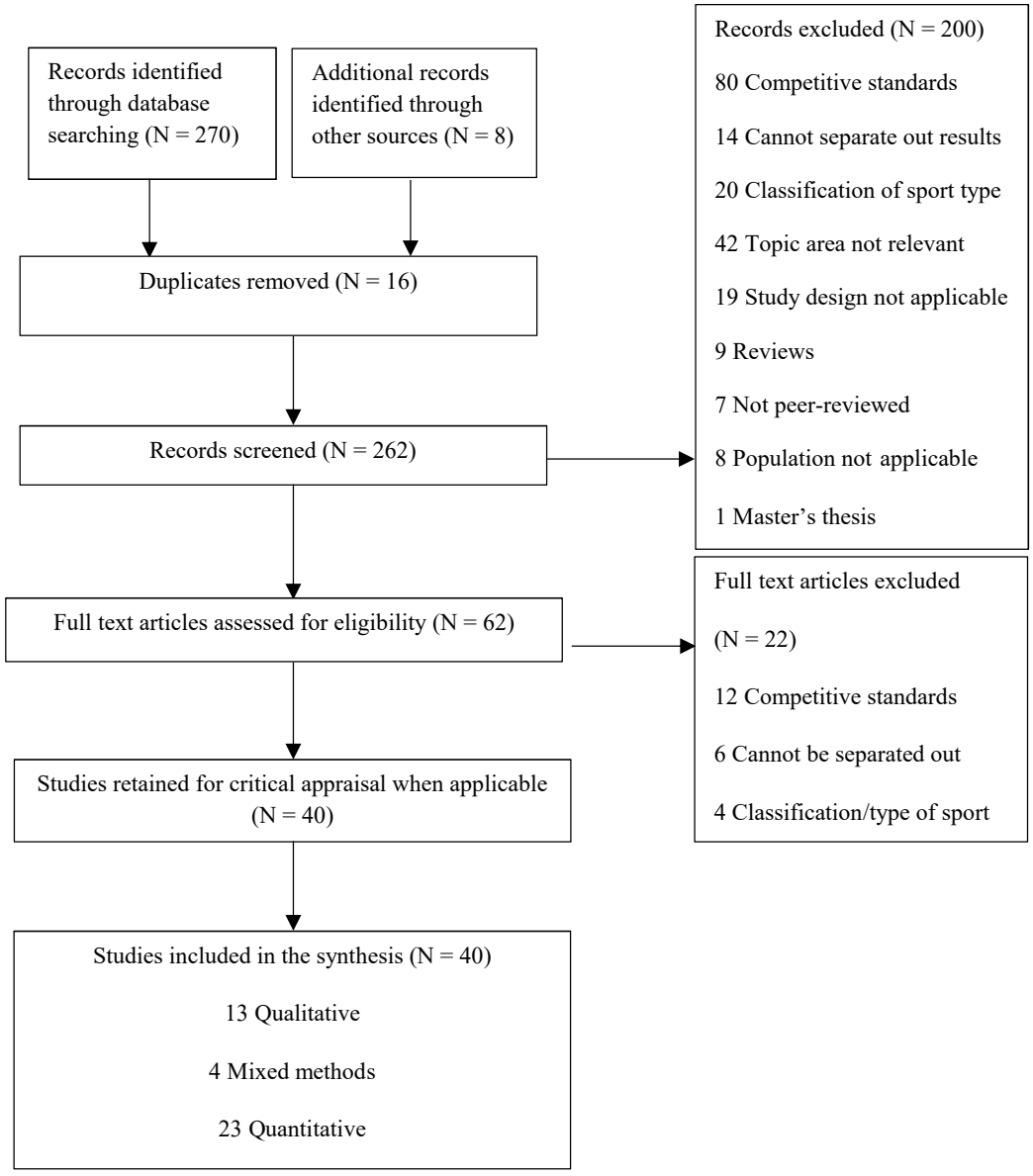
Results

Study Selection

According to Walsh and Downe (2005) it is recommended that the area of investigation be broad enough to fully capture the phenomenon of interest but conversely, it should be sufficiently focused to ensure that the findings are meaningful. By considering this recommendation, the final selection of included articles was deemed broad enough by the range of research designs and demographic information, and focused enough by specifically concentrating on elite and sub-elite endurance athletes and their psychological preparation and management of performance.

The initial broad screening of over 10,000 articles, across six databases, yielded a more focused sifting of 262 articles, to finally assess 62 for eligibility. Forty studies, spanning from 1977-2015, were retained that met the research objective, inclusion criteria and the operational definition. There were 13 qualitative, 23 quantitative (of which 4 were RCT, 3 were non-randomized and 6 were observational descriptive), and 4 mixed methods. Three different examples of article exclusion include: a study based solely on a muscular endurance test (Hill, Hall, Duda, & Appleton, 2011); the competitive standard was below national (sub-elite) level (Lindsay, Maynard, & Thomas, 2005); and the results and/or the specific endurance sports could not be separated, thereby giving a potential contamination of the sample results (Lundqvist, Kentta, & Raglin, 2011). The details of other excluded articles are in Appendix 2 and the flow diagram in Figure 1 provides details of the focused steps for the search strategy.

Figure 1. Flow Diagram of Inclusion and Exclusion Search Strategy



Study Characteristics

The extracted data were synthesized into three tables; Table 14 presents the athlete demographic information (gender, age, ability, nationality, competitive standard and chosen sport) clustered by study design; Table 15 illustrates the psychological, psychosocial and other factors affecting performance, clustered according to training and/or competition; and Table 16 provides the types of sports researched according to study design types and psychological, psychosocial and other factors.

In summary, there were a total of 809 athletes (male 399/49%; female 283/35%; unknown 127/16%); 100% of the samples were able-bodied; 487 (60%) were elite and 322

(40%) were sub-elite; the age range was between 16 to 49 years, but 268 were unknown. The nationalities of the athletes originated from 11 different countries and the sample population number ranged from 1 to 60 across the selected articles. The type of athlete included 642 (79%) endurance and 148 (18%) ultra-endurance, whilst 19 (2%) were from both. The type of sports studied included 38 exclusively focused on one sport: running (7), cycling (5), orienteering (5), triathlon (5), biathlon (3), cross country skiing (2), ultra-endurance cycling (2), ultra-endurance triathlon (2), ultra-endurance running (2), rowing (2), canoeing (1), adventure racing (1), and mountain biking (1); and the remaining 2 studies used cross-country skiing with orienteering (1), and run, cycle and swimming (1). There were 16 studies (10 low risk of bias, 4 moderate risk, and 2 high risk) that were conducted in naturalistic settings, of which 10 (6 low risk, 2 moderate risk, 2 high risk) were using competition(s) and the remaining 6 studies were during training seasons or camps. Within this naturalistic setting, a variety of sports were used: 4 cycling, 2 triathlon, 2 rowing, 4 running, 1 cross-country skiing, 1 orienteering, 1 mountain biking, and 1 canoeing.

The studies varied in research aims and outcomes but some similarities were apparent between different endurance sports and exploring the psychological and psychosocial factors, as well as reporting the coping and management methods used by athletes. In addition, fourteen quantitative studies combined a physiological and/or physical component with the psychological variable being studied for performance monitoring (e.g. Filhaire, Legrand, Lac, Pequinot, 2004; Geva & Defrin, 2013; Gustafsson, Holmberg, & Hassmen, 2008; Hurdiel et al., 2015; Purge, Jurimae, & Jurimae, 2006; Skorski et al., 2014). Seven qualitative studies reported on more than one psychological/psychosocial factor (e.g. Brick, MacIntyre, & Campbell, 2015; Gustafsson, Kentta, Hassmen, Lundqvist, & Durand-Bush, 2007; Kress & Statler, 2007; Schneider, Butryn, Furst, & Masucci, 2007; Simpson, Post, Young, & Jensen, 2014; Tenenbaum, Jones, Kitsantas, Sacks, & Berwick, 2003; Tracy, 2011).

Table 14 Demographical Characteristics of Population Samples

Demographic Details		Study Design			
		Qualitative (n=13)	Quantitative n=23)	Mixed (n=4)	Total Numbers
Gender:	Male	54	304	41	399
	Female	45	190	48	283
	Unknown	76	32	19	127
Age: (yrs.)	16-19	0	114	0	114
	20-29	42	154	74	273
	30-39	54	83	0	137
	40-49	0	17	0	17
	Unknown	76	158	34	268
Ability:	Able-bodied athlete(s)	175	526	108	809
	Athlete(s) with Disability	0	0	0	0
Nationality:	Australia	10	0	0	10
	Estonia	0	11	0	11
	Canada	0	28	0	28
	France	0	16	60	76
	Germany	0	77	0	77
	Italy	0	16	0	16
	Norway	2	0	0	2
	United Kingdom	29	0	0	29
	USA	15	40	0	55
	Spain	0	48	0	48
	Sweden	13	35	0	48
	Unknown	106	255	48	409
Competitive Standard:	Professional	13	40	0	53
	World	16	15	19	50
	Olympic	11	0	0	11
	International	89	280	0	369
	European	3	0	0	3
	Commonwealth	1	0	0	1
	National	42	191	89	322
Type of Endurance:	Endurance < 6 hrs	151	383	108	642
	Ultra-endurance > 6 hrs	24	124	0	148
	Both	0	19	0	19

Table 15 Management of Elite and Sub-Elite Endurance Performance During Preparation for Training and/or Competition

Management Factor(s)		Preparation Training	During Competition	Both	Not Specified
Psychological Strategy/Skill Used:	Association &/or Dissociation	35+,	26+, 32+, 33+, 39+	5+, 20+, 24º+, 25+	
	Visualisation / Imagery	11+, 20+	9+, 10+, 23+, 31+, 33+	15+, 20+, 38+	
	Relax, Breathing &/or Biofeedback	21+	5+	15+, 20+	
	Attentional Thought Control/Focus	11+,	1+, 5+/-, 9+, 10+, 23+, 31+, 33+	20+, 30+, 38+	
	Self-Talk		5+, 31+, 32+, 39+	20+,	
	Personal Motivation Video			38+	
	Gaze Control			40+	
	Pacing	34+	5+, 28+/-, 32+, 33+	23+	
	Use of Music	37+, 38+			
	Goal-Setting	38+	33+	20+, 22+	
	Anticipation	11+	9+, 23+		
	Decision-Making	11+, 38+	9+, 10+, 18-, 23+, 30+/-, 31+	5+	
	Deliberate Practice	10+, 11+, 20+			
	Mindfulness		5+		
Psychological and Psychosocial Construct(s) Monitored:	Pain (tolerance)		5+, 26+, 31+, 33+	14+, 20+	
	Burnout			3-, 16-, 36-	
	Stress Levels	16-	4-, 13º	36-	
	Anxiety Levels	16-	8-/º	36-, 40+	24+, 29-
	Arousal Levels			39-/+	25+/-
	Mood	6-, 12-	7º	3+, 17+, 38+	24º, 25º
	Motivation	16-/+	33+	20+, 38+	24+; 25º/+
	Confidence/Self-Esteem/Efficacy		5+, 8-/º, 16+/-, 31+, 33+	2+, 20+, 22+, 36-, 38+	
	Personality			16-	24º, 25º
	Coach &/or Athlete Perceptions	16-	13+,	20+/-, 22+/-, 23+, 36-	29+/-
	Psychobiosocial Well-being			2+, 22+, 38+	24+
	Social Support/Team Support	16-	31+	22+/-, 36-	
Other Linked Factors	Fatigue &/or Sleep Deprivation	16-, 34-	18-, 31-	2-	
	Rest and Recovery	6+, 7+, 19+, 27º, 34+	4+, 13º	2+, 3+, 16+, 17+, 22+, 36+	
	Overtraining/Overreaching	6-, 16-	4-	36-	

KEY: + = a positive effect, difference and/or performance improvement reported, OR positive message for practical application to monitor athlete(s); **-** = a negative effect, difference, and/or negative performance improvement reported OR negative message for practical application to monitor athlete(s); **º =** no significant difference found, zero effect or no performance improvement/decrement reported. 1. Baker et al. 2005b; 2. #Barnett et al. 2012; 3. Bergland & Safstrom, 1994; 4. Bouget et al. 2006; 5. Brick et al. 2015; 6. Comotto et al. 2015; 7. Coutts et al. 2006; 8. Dunn & Dishman 2005; 9. Eccles et al. 2002; 10. Eccles, 2006; 11. Eccles et al. 2009; 12. Filhaire et al. 2004; 13. Filho et al. 2013; 14. Geva & Defrin 2013; 15. Groslambert et al. 2003; 16. Gustafsson et al. 2007; 17. Gustafsson et al. 2008; 18. Hurdiel et al. 2015; 19. Kellmann et al. 2001; 20. Kress & Statler 2007; 21. Laaksonen et al. 2011; 22. Lundqvist & Sandin 2014; 23. Macquet et al. 2012; 24. Morgan & Pollock 1977; 25. Morgan et al. 1987a; 26. Phillippe & Seiler 2005; 27. Purge et al. 2006; 28. Renfree & St Clair Gibson, 2013; 29. Ruiz-Tendero & Salinero, 2012; 30. Rushall et al. 1988; 31. Schneider et al. 2007; 32. Silva & Appelbaum 1989; 33. Simpson et al. 2014; 34. Skorski et al. 2014; 35. Tammen, 1996; 36. Tenenbaum et al. 2003; 37. Terry et al. 2012; 38. Tracey, 2011; 39. Van Raalte et al. 2015; 40. Vickers & Williams 2007.

Table 16 Management of Elite and Sub-Elite Performance According to Types of Endurance Sport and Study Design

Management Factors:		Quantitative (n=23)	Qualitative (n=13)	Mixed (n=4)
Psychological Strategy/Skill Used:	Association / Dissociation	Run (2)		Run (2), Run/cycle/swim (1)
	Visualisation / Imagery	Biathlon (1)	MTB (1), Orient (4), Adv (1), UM (1)	
	Relax / Biofeedback	Biathlon (2)	Adv (1)	
	Attentional Control	XC-Ski (1)	UE-Tri (1); Run (1), Adv (1), UM (2) MTB (1), Orient (4), Cycle (1)	
	Self-Talk	Tri (1), Run (1)	Run (3), Adv (1), Cycle (1)	
	PMV		MTB (1)	
	Gaze Control	Biathlon (1)		
	Pacing	Run (1), Cycle (1)	UM (1), Orient (1)	
	Use of Music	Tri (1)	MTB (1)	
	Goal-setting		UM (1) Cycling (1) Orienteering (1)	
	Anticipation		Orient (3)	
	Decision-making	UTMB (1), Run (1)	Adv (1) Orient (4)	
	Deliberate Practice		Orient (2)	
	Mindfulness		Run (1)	
Psychological and Psychosocial Construct(s) Monitored:	Pain (tolerance)	(UE)Tri (1)	Cycle (1)	
	Burnout		XC-Ski (1)	Cycling (1)
	Stress Levels	(UE)Cycle (3), Row (1) Biathlon (1), Cycle (1)	XC-Ski (1)	Cycle (1)
	Anxiety Levels			Run (2)
	Arousal Levels	Biathlon (1)		Run (1)
	Mood	Cycle (2), Row (1), Canoe (1), Tri (1), XC-Ski/Orient (1), Tri (1)	XC-Ski (1)	Run (2)
	Confidence / Self-Esteem/efficacy	Cycle (1),	Adv (1), MTB (1), UM (1)	
	Personality	Canoe (1)		Run (2)
	Motivation	Tri (1)	MTB (1)	Run (1)
	Coach - Athlete Perception	Tri (1)	Orient (1)	
	PBS Well-being	Tri (1)	Orient (1)	Run (1)
	Social support/ Team Support	Tri (1)	Orient (1)	
Other Linked Factors:	Rest and Recovery	(UE)Cycle (3), Row (2), Tri (2), Canoe (1) XC-Ski/Orient (1)	Orient (1)	
	OT / OR	Tri (1), Cycle (1) XC-Ski/Orient (1)	XC-Ski (1)	Run (1)
	Fatigue /Sleep Deprivation	UTMB (1), Cycle (1)	Adv (1)	

KEY: *N.B. some of the sports cover more than one factor; PMV = Personal Motivational Video; PBS = Psycho-Bio-Social; OT/OR = overtraining/ overreaching; XC-Ski=Cross Country Skiing; Tri=Triathlon; UM=Ultramarathon; UE-Tri=Ultra-Endurance Triathlon; Adv=Adventure Racing; MTB=Mountain Biking; UTMB=Ultra Trail Mont Blanc.

Quality Appraisal

Following the rigorous quality appraisal process, a summary table was compiled for the overall result for each study against the three tools (see Table 17). Twenty-three (58%) studies were appraised as a low risk of bias, 12 (30%) were deemed as moderate risk and 5 (12%) were high risk. In addition, each research design result was grouped, so that an overall risk of bias was reported per research design: qualitative designs were a low risk (mean 84%, range 77-90%); quantitative descriptive designs were low risk (mean 75%, range 72-78%); quantitative non-randomized designs were low risk (mean 90%, range 80-100%); quantitative RCT designs as moderate risk (mean 66%, 63-69%); and mixed method designs as moderate risk (mean 58%, range 46-70%). The two sections, sampling and ethical matters, were scored with a lower rating in comparison to other sections, and this was consistent across all three appraisal tools. During the cross-checking process of the quality appraisal, it was reasoned that if results were 10% and lower this difference was acceptable and if it was found to be greater than 10%, a re-check was conducted to resolve any discrepancies.

Table 17 Summary of Risk of Bias Results according to the Three Critical Appraisal Tools

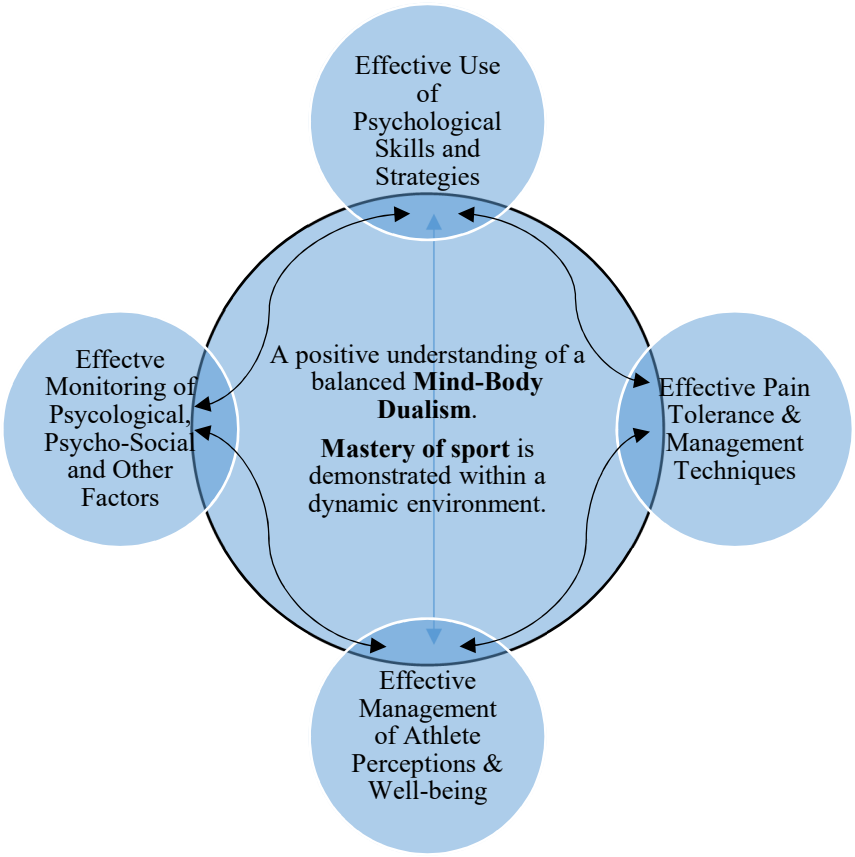
	Baker et al. (2005) Ql	**Barnett et al. (2012) Qd**	**Bergland & Safstrom (1994) Qd**	**Bouget et al. (2006) Qd**	**Brick et al. (2015) Ql**	**Comotto et al. (2015) Qd**	**Coutts et al. (2006) Qrct**	**Dunn & Dishman (2005) Qd**	**Eccles et al. (2002) Ql**	**Eccles (2006) Ql**	**Eccles et al. (2009) Ql**
MMAT	*** 75%	**** 100%	*** 75%	*** 75%	**** 100%	*** 75%	*** 75%	**** 100%	**** 100%	**** 100%	**** 100%
CCAT Total [%]	60	85	75	70	90	63	73	80	78	80	73
CASP (10 Qs)*	6/10	N/A	N/A	N/A	10/10	N/A	N/A	N/A	9/10	9/10	9/10
Risk of Bias	Moderate	Low	Low	Moderate	Low	Moderate	Moderate	Low	Low	Low	Low
	Filhaire et al. (2004) Qd	**Filho et al. (2013) Qd**	**Geva & Defrin (2013) Qnr**	**Groslambert et al. (2003) Qrct**	**Gustafsson et al. (2007) Ql**	**Gustafsson et al. (2008) Qd**	**Hurdiel et al. (2015) Qd**	**Kellman et al. (2001) Qd**	**Kress & Statler (2007) Ql**	**Laaksonen et al. (2011) Qrct**	**Lundqvist & Sandin (2014) Ql**
MMAT	*** 75%	*** 75%	**** 100%	*** 75%	**** 100%	*** 75%	*** 75%	**** 100%	**** 100%	* 25%	*** 75%
CCAT Total [%]	70	70	83	58	80	83	70	80	93	70	73
CASP (10 Qs) *	N/A	N/A	N/A	N/A	9/10	N/A	N/A	N/A	10/10	N/A	8/10
Risk of Bias	Moderate	Moderate	Low	Moderate	Low	Low	Moderate	Low	Low	High	Low
	Macquet et al. (2012) Ql	**Morgan & Pollock (1977) M**	**Morgan et al. (1987) M**	**Philippe & Seiler (2005) M**	**Purge et al. (2006) Qd**	**Renfree & St Clair Gibson (2013) Qd**	**Ruiz-Tendero & Salinero (2012) Qd**	**Rushall et al. (1988) Qrct**	**Schneider et al. (2007) Ql**	**Silva & Appelbaum (1989) Qd**	**Simpson et al. (2007) Ql**
MMAT	*** 75%	* 25%	** 33%	** 50%	*** 75%	*** 75%	*** 75%	*** 75%	**** 100%	** 50%	**** 100%
CCAT Total [%]	75	53	50	43	78	68	68	75	83	48	93
CASP (10 Qs)*	9/10	6/10	7/10	5/10	N/A	N/A	N/A	N/A	9/10	N/A	10/10
Risk of Bias	Low	High	Moderate	High	Low	Moderate	Moderate	Low	Low	High	Low
	Skorski et al. (2014) Qd	**Tammen (1996) Qd**	**Tenenbaum et al. (2003) M**	**Terry et al. (2012) Qnr**	**Tracey (2011) Ql**	**Van Raalte et al. (2015) Ql**	**Vickers & Williams (2007) Qnr**	**Mean Risk %/Rating (Mixed Methods Design)**	**Mean Risk %/Rating (Quantitative RCT/Non-Randomised Designs)**	**Mean Risk%/Rating (Quantitative Descriptive Design)**	**Mean Risk %/Rating (Qualitative Design)**
MMAT	**** 100%	** 50%	*** 75%	**** 100%	**** 100%	** 50%	**** 100%	46%	63%/100%	78%	90%
CCAT Total [%]	85	58	80	80	78	50	78	57%	69%/80%	72%	77%
CASP (10 Qs)*	N/A	N/A	10/10	N/A	9/10	5/10	N/A	70%	N/A	N/A	86%
Risk of Bias	Low	Moderate	Low	Low	Low	High	Low	Mod	Mod/Low	Low	Low

Key: *(10 Qs) refers to the CASP 10 questions and how many were answered '*yes*' during qualitative quality appraisal; Ql = Qualitative; Qd = Quantitative Descriptive; Qrct = Quantitative Random Controlled Trial; Qnr = Quantitative Non-Randomised; M = Mixed methods; N/A = Not Applicable

Synthesis

The purpose of this review was to address the research question of how do elite and sub-elite endurance athletes psychologically prepare for and manage their performances in their chosen sport. The hybrid deductive-inductive approach identified a data set for actively searching for key data items and extracts relating to the research question (deductive) and any other factors that may influence performance (inductive) (Braun & Clarke, 2006). The original data set was continually referred to and items were checked for sense and validity against the conceptual framework to ensure they reflected the analysis, synthesis and interpretation of the data set. Some overlapping data items or extracts were merged within sub-themes, (e.g. experience, control, autonomy, independence, pressure, and identity). Additionally, there were some items that linked into more than one theme due to the context of the narrative. This iterative process is represented by a conceptual framework in Figure 2.

Figure 2. A Conceptual Framework Representing the Preparation and Management of Elite and Sub-Elite Endurance Performers



At the 'core' of the framework, a holistic, positive and practical understanding is required for how the *mind and body* work together for each individual athlete; alongside a full demonstration of *mastery* in his or her sport, in all conditions and environments. The smaller circles represent the four embodied sub-themes and arrows are used to illustrate the interlinking of themes and sub-themes, and how all are contributing to the effective facilitation of a symbiotic relationship, an effective balance, a union between the mind-body. It is therefore posited that, if a deficiency in one or more of these key areas is detected, or exists without being addressed, a performance dip or an inability to effectively psychologically prepare for, and manage their performance during competition may result.

To fully address the research question, the two themes will be analyzed within the discussion section and referred to in the results section during the detailed explanations of the four sub-themes: Psychological Skills and Strategies; Pain Management; Management of Perceptions; Psychological, Psychosocial or Other Factors that Require Monitoring.

Sub-Theme: Psychological Strategies and Skills

This first sub-theme was created to reflect the variety of different individual psychological skills employed by athletes during their training and competition; the difference in when or how was contextualized to their individual somatic symptoms and the specific cognitive requirements of their chosen sport. Some of the skills were combined, as part of a strategy, after dynamically assessing their situation, and applying them in a manner which demonstrated their expertise or proficiency to instinctively know when and how to apply the appropriate skill(s), or strategy. A further underlying message was how the proficiency of the athletes developed after learning from experience and evaluating themselves after training and competition, illustrating the link of mastery with the mind-body dualism for successful performance.

For example, a variety of athletes found it beneficial to develop a 'strategy' that could assist with managing risk (Macquet, Eccles, & Barraux, 2012; Schneider et al., 2007, both low risk), tolerating the physical exertion of competition and training (Brick et al., 2015; Kress & Statler, 2007, both low risk) or for managing high pressure and arousal levels (Vickers & Williams, 2007, low risk). Equally, there were strategies for remaining motivated in training or competition (Tracy, 2011; Terry, Karageorghis, Saha, & Auria, 2012, both low risk) and maintaining a balanced state of physical and mental well-being (Lundqvist & Sandin, 2014, low risk). Some individual skills, reported as positive during training and competition, were attentional focus, task-related thought control, goal-setting, self-talk, visualization, imagery, and relaxation.

Maintaining attentional focus and using thought control were deemed important for performance in 11 studies. These related to having proactive thoughts on performance related information (Baker, Cote & Deakin, 2005, moderate risk), using task relevant statements (Rushall, Hall, Roux, Sasseville, & Rushall, 1988, low risk) or directing visual attention and gaze control externally to critical task information to prevent choking under high pressure (Vickers & Williams, 2007). The use of a personal motivational video was reported to psychologically prepare and focus a professional mountain bike rider ready for competition: '…Being able to start the warm-up and the race with a viewing…helped to maintain focus and prepare for the two hours of slogging the mud and cold that was ahead' (Tracey, 2011, p. 315). Runners also discussed 'active distraction' strategies to make running feel easy, such as counting and chunking distances together to maintain a present focus, and to break down perceived challenges (Brick et al., 2015). The use of athletes using association more than dissociation to aid performance was also reported (Morgan and Pollock, 1977, high risk; Morgan. O'Connor, Sparling, & Pate, 1987, high risk; Phillipe & Seiler, 2005, high risk; Silva & Appelbaum, 1989; Tammen, 1996, moderate risk; Van Raalte et al., 2015).

Olympic cyclists recounted using positive self-talk during rides to lessen the intensity (Kress & Statler, 2007) and similarly, the content of elite marathoners' self-talk was reported as 43% positive/motivational (Van Raalte, Brennan, Cornellius, & Brewer, 2015, high risk). Some specific examples of self-talk phrases, used by elite adventure racers to help reduce risk and cope with the demands in competition, included: 'just relax', 'you can do this, keep your head together', 'I'm a better climber than this', 'you've run harder' and 'goddam it pay attention' (Schneider et al., 2014).

Furthermore, goal setting was used as part of a short-term strategy, for example, to stay focused within a cycle race (Kress & Statler, 2007); and longer term goal-types, such as global goals, were implemented to help maintain a good balance between family-friends' relationships. Additionally, sport-specific goals were implemented to be more purposeful and inspiring for training and competition, to facilitate a positive well-being and enhanced performance in orienteers (Lundqvist & Sandin, 2014).

Active self-regulatory strategies were drawn on for monitoring the body and mind to enhance performance, such as relaxing during running (Brick et al., 2015, p. 6): '…the minute I relax and I drop my arms, elbows are in and knees are high, my stride automatically lengthens…So already I'm on a better flow'. An adventure racer maintained an open mind to cope with the competition pressure and others noted employing a sense of calm or relaxation prior to a risky situation (Schneider et al., 2007). Olympic cyclists reported a combination of

using relaxing and controlled breathing as a good form of stress reduction, explaining that having an acute awareness of their optimal arousal helped to develop a heightened sense of their bodies and stressors that needed to be controlled (Kress & Statler, 2007). Two quantitative studies found positive results for the use of autogenic relaxation training and imagery as the independent variable and shooting performance as the dependent variable whilst exploring if and how these interventions could enhance performance (Groslambert, Candau, Grappe, Dugue, & Rouillon, 2003, moderate risk; and Laaksonen, Ainegren, & Lisspers, 2011, high risk).

An effective pacing strategy was important for athletes in 6 studies; 1 was during training in cycling (Skorski, et al., 2014, low risk), 4 during competition for running and ultra-running (Brick et al., 2015; Renfree & St Clair Gibson, 2013, moderate risk; Silva & Appelbaum, 1989, high risk; Simpson et al., 2014, low risk) and 1 during both training and competition (Macquet et al., 2012). Like active self-regulation, pacing was linked to the athlete monitoring their bodies and surroundings, through learned experience and effective decision-making; thus, the more skilled athletes were more adept at successfully implementing the right pacing strategy for them.

Finally, other cognitive-based strategies were related to effective decision-making, anticipation, and deliberate practice; in some specific cases, preparation and practice of these were related to managing themselves within a dynamic and high-pressure environment. For example, an enhanced long term memory seemed to develop well from effective reviewing and evaluation of performance related information by world-class orienteers (Eccles, Walsh, & Ingledew, 2002; Eccles, 2006; Eccles, Ward, & Woodman, 2009; all low risk) and it was concluded that mental practice for elite performance preparation was equally as important as physical practice. A good combined physical and mental practice example was illustrated by an orienteer mentally preparing for a World Championship: ‘I pulled out the maps I had in advance…I tried to focus on the kind of things that’ll go wrong…how I would simplify this leg…when I got there a week before…I’d go out into the forest and I’d run on it and when I got back I would write things.’ (Eccles et al., 2009, p. 103). Adventure racers implemented strategies to manage the possibility of encountering risk during a competition, such as combined visualization and self-talk; one adventure racer reduced risk by using his long-term memory whilst in the water, using his brain as a camera to remember hazardous features: ‘…I could draw you pretty much rock for rock every rapid I’ve been through…I remember every course I’ve done…everything’ (Schneider et al., 2007, p. 351).

In summary, these well-practiced skills and honed strategies were implemented according to the individual's somatic symptoms and cognitive requirements of the sport illustrating the reciprocal relationship between mastery of the sport and balance of the mind-body dualism during critical times of training or competition.

Sub-Theme: Pain Management

The perception, acceptance and tolerance of temporary or constant pain was an important factor, monitored by endurance athletes. Pain was an accepted part of cycling (Kress & Statler, 2007) and in adventure racing, an ability to defy one's body for training in physical tasks and displaying no fear of injury seemed to be the norm (Schneider et al., 2007), thus, both being beneficial to performance. During competition, a higher tolerance threshold resulted in positive effects on performance for runners of differing distances (including ultra), cyclists and swimmers, triathletes and ultra-triathletes (Brick et al., 2015; Geva & Defrin, 2013; Kress & Statler, 2007; Phillipe & Seiler, 2005; Simpson et al., 2014). Additionally, it was hypothesized that triathletes can tolerate greater training loads after displaying a greater tolerance to pain than a control group ($p<0.001$), had lower pain ratings ($p<0.01$), and a lower fear of pain values ($p<0.05$) (Geva & Defrin, 2013, low risk). Furthermore, Phillipe & Seiler (2005) hypothesized that women tended to dissociate more in competition to avoid pain ($F_{1,58} =6.00$, $p<0.05$); whereas men associated more ($t_{29}=8.25$, $p<0.01$) than women ($t_{27}=3.15$, $p<0.01$).

Strategies for dealing with pain were similar across different sports, for example, during cycle training and competition, Kress & Statler (2007) reported how nine Olympic cyclists used positive self-talk, goalsetting and imagery to lessen the intensity of the pain. Elite runners had reported using active self-regulatory and metacognitive strategies when running felt hard such as imagery, pacing and tactical decision-making, plus mindfulness to help with exertional pain (Brick et al., 2015); appraising exertional signals, during running to deal with pain signals:

> "…I suppose there's times when things are appropriate and when things are not…like your emergency strategies……sometimes I would count…you might be mildly uncomfortable…But…the thing where you look at your band or just have to accept, you do the pain acceptance thought in your head…'cause you're in a lot of pain, you're really suffering quite a bit…" (Brick, 2015, p. 6).

An added dimension for coping with and tolerating the pain was whether it was externally or internally paced and imposed, for example, during a breakaway in a cycling stage race (Kress and Statler, 2007). Olympic cyclists referred to 'others' dictating the pain: "Suffering is when somebody else is dictating the speed you have to ride at…" and "Somebody is really hurting you…" (p. 444). Therefore, the notion for the acceptance of pain and cyclists' voluntary experience of pain was highlighted by how it was the cyclist who actively chooses to ride at that pace or intensity or not when it is not set by themselves, thereby helping them to employ the most effective cognitive coping strategy at that time. Conversely, riders expressed feeling good when they set the pace and seeing others struggle; pain was also perceived as harder when a rider's race position was further back in the peloton.

This demonstrated the reciprocal relationship and interactions between the mind and body to control the body or vice versa.

Sub-Theme: Management of Perceptions

This sub-theme represented how several identified psychological and psycho-social factors have the potential to positively or negatively affect the athlete's performance and wellbeing, dependent on the individual's perceptions of the situation or disposition. Positive effects stemmed from the repeated mentions of the feeling of being in control or having the autonomy to make their own decisions, whether it was in their personal life or sports situations. This related to the control for longer term planning such as daily routines and global or sport-specific goals (Lundqvist & Sandin, 2014); perceived control during a competition (Schneider et al., 2007; Tracy, 2011), and personal control of evaluating then strategizing from past to future performances (Brick et al., 2015). In addition, the influences of the psycho-social factors, such as perceiving a multidimensional identity, with a good social and support network, were also beneficial to the athlete because they facilitated a sense of wellbeing. This positive effect resulted in effective management of perceived stressful situations, promoted a positive rest and recovery for their mind and body. Also, the multidimensional identity provided a broader base in their daily life, coupled with perceptions of good functioning relationships between team mates (Lundqvist & Sandin, 2014).

Feelings about perceived pressure were mixed up in short- or long-term situations and sometimes resulted in a negative effect. For example, experiences of feeling the effects of high pressure and competition anxiety, when not managed correctly, lead to choking during performance (Vickers & William, 2007). Or, athlete perceptions of externally imposed

pressures, such early junior success and promotion (Gustafsson et al., 2007), or from the coach, fans, peers, parents; a perceived lack of a social support network produced negative effects on the athlete (Gustafsson et al., 2007; Tenenbaum et al., 2003). One specific example of a perceived lack of control was illustrated by the signs and symptoms of a burned out cross-country skier, reading her winter training and competitions schedule: 'I was caught in a net, like a spider's web …I didn't have any control at all. I thought I had control, but I now realize that I had this control dependent on the will of others' (Gustafsson et al., 2007, p. 405).

Finally, a moderate risk study explored the perceptions of the coaches and athletes to ascertain any similarities or differences, and how this could affect the triathlon performances. Ruiz-Tendero and Salinero (2012) used the Complex Model System to produce positive and negative psychosocial factors relating to performance, and to assess any differences in coach-athlete perceptions. They observed that, despite sharing many hours together in training and competition, there were differences in perceptions. For example, significant differences were highlighted for the negative factors, with only injury rated similarly at number 1 and competitive anxiety at number 4 on their lists. However, athlete-coach perceptions were in agreement on the top five positive influential factors: dedication, perseverance on training, volitional capacity, coach and family support. Conclusions were drawn from this that athletes appear more sensitive to the personal level, while coaches tend to give more importance to the technical and institutional aspects (Ruiz-Tendero & Salinero, 2012).

Sub-Theme: Psychological, Psychosocial and Other Factors That Require Monitoring

This sub-theme focused on how important it was for the elite and sub-elite athletes to monitor different psychological or psychosocial factors for a successful endurance performance. This included facilitating the right levels of motivation, self-efficacy, and optimal arousal, plus effectively managing any mood disturbances or perceived stress and anxiety levels. One qualitative study demonstrated how an elite mountain bike rider helped to maintain his own motivation levels, mood and positive emotions by actively selecting his own music, images and photo clips. This was compiled into his personalised motivational video and successfully utilized throughout the preparation period and competition season:

> In the winter, it's a lot tougher when you're inside…so I was even using it …when I started getting bored...it served to remind me of why I was doing it and motivate me again. With the music and images of different people who look up to me or who I

> look up to and races that were sort of my goal for next year so for training…it really helped.... The effect of watching last year's nationals before the actual nationals was amazing. I thought…the pictures of the start especially really helped me visualize what it would be like at the start and I think it made a difference in my anxiety control…I had a pretty good start and just rode smooth (Tracy, 2011, p. 314-315).

Conversely, there are some negative effects on performance when athletes exhibit extremely high levels of motivation. This was demonstrated by three elite cross country skiers whose very high motivation levels lead to over-training to compensate for their performance deficits, so by ignoring their body's symptoms and signs, burnout subsequently resulted (Groslambert et al., 2007, low risk). Additionally, a mixed method study, (Tenenbaum et al., 2003), revealed how three cyclists experienced failure adaptation, and one female displayed high anxiety towards competition, with significant negative mood changes. Moreover, a depersonalisation towards relationships with everyone, and her degree of social acceptance and self-worth were threatened by her decline in performance. These two examples revealed how a negative balance in the mind and body dualism can produce adverse consequences on the well-being of the athlete, especially when not monitored or managed properly. It also illustrated how the individualized perceptions of the same situations produced very different outcomes.

The effects of possessing a higher confidence and stable self-efficacy levels were closely linked to positive experience(s) and successfully learning from them (e.g. Eccles et al., 2009; Simpson et al., 2014; Tracy, 2011); the ability to successfully mediate risk (Schneider et al., 2007); to manage anxiety levels (Dunn & Dishman, 2005, low risk) and associated with feeling in shape and suppressing fatigue/lack of energy levels (Barnett, Cerin, Reaburn, & Hooper, 2012, low risk).

The importance of monitoring rest and recovery during training and competition was highlighted, with five studies also assessing for any biological, biochemical and physiological markers of rest and recovery, and/or gauging overtraining/overreaching. The review noted a difference in the duration of monitoring, across 13 studies, that demonstrated some useful insights into more naturalistic settings of the athletes. Four studies used the RESTQ or POMS during a season, e.g. 4-8+ months (Barnett et al. 2012; Bergland & Safstrom, 1994, low risk; Filhaire et al., 2004, moderate risk; Purge et al., 2006, low risk); two during competition periods (Dunn & Dishman, 2005; Filho et al., 2013, moderate risk); three studies used POMS and RESTQ during training camps (Comotto et al., 2015; Gustafsson et al., 2007; Kellman et

al., 2001, low risk; Skorski et al., 2014); and the RESTQ was used over a set period of weeks (Coutts et al., 2006), or within a period of 2-4 days (Bouget et al., 2006). Also, one study used POMS, as a measure on a same day basis, as part of a battery of other psychometric tests (Morgan et al., 1987). Correspondingly, mood disturbance was deemed important to monitor by 8 studies, of which 6 quantitative used the POMS, 1 quantitative used the RESTQ and 1 qualitative used a personal motivation video, to monitor and report on how mood was affected by heavy training loads. Consistently, overtraining and overreaching were reported in 4 studies as producing a negative effect on performance; 2 were in preparation periods (quantitative and mixed design) for triathlon and cross-country skiing (Comotto et al., 2015, moderate risk; Gustafsson et al., 2007), 1 quantitative study was during the Girobio 2012 cycling competition (Bouget et al., 2006, moderate risk) and 1 mixed design was during a cycling training and competition period (Tenenbaum et al., 2003).

So, a prudent monitoring of certain psychological, psycho-social or other related factors actively emerged as key to facilitating the athlete's balance between mind and body. In all reported cases of monitoring, over more than 2-4 days, a tapering period and sufficient recovery produced positive effects on mood disturbances and observed effects of overtraining or overreaching. However, where this did not take place burnout and failure adaptation were reported, as reported by Gustafsson et al. (2007), who emphasized the importance of emotional, mental and physical recovery because a lack of recovery days had produced burnout for three senior national cross-country skiers. Additionally, Tenenbaum et al. (2003) found support for the utility of the stress-response model and reported on the failure adaptation of three cyclists, and how a lack of understanding or support by some coaching staff did not assist their recovery.

A further consideration for monitoring the effects of fatigue on performance decrements was related to cognitive functioning and decision-making, over varying periods of time. This provided another important example of the close link between the mind-body dualism and mastery of the sport for effective performances. For example, the short-term risks of fatigue in 17 sub-elite ultra-trail runners, during the Ultra-Trail Mont Blanc race, was assessed by a low risk study (Hurdiel et al., 2015). The evidence showed the negative effects of fatigue and sleep deprivation on the cognitive test results after the race (e.g. number of reaction time lapses >500ms $P=0.005$, $d=1.39$; the mean response time increased after the race $p=0.001$, $d=1.68$; number of errors of commission >100ms, $p=0.02$, $d=0.9$). Congruently, a comparable experience of prudent balancing of sleep deprivation and decision-making by adventure racers in competition, was reported by Schneider et al. (2007).

Elite racers had to offset their decision-making of no sleep affecting their personal safety and their physical or cognitive performance. This competitiveness was aligned with the acknowledged inherent hazards and risks associated as part of their sport. For example, one team of elite adventure racers were willing to take risks in competition to win an event, except when perceived as life-threatening. Sleep deprivation over a 7-day race in a team can negatively affect their navigation and decision-making:

> …you know there's a huge risk there when you're sleep deprived and stumbling around and it's dark and it's a lake and you're trying to get out there fast. You're not thinking very well….We found ourselves at night in some fairly volatile weather.…where we could have walked off a cornice…then I found myself sleepwalking on a cornice… (Schneider, 2007, p. 343-344).

Discussion

As previously stated, the objective was to capture a fuller breadth and depth of evidence, as well as to gain a highly practical and newer understanding, to address the research question of how do endurance athletes psychologically prepare for and manage their performances during training and competition. Implementation of the *a priori* criteria yielded 40 empirical papers for inclusion, with a surprisingly low number of mixed method papers. Nonetheless, piloting of the search strategy and supplementing the electronic search with hand searches and reference lists of included papers allowed some confidence that all papers would contribute to achieving the research aim and objective and thus addressing the research question.

The two overarching themes, Mind-Body Dualism and Mastery, were deemed equally as important to the athlete's success. This was because of how important it is to have a balanced union of the mind and body working together, in and out of competition or training, and for how necessary it is for the athletes to possess the required expertise and skill levels tantamount to being elite and sub-elite in their chosen sport. These two themes were inextricably linked by the four descriptive sub-themes: Psychological Strategies and Skills; Pain Management; Psychological, Psychosocial and Other Factors that Require Monitoring; and Management of Perceptions. Successful athletes could dynamically assess their situation, and demonstrate their proficiency for managing the sporting situation, by instinctively applying the most appropriate self-regulatory or cognitive-based strategies relevant to their somatic symptoms and the cognitive requirements of the sport.

Mastery

Within the mastery theme, effective cognitive functioning emerged as more vital in certain endurance-based sports than in others, such as crucial decision-making and anticipation in the cycling peloton or on fast downhill hairpin bends, accurate navigational skills on rocky mountainside paths in the pitch-black night, and shooting accuracy for biathlon. These findings are pertinent when one considers the remoteness of some ultra-marathons where a further risk dimension is added to the competitors because they are expected to be self-sufficient and autonomous between checkpoints (Hoffman et al., 2014). The strategies employed by the athletes for continual improvement were based around a range of knowledge-driven strategies. These were employed for deliberate practice and specific preparation, assessing performance-related information or task-related cues, and processing that information into their long-term memory to enhance their performance. In the

review, expert performance was also facilitated by the ability to problem-solve, review their cognitive and self-regulatory strategies and being self-aware of any relevant psycho-social or psychological factors that can influence their performance.

Congruent observations can be noted from Cisek & Kalaska, (2010) who stated that the complex performance environment requires the athlete to continuously modify ongoing behaviour, evaluate alternative behaviour that may be available and make trade-offs between choosing to persist in each behaviour and switching to another one. This would seem applicable to the endurance athlete's control of deliberate practice, reviewing of performance and confirms how both mental and physical practice will develop their expert performance and mastery of the sport; especially true when attending to task-related or performance-related cues and information that is of a life-threatening or risky nature.

These observations also coincide with the different types of knowledge that are gained from learning from experience, such as tacit knowledge, a 'socially constructed, an intangible rich source inside a head, it is knowledge from a mastery of a skill' (Sallis, 2002;82-83). In the context of the elite and sub-elite endurance athletes, this tacit knowledge was the enabling factor in preparing themselves for and managing their competition experiences. Other salient definitions of knowledge that are congruent to tacit, originate from a distinction between declarative and procedural knowledge. According to stage theories, declarative rules are gradually transformed, through practice, into procedural knowledge that automatically guides performance without recourse to conscious attentional resources (Abernethy et al., 2007). These theories are believed to predict expert motor performance and would place fewer demands on attentional resources (Abernethy et al., 2007).

This knowledge aligns with the athlete who demonstrates mastery over their sport, both physically and psychologically, with effective cognitive functioning for anticipating and decision-making, in a variety of dynamic pressure situations and environments. The athlete who is also self-aware of the competitive risks involved can operate at an autonomous skill level throughout, be it technical or psychological. However, Masters (2000) and Masters and Maxwell (2004) suggest that when faced with certain demands such as perceived risks or hazards, expert performance may choose conscious control. This would seem relevant when considering the competitive orienteer, adventure racer or 24-hour ultra-trail runner.

In the context of developing mastery, other assertions were congruent too. The tactical knowledge and cognitive skills, discussed by Farrow, Baker and MacMahon (2008), are developed through expertise, when the sport-specific knowledge is being stored in the long-term memory. To achieve automaticity with practice, the role of attention for the

management of limited information-processing resources is applicable, as well as an understanding of the different tasks required (Abernethy, Maxwell, Masters, Van Der Kamp, & Jackson, 2007); lastly, the increase in anticipation and decision-making is dependent on the situation and contextual information according to each endurance sport (Williams & Ward, 2007).

The need for effective reviewing and combining both types of physical and mental practice is similarly reflected in previous works of Suinn (1994, 1997) which refers to the necessary error analysis and efficacy building during practice. Where acquisition is concerned, it is accepted that the more physical practice trials, the better the learning. After acquisition, the rule remains that the more practice, the better the performance (except for the unique case of overtraining). One proviso made, pertinent to this review, was that the main consideration regarding length or amount of practice was the need to avoid fatigue; this applies to both physical practice and mental practice sessions (Suinn, 1997). It is worth adding that, in support of the linked overarching themes, whilst deliberate practice is necessary, it is the combination of other factors that are also important influences for performance, echoed by Ackerman (2014). Developing further the idea of resonating influential factors, a review of the primary and secondary influences in expertise (Baker & Horton, 2004) found the primary influences to include: demonstration of exceptional level of skill, ability to focus on task, managing anxiety, increased self-confidence, possessing the 'iceberg profile' in POMS assessments, increased concentration, ability to rebound from mistakes, risk-taker and sensation-seeker. The secondary influences were socio-cultural and cultural factors, coaching and the coach's ability to facilitate the right environment, and sport maturity. Thus, the review findings point towards a holistic and multidisciplinary approach to benefit the endurance athlete. Practical support for designing a tailored individual monitoring program for the endurance athlete is highlighted by an example of Carlson (2011), who found that the successful Swedish elite biathletes had all benefitted from an individualized program and effective reciprocity of communication with their coaches.

Mind-Body Dualism

The question of whether it is the mind or the body that controls one another is an interesting discussion topic, as indicated in the introduction section (Lind et al, 2014; Marcora, 2010; Noakes & Tucker, 2008; Renfree et al., 2014; Smits et al., 2014) and elucidated in the results section. The sense of one controlling the other, whether in training or competition, and over short or long term periods of time is comparable to a symbiotic

relationship. A balanced, reciprocal relationship is paramount to the successful preparation and management of performance. It is achieved when the athletes understand the influential factors and can affect the mind-body balance, at a micro and macro level. Thus, they can work towards feeling in control and possessing a global, multidimensional identity and sense of well-being. Equally, the controlling mechanism for their homeostatic mind-body dualism is supported by the athlete's mastery of their sport.

The review highlighted possessing strong feelings of perceived autonomy and control for this interdependence of mind and body to thrive, and the need for owning their own global and sport-specific goals. This potentially echoes with key tenets of self-determination theory (Ryan & Deci, 2000) when the endurance athlete's basic needs are being met. These findings also align with Goodger, Gorely, Lavallee, and Harwood (2008) who found that those athletes that possessed a positive mental health profile were more successful and those that felt in control and experienced greater autonomy reported lower burnout. The relevance of the Mental Health Model resonates with the mind-body dualism theme because of the psycho-social factors that can positively or negatively affect the athlete. These factors and perceptions are worth monitoring such as internally or externally generated pressure. The model assumes positive mental health is associated with high performance levels and mood disturbances are predicted to result in performance decrements (Morgan, 1985). This model was also revisited with the aim to discuss how it indicated the importance of psychological health and its impact on an athlete's sport performance and well-being (Raglin, 2001).

The review findings link to an assertion, made by Shephard (2000), stating that if competition is perceived as unusually stressful from a psychological perspective, there can be an interaction between physiological and psychological stress, exacerbating hormonal fatigue. Although this added physiological dimension was not planned for in the original scope of the review, it actively emerged as important and necessary for monitoring, alongside other psychological and psychosocial factors. Important considerations should be also be aimed at those [ultra]-endurance athletes competing in extreme environmental conditions, as reported by Lane, Terry, Stevens, and Dinsdale (2004), to monitor elite and sub-elite athletes' mood responses, as well as their vigor and fatigue. For example, the winners that are successful in extremes of altitude and temperature compete in races such as the Baikal Ice marathon and the Antarctic Ice marathon with a −45°C mean temperature, or in the Marathon de Sables and Badwater ultramarathon in +55°C mean temperature (Kalin, Knechtle, Rust, Mydlak, & Rosemann, 2012). Lane et al. (2004) advised that monitoring should be very

individualized, which also echoes with this review, whilst training under normal conditions, due to the rate of positive adaptation to extreme conditions.

The mind-body dualism theme confirms that there is an association between the physical and mental aspects of performance and that the athlete's wellbeing is detectable over varying time periods and across a variety of endurance sports. The results also confirm the benefits of monitoring and evaluating the emotional and psychological state of athletes by the coaching staff, via the POMS, RESTQ and RPE. This highlights a congruence with the reviews of Meeusen et al. (2013) and Bell and Ingle (2013), who both agree there is no one single indicator for overtraining, but highlight the multiple stressors, confounding factors relating to POMS/RESTQ/RPE, social factors and travelling experienced by the athlete, plus the need for adequate rest. Additionally, they stress the importance to coaches to also be aware of the prevention, diagnosing and treating of overtraining syndrome with the use of POMS and RESTQ questionnaires. They recommended a multidisciplinary team approach to monitoring the athletes, resonating with this review's practical implications and conclusions.

Therefore, a prudent monitoring system that encompasses these factors for maintaining a healthy balance between the mind-body dualism would be invaluable to the athlete and coaching team as the results indicated the benefits of adopting a holistic approach within a multidisciplinary team. This approach would help to effectively detect, monitor and manage any potential negative effects of mood, stress, anxiety and impaired cognitive functioning to prevent negative effects on performance. This is particularly helpful during the short-term effects of fatigue and sleep deprivation, or long-term effects of overtraining and a perceived lack of autonomy or social support. This review adds to the knowledge on the long-term effects of sleep deprivation, mood disturbances, overtraining syndrome, and burnout. It also builds on the findings of McCormick et al. (2015) relating to mental fatigue's negative effect on performance.

Interestingly, the sleep/wake patterns of elite athletes were studied for a range of sports, which included individual sports cycling, mountain biking, race-walking, swimming and triathlon. In comparison to the team sports, the individual endurance athletes went to bed earlier and got up earlier for training and accumulated on average the least sleep at 6.5 hours (Lastella, Roach, Halson, & Sargent, 2014). Perhaps a further consideration when monitoring endurance athletes.

Pain

The sub-theme of pain acknowledged the additional physical and mental challenges that athletes face in preparation and competition, and the psychological strategies required to maintain their performance. The ability to accept, control and manage these perceived sensations, using the self-regulatory and cognitive strategies, added to the learning processes taking place in the endurance athletes; thereby suggesting that the cognitive modulation of pain can be a powerful tool during endurance performance. Several theories centre around pain and exercise, and the parallel processing theory (Levanthal, 1993) as adopted in previous reviews (e.g. Brewer & Bumen, 2006; Brick et al, 2014), is potentially relevant for interpreting the results of this review, alongside the premise of automaticity (Laasch, 1995) and a dual task paradigm (Abernethy et al., 2007). This is because of the symbiotic link between the mind-body dualism and mastery themes, e.g. the ability of the elite athlete to attend to more than one thing and concentrate on two different aspects of performance such as dynamically managing perceptions of pain whilst executing the skill levels required against the constraints and risks of the sport. Thus, the acceptance of pain is important to the endurance athlete.

Moseley and Arntz (2007) presented an interesting argument stating that pain is modulated by psychological, somatic and social domains. This is potentially congruent with the findings of this review, when ascertaining the interpretation or attaching meaning to the pain, as the four factors proposed were the amount of attention directed towards pain, the expectation of the intensity of the stimulus and the anxiety levels associated with the attention (Moseley & Arntz, 2007). Social context may also affect the pain it evokes for interpretation and meaning (Moseley & Arntz, 2007), therefore evaluative context is important, such as in tough ultra-endurance competitions. Bastian et al. (2014) reviewed pain and its consequences, using the idea of pain being an independent variable rather than a dependent one, as is usually the case in most studies. Bastian et al. investigated why people sought out pain in activities, such as during intense exercise, hypothesizing that by using positive framing of pain it could increase pain tolerance. When comparing the perceptions of pain by elite and sub-elite endurance cyclists, triathletes' and distance runners', tenets of prospect theory were congruous to weighing up the benefit-cost ratio for enduring pain (Bastian et al., 2014). Although none of the studies used by Dannecker and Koltyn (2014) were analogous to this review, their study of healthy adults and pain did propose an interesting conclusion that, referring to during and after aerobic exercise, pain is a multidimensional and multi-factorial

perception. This seems relevant in terms of the different types of endurance sport and their specific requirements, how each individual athlete may assess their situation differently, varied levels of perceived tolerance and interpretations, plus the attention and thought control paid to it for example. Indeed, further research in this area would be insightful.

Finally, an excerpt from the ex-professional cyclist Paul Kimmage sums up the reciprocal relationship between how mind and body battle for control over each other in specific sporting situations, in this case coping with the perceived pain from the harsh environment, and illustrating some congruence with the theories of pain. It also helps to confirm the benefits of using a naturalistic setting in future studies:

> …climbing a mountain in snow is not really a problem…The trouble starts when you go down the other side…..There is no physical effort involved here, just the mental concentration of braking and turning. The heart rate drops and the body no longer produces heat and within minutes you are not sweating but shivering….I screamed at the top of my voice in an effort to motivate myself, but it was getting harder and harder to brake….I suppose in a way it became a challenge, a survival of the fittest that appealed to the cannibal instincts in me… (Kimmage, 2007, p. 207-208).

Practical Implications

For the professionals and athletes, there are several recommendations. Firstly, as no one size fits all for prescribing skills and strategies, once the athlete has achieved the necessary mastery of their chosen endurance sport, they should concentrate on working out the best skills and strategies that work best for them, in a variety of dynamic training and competition scenarios. More specifically, no two athletes are the same, meaning that a team of athletes could perceive and react very differently to self-imposed factors or the same external stimuli or environmental factors. Therefore, these differences should be accounted for when applying an individualized, holistic and multidisciplinary approach, and by using the conceptual framework as the underpinning guideline for coaches and the athletes for the important key factors specific to them, will enable clearer communication at all levels. The practical implication is for the coach to encourage and facilitate the right learning environment and allow the athlete's autonomy to develop. Once achieved this will allow learning and acting from experience, regular reviews of training and competition performances, and how they can successfully manage different dynamic situations

independently. Hence, the deliberate mental and physical practice of skills and strategies is paramount, perhaps incorporating an intervention strategy approach, if applicable.

To support these practical recommendations, Myburgh (2003), whose stance was from an exercise science perspective, also advocated a multidisciplinary and inter-disciplinary approach whilst trying to solve the 'conundrum' of what makes an endurance athlete world-class. Her points were noted regards administering a developmental intervention strategy for effective use of mental skills during high intensity bouts of strenuous training and competition. On a more generic basis, Smith's (2003) model of the contributing components to a measurable athletic performance was equally applicable, which included psychology, tactics and health-lifestyle. Similarly, the principle of individualization was also posited for effective monitoring of the training and recovery (Smith, 2003).

Additionally, it would be beneficial to refer to the checklist, recommended by Meussen et al. (2013), used to eliminate the possible causes of underperformance. Such complex psychological factors to monitor included increased expectations of the coach and family, competitive stress, personality structure, social environment, relationships with family and friends, personal or emotional problems, and school or work-related demands. Therefore, the regular monitoring of these factors can be beneficial since no one single marker is conclusive. Lane and Wilson (2011) support the notion that trait emotional intelligence associates with adaptive psychological states, suggesting that research should test the effectiveness of interventions designed to enhance trait emotional intelligence and examine the attendant impact on emotional responses to intense exercise during multi-stage events.

Other practical avenues could be continuing a trend for the use of technology and other novel methods of data collection, in a variety of different sports to increase the ecological validity and recall of specific events and experiences. Clearly, this should only be considered when safe to do so during training and within the rules of the competition. Examples may include the use of waterproof and shockproof cameras or videos attached to clothing, equipment and the body.

Strengths and Limitations

To evaluate the significance of these findings, this systematic review was considered as an important contribution to the existing literature as it presented the reviewed quantitative evidence that shows associations between psychological, psychosocial and psychobiology factors that influence endurance performance, as well as which skills, strategies or

interventions may enhance performance. Similarly, the qualitative and mixed evidence highlighted the mechanisms and processes for athletes to manage their performance and which skills or strategies are used, and when.

In addition, this current review of mixed studies included 40 studies not reviewed by McCormick et al. (2015) and by doing so addresses some of their highlighted limitations. Firstly, four of the included studies (3 low risk and 1 moderate) were theoretically driven to examine the mechanisms that affect athlete endurance performance and preparation, two of which were based in a competition season and one during the Tour de France: one used Failure Adaptation theory (Tenenbaum et al. 2003); one used the Complex Model System (Ruiz-Tendero & Salinero, 2012); one used Hanin's IZOF and Bandura's Self-Efficacy theory; and one used Relaxation theory and Hanin's IZOF theory. Secondly, this review sheds some light on the individual differences of endurance athletes, the demands they face, and the results of the studies designed to cope with these demands. The results highlight participant dispositions within the various psychological and psychosocial factors**.** Thirdly, there is some congruence found between the two systematic reviews confirming the need for more studies to be conducted in a realistic and naturalistic setting.

As an aside, these recommendations for naturalistic settings are akin to assertions made by Cioffi (1991) who stated that an individual prepared to experience a complex set of sensations in a laboratory, such as cold ice or water exposures is different to those athletes competing outside against the real elements and having to implement a real set of strategies to overcome the sensations experienced.

A reflective process of the methodological approach was employed by the researcher throughout, to conclude that the research purpose and objectives were not too narrow and allowed for the answers to emerge iteratively. Furthermore, the author referred to the guidelines of the Confidence in the Evidence from Reviews of Qualitative research (CERQual), as recommended by Lewin et al., (2015), to evaluate the confidence in the methodological findings in terms of adequacy, coherence and relevance.

Referring to 'coherence', a process of conceptual mapping was internally generated from all the studies which was then transformed into a conceptual framework (see Figure 2) based only on the key findings of low risk and low/moderate risk findings. In terms of 'adequacy', the richness of data was present with sufficient detail triangulated from a variety of research design sources, covering some similar phenomenon of interest within the included 40 studies. The overall methodological quality was largely low and moderate risk which also increased the confidence of the results.

An increased understanding was gained from analyzing elite (60%) and sub-elite endurance athletes, competing in a wider variety of sports, and 16 were studied within a naturalistic setting, 10 based around competition(s) and the remainder were conducted during training seasons or camps, thereby adding to the external validity of the results. However, some caution is necessary when one considers that all endurance populations were 100% able-bodied endurance athletes and the actual numbers of female (35%) to male (49%) ratio.

A limitation of conducting this review is that it was restricted to peer-reviewed journals in the English language only, leading to potential publication bias, as there could be unpublished insightful papers, in other languages, that could be added to the results of this review. In addition, as some studies were excluded, when information could not be clearly separated out, this could also have omitted some insightful information. The decision to include the 5 high risk studies in the results following their appraisal could be deemed a limitation by some researchers, however, the reporting of the results with its assigned risk, helped to ensure a reduced risk of reporting bias, so that results were reported and highlighted for the reader to make their own judgements.

Future Directions

The research gaps and subsequent future directions relate to a combination of research design, demographic information and specific topic areas to focus on. More longitudinal, comparative, observational, case study-type and qualitative research should be considered to capture athletes' perceptions and how their strategies change and develop over prolonged periods of time. Such as individual or group case studies over a season to review and evaluate during training and competitive season. In this review, the qualitative research designs used a wider variety of sports, however, the study of more ultra-endurance sports, given the low number studied, would be encouraged to investigate more psychological outcomes because of the skills and strategies employed, especially in extreme environmental conditions.

A gap exists for a good mixed methods design researching the effective employment of skills and strategies by athletes across a greater breadth of sports. The method of one-to-one interviews should be considered within mixed methods designs to increase the descriptive and experiential information gathered and not just relying on quantitative data alone. Additionally, continued controlled investigations, over meaningful periods of time with elite athletes, but using naturalistic, observational studies and quasi-experimental designs can be useful for examining potential determinants of, and mechanisms of influences on, athletes' performance related psychobiosocial states.

An interesting line of inquiry would be to extend the knowledge around pain tolerance and management as a continuation of exploring preparation and management strategies. Researching it from a qualitative (intensity, duration and location), emotional (unpleasant, anxiety), and cognitive (appraisal, attention, coping) perspective exploring the pain experienced by athletes would be recommended. Also, perhaps using an integration of the most applicable pain theories would help underpin this line of inquiry. This would be particularly useful when looking at ultra-endurance sports and endurance athletes with a disability, especially within longitudinal studies.

A recommended note for future researchers of this specific topic is to ensure that greater detail is provided on the sampling method, size and protocol; and for greater attention to be paid to reporting the participant and researcher ethical matters. Furthermore, for those researchers conducting mixed methods studies, it is also recommended that the qualitative and quantitative elements are conducted and reported with equal strength in methodological approach. This specifically refers to highlighting how the integration of qualitative and quantitative data is relevant to address the research question and reporting on how appropriate consideration was given to the limitations associated with this integration.

In terms of demographics, the results revealed low recruitment numbers from some countries, and was non-existent for endurance athletes from Asia and South America across research design types. It is beyond the scope of this review to state why this may be, however, perhaps for future research, and to extend the external validity, the purposeful recruitment of a wider range of nationalities would also be useful to compare psychological preparation and performance management.

Likewise, an examination of the monitoring of psychological, psychosocial and other associated factors for any cultural differences amongst elite males and females may be advantageous. Similarly, the same purposeful recruitment applies for the general recruiting a larger sample size of elite and sub-elite athletes as far as is practically possible would be beneficial across all study designs, acknowledging the difficulty this may pose for coaches and researchers. Lastly, it would be beneficial to gain further insight into the effective preparation and competition strategies, particularly when based in naturalistic settings, for more elite level female endurance athletes and elite athletes with a disability.

Demographic information about the sample used in each study should be as complete as possible, at a minimum: age, gender, ability, nationality. This should clearly not compromise the identity of the samples but should still be enough to allow sufficient comparisons of data, eliminate any ‘unknown’ gaps, and to gain more insight to the

similarities or differences for interested readers. Finally, the exact competitive standard of the athletes should be made more explicit in the method sections. Swan (2012) attempted to address this discrepancy by reviewing and suggesting a framework for different levels of elite, and so this type of consistency for future reporting would be beneficial to future reviewers and readers.

Conclusion

This review has elucidated that effective psychological preparation and management of performance by endurance athletes is dependent on the complexities of the individual athletes' and their chosen sports.

Overall, the review findings report a similar positive use of self-regulatory and cognitive based strategies across different endurance sports. For example, a combination of pacing, visualization, self-talk, attentional focus and thought control were employed to psychologically prepare for and manage endurance performance, in both competition and training. However, the differences lay in how or when these were applied, following the dynamic assessment by the athlete on their somatic symptoms and the cognitive requirements, arousal or anxiety levels. Similarly, as each sport may present its own inherent risks, hazardous situations and contextualized experiences, athletes utilized strategies for dealing with them as they arose.

Therefore, it is recommended that an individualized, holistic and multidisciplinary approach, taking account of the individual athlete's psychological, psycho-social and other related factors, is adopted by the coach and sports organization when monitoring and facilitating the right learning environment for athletes. Although the mastery in their chosen sport is as an initial guarantor for successful performance, athletes need to maintain a healthy, symbiotic balance between their mind and body to prevent deficits in performance and preparation. Athletes need to be autonomous, independently learning from experiences and evaluating themselves in training or competition, to develop the most effective psychological strategies specific to them and their contextualized situations.

For future research, the use of the conceptual framework is recommended as a guideline tool for gaining baseline assessment information when assessing individuals. This should be referred to in conjunction with relevant underpinning theory and with other monitoring tools such as the RESTQ, POMS and the Meussen et al. overtraining-overreaching checklist. This could be especially beneficial to competitive junior athletes on a development programme working towards senior level performances. The baseline data can be referred to during the regular reviewing process of all athletes and to identify the contextualized factors required for maintaining successful performance. Finally, more quality mixed method research is recommended and research conducted over a longitudinal period, within a naturalistic setting, would also be beneficial to gain more insightful evidence.

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Appendix 1. An Example of an Online Database Search

Search Terms
Examples of these combinations include: ‘coping’, ‘cognitive’, ‘preparation’, ‘strategies’, endurance* and psychology, cognitive strategies* and endurance*, coping* and endurance*, endurance sport, endurance sport and psychological preparation, mental preparation and ultra-endurance, mental preparation of [triathletes, cyclists, mountain biking, skiing, biathlon, duathlon, aquathlon, running, rowing, swimming, mountaineering, speed skating, walking, long distance running, canoeing, orienteering], mental strategies and the perception of effort of marathon runners, mental preparation in endurance sports, mental skills in endurance sport, cognitive coping in [endurance sport, ultra-endurance sport/activity, long distance running], marathon speed skating and mental preparation, coping in endurance sport, mental preparation in endurance performance.

Example search strategy:

Using electronic databases Zetoc, Sport Discus with full text (Ebesco), PsychINFO (Ebesco), PsychARTICLES, MEDLINE (Ebesco), Physical Education Index (CSA) (ProQuest XML), ScienceDirect.

Search term: *‘*endurance sports and *coping strategies’*

827 yielded, of which 20 peer-reviewed articles.

Screen of 20 titles: 6 possible; 3 maybe

Screen of 9 abstracts: 2 possible, 2 maybe

Screen of 4 full text (methods & results section): 2 possible

Appendix 2. Excluded Article Details

Author/Year	Primary screening (Title and abstract)	Secondary screening of Article (method/results section)	Tertiary screening (full article)	Reason for exclusion
Acevedo et al. (1992)	Looks potentially relevant	Looks relevant still	Email sent to check competition standard	Exclude on basis of comp standard not being guaranteed
Aitchison et al. (2013)	Looks potentially relevant	Recreational standard population used		Competitive standard not elite/sub-elite
Allen et al. (2012)	Possible relevance	Uses some elite/sub-elite triathletes		Unable to separate out exactly the results/standard for triathletes
Allen et al. (2011)	Looks potentially relevant	Looks potentially relevant	Email sent to clarify sports used	Standard mixed & no sports specified
Anshel & Sutarso (2006)	Looks potentially relevant Standard high school/collegiate			Competitive Standard
Antonini et al. (2005)	Looks potentially relevant	Potentially relevant	Email sent for exact standard of athletes	No reply – comp standard not clarified
Asp (2013)	Looks potentially relevant but not peer-reviewed			Not peer reviewed
Baden et al. (1995)	Looks relevant for title and abstract	Population used not relevant		Non-elite population used
Baker et al. (2007)	Looks potentially relevant	Relevant for training and practice.		Topic: Does not meet inclusion criteria
Baker et al. (2005)	Looks potentially relevant but not a specific PBS factor for inclusion			Topic area: Not psych construct as such due to no PBS element. Doesn't meet study design or outcome criteria
Balague et al. (2012)	Looks potentially relevant but uses physically active people			Non-elite population
Bar Eli et al. (2010)	Looks potentially relevant but it is muscle endurance			Classification of activity does not meet criteria

Author/Year	Primary screening (Title and abstract)	Secondary screening of Article (method/results section)	Tertiary screening (full article)	Reason for exclusion
Barwood et al. (2012)	Looks potentially relevant	Population		Non-elite population used
Beauchamp et al. (2012)	Looks potentially relevant	Looks potentially relevant	Email sent to confirm classification of sport i.e. energy details	Research and email with researcher confirmed that anaerobic system is predominantly used: Classification.
Beaudoin et al. (1998)	Looks potentially relevant	Limited Demographics available		Study design -
Bertollo et al. (2007)	Looks potentially interesting but sports include anaerobic systems			Classification of sport
Blanchfield et al. (2014)	Looks potentially relevant	Population non-elite		Comp Standard Non-elite
Blank et al. (2014)	Looks potentially relevant but population not relevant			Population Intervention Strategy Military
Blaydon et al. (2010)	Looks potentially relevant but not topic specific to review			Topic area
Bottoni et al. (2011)	Looks potentially relevant but not PBS related			Topic area criteria
Breivik (2013)	Looks potentially relevant does not explicitly talk about endurance athletes Concepts Refs links well with pacing			Sports not explicit
Breslin et al. (2014)	Looks potentially relevant population used not elite/sub-elite			Non-Elite
Bueno et al. (2007)	Looks potentially relevant	limited demographics info		Study design: Minimal demographics
Bull (1989)	Looks potentially relevant but standard non-elite			Minimal demographics - No level

Author/Year	Primary screening (Title and abstract)	Secondary screening of Article (method/results section)	Tertiary screening (full article)	Reason for exclusion
Buman et al. (2008)	Looks potentially relevant – population used is recreational			Competitive standard
Burke and Jin (1996)	Looks potentially relevant	Comp Standard non-elite used		Competitive standard
Burke et al. (2010)	Looks potentially relevant	Elite climbers used and can be separated	Emailed BMC to clarify definition of 'elite' for climbers	Elite definition questionable official structure set-up non-competing not official structure in sense of word. Competitive standard is subjectively stated
Butryn and Furst (2003)	Looks potentially relevant but sample used non-elite			Comp standard
Caird et al. (1999)	Looks potentially relevant	Potentially relevant.	Emailed to clarify sub-elite standard	Standard unclear; emailed and not able to confirm 22/07/15
Callow and Roberts (2010)	Looks potentially relevant	Sports not separated/standard?		Classification/standard
Carlson (2011)	Looks potentially relevant but not exactly fitting the criteria			Topic area
Carter & Sachs (2012)	Looks potentially relevant			Not peer reviewed Running Article Running
Cathcart et al. (2014)	Looks potentially relevant	Rowing? Swimming? Cycling? Kayak?		Endurance Sports not stated directly
Cejuela et al. (2012)	Looks potentially relevant – physiology based only			Topic area: Physiology only; i.e. no psych
Connaughton et al. (2008)	Looks potentially relevant	Uses triathlon but can't be separate in results		Cannot separate out All 7x Tri
Connolly & Janelle (2003)	Looks potentially relevant but collegiate varsity rowers used			Non-elite population used

Author/Year	Primary screening (Title and abstract)	Secondary screening of Article (method/results section)	Tertiary screening (full article)	Reason for exclusion
Cooke et al. (2011)	Looks potentially relevant non-elite and muscle end task			Non-sport specific hand grip used Non-elite
Coumbe-Lilley, J.E., Hamstra-Wright, K., & Weidner, A. (2015)	Looks relevant at title	Still looks relevant	Read paper but standard still unclear – needs email to check	All recreational runners so 'sub-elite' tag is not really relevant to my definition of sub-elite.
Crews (1991)	Looks potentially relevant but is a review paper			Review Paper
Cronan & Scott (2008)	Looks potentially relevant, non-elite used			Not elite population
Crust et al. (2012)	Looks relevant at title but non-elite population used			Non-elite population used
Crust & Clough (2011)	Looks potentially relevant but not specific enough			Topic area not specific to criteria
Crust et al. (2011)	Looks potentially relevant ultra event	Non-elite participants used		Non-elite standard of athlete
Crust & Clough (2007)	Looks potentially relevant but population used non-elite			Non-elite standard
Crust & Azadi (2009)	Looks potentially relevant	Sports used not relevant		Sports Not specific enough to criteria
Crust & Clough (2005)	Looks potentially relevant in title but not after abstract			Topic Not relevant
Cutton & Hearon (2013)	Looks potentially relevant but not relevant to inclusion criteria			Topic Not Relevant
Davis et al. (2007)	Potentially relevant	Types of sports some relevant		Unable to separate out the results for types of sports.

Author/Year	Primary screening (Title and abstract)	Secondary screening of Article (method/results section)	Tertiary screening (full article)	Reason for exclusion
De Petrillo (2009)	Title looks potentially relevant but abstract states standard non-elite			Non-elite population used
Dewhurst et al. (2012)	Looks potentially relevant	Population used non-elite		Non-elite population
Dolan et al. (2011)	Looks potentially relevant Triathlon Sprint Olympic	Standard is unclear and cannot be separated out		Standard cannot be confirmed.
Donohoe et al. (2002)	Looks potentially relevant but X-country N Div1 unclear also distance			Competition standard not clear as to whether sub-elite
Dreidiger et al. (2006)	Potential relevance	Types of sports used not relevant		Types of sport not endurance relevant
Drozdovski et al. (2012)	Looks potentially relevant	Still potentially relevant	Email sent to clarify if results for biathlon can be separated out	No reply – cannot separate sports
Dyer & McKune (2013)	Looks potentially relevant	Standard non-elite		Non-elite Cyclists
Egloff & Gruhn (1996)	Looks potentially relevant but not exactly fitting criteria	Standard non-elite		Topic area and standard
Eichenberger et al. (2012)	Looks potentially relevant but topic area not PBS based			Topic area
Esteve-Laneo et al. (2014)	Looks potentially relevant but not PBS-based			Topic area doesn't' meet inclusion criteria No Psych
Evans et al. (2013)	Looks potentially relevant	Uses mix of regional and national standard – not separated		Regional/ national (not elite) sub-elite
Farkas (1989)	Looks potentially relevant	Non-elite		Competitive standard

Author/Year	Primary screening (Title and abstract)	Secondary screening of Article (method/results section)	Tertiary screening (full article)	Reason for exclusion
Filby et al. (2009)	Title possible relevance abstract states football task used			Type of sports used
Fishbach & Labroo (2014)	Looks potentially relevant for one of the studies conducted	Population and study design		Both do not meet inclusion criteria
Fletcher & Hanton (2001)	Looks potentially relevant uses non-elite population			Non-elite population
Freund et al. (2013)	Looks potentially relevant Include as unique event? Psych determinant relating to coping Pain tolerance + personality	No entry requirement for the event open to on-elites. Standard not clear		no entry requirement to enter the event i.e. non-elite
Gallman et al. (2013)	Looks potential for sport but topic area not PBS related			Topic area
Gan et al. (2009)	Possible relevant	Types of sports covered do not include endurance		Types of sport do not meet inclusion criteria
Gaudreau et al. (2005)	Looks potentially relevant	Mixed standard and not separated out		Mixed standard and not separated out
Gaudreau & Blondin (2004)	Looks potentially relevant	Still potential	(email sent to clarify if sports can be separated out) no reply	Individuals not specified for sport – email confirms cannot separate
Gaudreau & Blondin (2002)	Looks potentially relevant	Sports cannot be separated out		Sports not specified
Gianoli et al. (2012)	Looks potentially relevant – uses recreational triathletes			Comp Standard
Gordon & Gucciardi (2011)	Looks interesting but not specifically relevant			Not relevant - topic
Gould & Maynard (2009)	Looks potentially interesting but is a review			A review

Author/Year	Primary screening (Title and abstract)	Secondary screening of Article (method/results section)	Tertiary screening (full article)	Reason for exclusion
Grand'Maison (2004)	Looks interesting & potentially relevant but is master research paper			Masters research survey
Gravel et al. (1980)	Looks potentially relevant	Population non-elite		Competition standard non-elite
Grealy et al. (2012)	Looks potentially relevant but physiology based			Physiology only
Gucciardi (2012)	Looks potentially relevant but not specific enough			Lack of specificity of topic
Hamilton et al. (2013)	Looks potentially relevant	Population		Population used
Hamilton et al. (2007)	Looks potentially relevant	Non-elite population used		Non-elite population used
Hammermeister & Burton (2004)	Looks potentially relevant	Variety of standard used but cannot be separated out in results		Standard - pro-Mid-Age cannot be separated out in results
Hammermeister & Burton (2001)	Looks potentially relevant Tri/ Running/ Cycling CSAI-2 Anxiety Lazarus Stress Model	Standard separated?		Standard - pro-Mid-Age cannot be separated out in results
Hammermeister & Burton (1995)	Looks potentially relevant	No definition of elite; mix endurance Athletes Age, gender, demographics Elite/ pro AG's		Contaminated age group tri run cycle entry level
Hamstra-Wright et al. (2013)	Looks potentially relevant	Sample used non-elite		No Standard
Hanton et al. (2008)	Possible relevance as coping and elite	Unable to separate out the types of sports for endurance relevance		Types of sports used
Hardcastle et al. (2014)	Looks potentially relevant – age cat low and sports used			Age Cat and sports used

Author/Year	Primary screening (Title and abstract)	Secondary screening of Article (method/results section)	Tertiary screening (full article)	Reason for exclusion
Harmison (2006)	Looks potentially relevant	Types of sports needs to be explicit for endurance		Sports classification
Harung et al. (2011)	Looks potentially relevant	Looks relevant still	Sports cannot be separated out for standard	Sport classification
Hausswirth & Brisswalter (2008)	Title looks relevant but is a Review article when reading abstract			Review article
Heazlewood & Burke (2011)	Looks potentially relevant	Minimal demographics available		Study design: Minimal demographics
Hill et al. (2011)	Looks potentially relevant – muscle endurance task			Study design
Hodges et al. (2004)	Looks potentially relevant but not relevant to topic area aim			Topic area
Hoffman (2014)	Looks potentially relevant but no PBS element			Topic area
Holt et al. (2014)	Looks potentially relevant	Non-elite population		Comp standard
Hooper et al. (1997)	Title/abstract potentially relevant; distances need clarifying for energy system criteria.	Swim Distances are not predominantly aerobic		Energy system classification - Does not explicitly meet predominantly aerobic criteria
Horsburgh et al. (2008)	Looks potentially interesting but physiology based and not explicitly relevant			Topic area and non-elite standard
Hughes et al. (2003)	Looks potentially relevant	Entry requirement needs to be confirmed and comp std.	emailed 18/5/15 but no reply	No standard clarified
Hutchinson & Tenenbaum (2007)	Muscle endurance task & population is non-elite			Task & Non-elite population used

Author/Year	Primary screening (Title and abstract)	Secondary screening of Article (method/results section)	Tertiary screening (full article)	Reason for exclusion
Jaeschke & Sachs (2012)	Looks potentially relevant but is not peer-reviewed			Non-peer reviewed
Jampen et al. (2013)	Looks potentially relevant but just looks at times of performance. Non-elite population used			No standard and topic relevance
Johnson et al. (2016)	Event unofficial structure	Ex-elite	Self-organized event	Classification: Dos not meet criteria
Johnson et al. (2013)	Title not relevant topic			Topic area
Johnson et al. (2012)	Looks potentially relevant	Population		Non-elite population used
Jones (2014)	Looks potentially relevant not specific enough			Topic area broadness
Kalin et al. (2012)	Looks potentially relevant on pacing but too physiology based			Topic area
Kaufman et al. (2009)	Looks potentially relevant at title but abstract states irrelevant sports used			Sports used
Kerr & Mackenzie (2012)	Looks purely at motives – not relevant to topic aim			Topic area
Khodayari et al. (2011)	Looks potentially relevant	Competitive level non-elite		No standard
Kingston et al. (2010)	Looks potentially relevant	Cannot separate out sports in results despite all elite		Non-separation of sports results for end sports
Knechtle et al. (2007)	Physiology based only			Topic area

Author/Year	Primary screening (Title and abstract)	Secondary screening of Article (method/results section)	Tertiary screening (full article)	Reason for exclusion
Konings et al. (2015)	Title sounds relevant but on abstract it is a review			A review
Kovarova & Kovar (2009)	Looks potentially relevant but standard non-elite			Comp standard/also not peer reviewed
Krouse et al. (2011)	Looks potentially interesting but motivation based only and standard unclear	Non-elite population used		Comp standard & topic area
Laasch (1994-95)	Title sounds relevant but then realize it is a review type of paper			Review paper
LaCaille et al. (2011)	Title abstract looked potentially relevant,	Method revealed recreational athletes used		Non-elite population used
LaChausse (2006)	Motivation based / standard unclear	Non-elite population		Comp standard & topic area
Lafferty & Dorrell (1999)	Looks relevant at first but Population too young			< 16 yr. population used
Lane & Wilson (2013)	Looks potentially relevant	Population		Non-elite population used
Lane & Wilson (2011)	Looks potentially relevant	Population used		Non-elite population used
Lane et al. (2004)	Looks relevant but is a review			A review
Lastella et al. (2014)	Looks potentially relevant but not directly related to PBS			Topic area
Laursen (2011)	Looks potentially relevant but is a review			Review paper

Author/Year	Primary screening (Title and abstract)	Secondary screening of Article (method/results section)	Tertiary screening (full article)	Reason for exclusion
Leivert (1999)	Looks potentially relevant	Still potentially relevant	Email sent for exact competition standard	No reply – standard not confirmed
Lepers et al. (2012)	Looks potentially relevant but not PBS based			Topic area
Lerner & Locke (1995)	Looks relevant from title but abstract states a Sit up endurance test is used			Study design - task
Levy (2002)	Topic area not relevant			Topic area
Linderman et al. (2003)	Looks potentially relevant but non-elite population used			Comp standard
Lindsay et al. (2005)	Looks potentially relevant	Still looks potentially relevant	Emailed for sub-elite standard confirmation 22/7/15. Regional level confirmed	Non-elite population
Lisspers et al. (2011)	Looks relevant	Still looks relevant	Email sent to find out exact number and standard for 10-week shoot program	No reply – standard and population number not confirmed
London et al. (1968)	Title/abstract possibly relevant	Population and task set		Study design and non-elite population used
Lowes (2007)	Not peer-reviewed article			Not peer-reviewed article
Lundqvist et al. (2011)	Looks potentially relevant	Still looks potentially relevant	Emailed 24/7/15 to gain confirmation of separating out results for different ports.	Cannot separate out results
Macmahon et al. (2014)	Looks potentially relevant but non-elite population used			Competition standard
Malinauskas et al. (2014)	Looks potentially relevant but topic area not specific to review			Topic area

Author/Year	Primary screening (Title and abstract)	Secondary screening of Article (method/results section)	Tertiary screening (full article)	Reason for exclusion
Mallet & Hanrahan (2002)	Looks potentially interesting but purely on motivation			Topic area
Martha & Laurendeau (2010)	Possible relevance	Triathletes used and separated out in results however standard is club/regional	Email sent to check exact standard	Non elite population as sample
Mattie & Munroe-Chandler (2014)	Looks potentially relevant but not specific enough			No standard
Maynard et al. (2005)	Looks relevant	Looks relevant	Email sent for comp standard	Comp standard: regional
Micklewright et al. (2009)	Looks potentially relevant but standard unclear			No standard
Miller & Donohoe (2003)	Potentially relevant; population is high school standard			Comp standard
Morgan et al. (1983)	Potentially relevant	US army used		Non-elite population used
Muehlbauher et al. (2010)	Potential from title but from abstract it is more physiology based for pacing			Topic area
Myburgh (2003)	Looks potentially relevant but physiology based mainly			Topic area
Neil et al. (2011)	Looks potentially relevant	Sports results cannot be separated out.		Study design
Neumayr et al. (2004)	Looks potentially interesting but physiology based			Topic area

Author/Year	Primary screening (Title and abstract)	Secondary screening of Article (method/results section)	Tertiary screening (full article)	Reason for exclusion
Newland & Kellett (2012)	Topic area not relevant			Topic area
Nibbeling et al. (2012)	Task not relevant Population used non-elite			Study design and sample population used
Nicholls et al. (2011)	Looks potentially relevant but topic too broad for population and sports			Study design and population used
Nicholls et al. (2008)	Looks potentially relevant but too broad in sports and ability			Study design and population used
Nicolas et al. (2011)	Looks potentially relevant	Population group used		Non-elite population used
Nicolas & Jebrane (2009)	Looks potentially relevant	Distances for sports and separation of each one - query for energy system predominantly used	Emailed and distance can't be separated	Energy system and sport distinction possible/ age of juniors
Nietfeld et al. (2003)	Title relevant but abstract states standard not			Competition standard
Nieuwenhuys et al. (2011)	Looks potentially relevant	Different sports cannot be separated out		Study design can't separate put sports
Nieuwenhuys et al. (2008)	Looks interesting but not sport required			Sport classification
Oktedalen et al. (2001)	Looks potentially interesting but standard non-elite and doesn't fit the topic area			No standard
Orlick & Partington (1988)	Looks potentially relevant but quite broad for topic area	Only 1 rower in there and not potentially relevant to include		Study design: Does not meet overall criteria
Parry et al. (2011)	Looks relevant	Non-elite population		Population standard does not meet inclusion criteria.

Author/Year	Primary screening (Title and abstract)	Secondary screening of Article (method/results section)	Tertiary screening (full article)	Reason for exclusion
Patrick & Hrycaiko (1998)	Looks potentially relevant	Results cannot be separated out for the athletes in standard		Competition standard not separated out
Pauline (2013)	Topic not relevant			No standard
Pensgaard & Roberts (2000)	Looks potentially relevant	Cannot separate out the sports for results		Study design – can't separate out sports
Raglin (2007)	Looks potentially relevant			No standard
Rauter & Topic (2011)	Topic not relevant and standard is non-elite			Topic and comp standard
Razon et al. (2009)	Title possibly relevant. Abstract shows population and muscle endurance task not relevant			Population and study design used
Ritz (2012)	Relevant title but Not peer-reviewed			Non- peer-reviewed
Robazza et al. (2004)	Title sounds relevant but abstract states sports which are not relevant.			Topic area
Robinson et al. (2014)	Standard is novice			Comp standard
Ronkainen et al. (2013)	Interesting but not relevant topic area			Topic area
Rundio et al. (2014)	Title seemed potentially relevant due to word endurance but not at all relevant topic on closer inspection of abstract			Topic area
Rust et al. (2012)	Topic not relevant – European domination of double iron tri			Topic

Author/Year	Primary screening (Title and abstract)	Secondary screening of Article (method/results section)	Tertiary screening (full article)	Reason for exclusion
Rust et al. (2012)	Topic not relevant – peak age related perf tri			Topic
Saintsing et al. (1988)	Title/abstract sounds relevant	Population is non-elite		Comp standard
Salminen et al. (1995)	Looks relevant, standard not clear and which distances	Non-elite, distances cannot be separated out		Comp standard
Samson (2014)	Looks potentially relevant but standard is collegiate			Comp standard
Saw et al. (2015)	Looks relevant	Elite /sub-elite used but different individual/team sports included	Email sent to check if it was possible to separate out the sports	Results cannot be separated out for specific endurance sports despite all similar themes confirmed.
Schnell et al. (2013)	Looks potentially relevant, age falls out of inclusion criteria	Sports cannot be separated out		Age and sports not separated out for results
Schomer (1986)	Looks potentially relevant	Sports cannot be separated out for standard		Comp standard
Schuker et al. (2014)	Looks potentially relevant	Standard is non-elite	Email sent to check exact standard	Non-elite standard
Schuker et al. (2009)	Looks potentially relevant, non-elite population used			Non-elite standard
Schuler et al. (2014)	Looks potentially relevant but only based on motivation	Sports not included for criteria, standard is non-elite		No standard
Schuler & Brunner (2009)	Looks potentially relevant	Standard non-elite		Comp standard
Seppanen & Jauho (unknown)	Uses military police for sample			Population used & Study design

Author/Year	Primary screening (Title and abstract)	Secondary screening of Article (method/results section)	Tertiary screening (full article)	Reason for exclusion
Sharp & Hodge (2013)	Looks potentially relevant but sports not specific enough			Sports used
Sheard & Golby (2011)	Potential relevance	Sports cannot be separated out for relevance		Cannot separate out sports
Sheard & Golby (2010)	Possible relevance	Mix of elite/sub-elite and endurance sports included potentially		Unable to separate out exactly the results for the endurance athletes
Sheard & Golby (2006)	Look relevant	Sub elite juniors		Age of population does not meet criteria
Shoak et al. (2013)	Not relevant enough in topic			Topic
Shucker et al. (2014)	Not peer reviewed standard query			Not peer reviewed
Smith et al. (2014)	Looks relevant at title/abstract	Non-elite population		Non-elite population used
Spink (1988)	Muscle endurance task, standard used non-elite			Study design and non-elite standard
Stambulova et al. (2012)	Irrelevant sports in abstract			Sport classification
Stanley et al. (2007)	Title sounds potentially relevant. Abstract suggests the group will be recreational	Method section confirms the non-elite sample used		Comp standard
Stanley et al. (2014)	Looks relevant	Population used		Non-elite population used
Stanley et al. (2012)	Looks potentially relevant at title but standard unclear	Sample includes a range of standard but cannot be separated out in the results.		No separation: Some Elite/sub-elite population reported but no results specifically for them.

Author/Year	Primary screening (Title and abstract)	Secondary screening of Article (method/results section)	Tertiary screening (full article)	Reason for exclusion
Stanula et al. (2013)	Title looks like physiology based & abstract confirms this			Topic area
Stewart et al. (2011)	Not relevant topic			Topic area
Stoate et al. (2012)	Looks potentially relevant at title and abstract but unclear on standard	Method confirms that they are club level sample Population		Non-elite population used
Stoeber & Crombie (2010)	Non-elite population used			Population sample non-elite
Stoeber et al. (2009)	Sounds potentially relevant	Standard not clear		Non elite population as sample
Stoeber et al. (2008)	High school and university students used for sample			Non-elite standard
Summers et al. (1983)	Looks potentially relevant but looks based on motivation	Standard non-elite		No standard
Sun & Wu (2011)	Looks potentially relevant	Sports not clear for which ones are covered.	Email sent but no reply.	No reply to email to clarify which Sports
Szabo et al. (2013)	Not relevant			No relevant topic
Szalma (2009)	Looks potentially relevant	University students non-elite		Non-elite comp standard
Tamminen et al. (2012)	Looks potentially relevant	Not relevant		Topic area/study design
Taylor (1979)	Not really relevant - & uses isometric grip			Study design

Author/Year	Primary screening (Title and abstract)	Secondary screening of Article (method/results section)	Tertiary screening (full article)	Reason for exclusion
Tenenbaum & Connolly (2008)	Title looks relevant abstract reveals non-elite population used – high school level			Non-elite population used
Tenenbaum et al. (2004)	Looks potentially relevant	Non-elite group used		Comp standard
Thelwell & Greenlees (2003)	Gymnasium triathlon used and non-elite population used			Study design and non-elite population
Thiel et al. (2012)	Not relevant			Topic
Thiese & Huddleston (1999)	Looks potentially relevant but collegiate population used			Non-elite standard
Vaeyens et al. (2008)	Not relevant			No standard
Vallerand et al. (2007)	Not at all relevant in abstract – basketball and comp standard			Sport used & comp standard
Wagstaff (2014)	Looks potentially relevant	Used club and sub-elite athletes; can't be separated out for results		No standard
Wagstaff et al. (2013)	Not relevant			No standard
Weinberg et al. (2012)	Population group used not relevant			Non-elite population used
Weinberg et al. (1990)	Sit-up endurance test used			Study design
Westaway (2013)	Looks interesting but not relevant			No standard

Author/Year	Primary screening (Title and abstract)	Secondary screening of Article (method/results section)	Tertiary screening (full article)	Reason for exclusion
Whelan et al. (1991)	It's a review			Review
Williams et al. (2013)	Not specific enough			Population/sport used
Woodcock et al. (2011)	Looks relevant but non-elite standard XC-runner (university)			No standard
Woodman & Hardy (2011)	Meta-analysis review			Review
Woodman et al. (2010)	Looks potentially interesting but non-elite standard used			No standard
Wu et al. (2014)	Standard unclear and not really psych related			Non-elite standard/study design
Zingg et al. (2015)	Not relevant topic area			Topic

References for a Sample of Full Text Articles That Were Excluded

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Baker, J., Deakin, J., & Cote, J. (2005a). On the utility of deliberate practice: Predicting performance in ultra-endurance triathletes from training indices. *International Journal of Sport Psychology*, *36*, 225-240.

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Appendix 3. Summary of Themes, Sub-Themes and Sports (1)

Author/Year	Open Coded Factors/Data	Sub-Themes	Themes	Sport
1 Baker et al. (2005)	Attentional Control Greater Cognitive Thoughts	Psychological Skills & Strategies	Mastery	Ultra-Triathlon
2 Barnett et al. (2012)	Self-Efficacy Fatigue/Wellbeing	Psychological, Psychosocial and Other Factors That Require Monitoring	Mind-body dualism	Triathlon
3 Bergland & Safstrom (1994)	Mood Changes	Psychological, Psychosocial and Other Factors That Require Monitoring	Mind-body dualism	Canoeing
4 Bouget et al. (2006)	Stress-Recovery	Psychological, Psychosocial and Other Factors That Require Monitoring	Mind-body dualism	Cycling
5 Brick et al. (2015)	Attentional Focus, Self-Regulation Strategies, Being Proactive.	Psychological Skills & Strategies Psychological, Psychosocial and Other Factors That Require Monitoring	Mind-body dualism Mastery	Running
6. Comotto et al. (2015)	Mood Changes	Psychological, Psychosocial and Other Factors That Require Monitoring	Mind-body dualism	Triathlon
7. Coutts et al. (2006)	Stress-Recovery	Psychological, Psychosocial and Other Factors That Require Monitoring	Mind-body dualism	Triathlon

Summary of Themes, Sub-Themes and Sports (2)

Author/ Year	Open Coded Factors/Data	Sub-Themes	Themes	Sports
8. Dunn & Dishman (2005)	Anxiety, Self-Confidence	Psychological, Psychosocial and Other Factors That Require Monitoring	Mind-body dualism	UE-Cycling
9. Eccles et al. (2002)	Cognition, Anticipation, Decision-Making, Visualisation	Psychological Skills & Strategies; Psychological, Psychosocial and Other Factors That Require Monitoring	Mastery	Orienteering
10. Eccles (2006)	Decision-Making, Deliberate Practice, Anticipation	Psychological Skills & Strategies; Psychological, Psychosocial and Other Factors That Require Monitoring	Mastery	Orienteering
11. Eccles et al. (2009)	Decision-Making, Deliberate Practice	Psychological Skills & Strategies; Psychological, Psychosocial and Other Factors That Require Monitoring	Mastery	Orienteering
12. Filhaire et al. (2004)	Mood Changes	Psychological, Psychosocial and Other Factors That Require Monitoring	Mind-body dualism	Cycling
13. Filho et al. (2013)	Stress-Recovery	Psychological, Psychosocial and Other Factors That Require Monitoring	Mind-body dualism	UE-Cycling
14. Geva & Defrin (2015)	Perceived Pain Thresholds/Intensity/Tolerance / Less Fear	Pain management; Management of Perceptions	Mind-body dualism	Triathlon/UE-triathlon

Summary of Themes, Sub-Themes and Sports (3)

Author/Year	Open Coded Factors/Data	Sub-Themes	Themes	Sport
15. Groslambert et al. (2013)	Imagery, Autogenic Training	Psychological Skills & Strategies	Mastery	Biathlon
16. Gustafsson et al. (2007)	Burnout, Pressure, Stress, Motivation, Control, Wellbeing, Identity	Psychological, Psychosocial and Other Factors That Require Monitoring; Management of Perceptions	Mind-Body Dualism Mastery	Cross-Country Skiing
17. Gustafsson et al. (2008)	Mood Changes Multi-Disciplinary	Psychological, Psychosocial and Other Factors That Require Monitoring	Mind-Body Dualism	Cross-Country Skiing, Ski Orienteer, Orienteer
18. Hurdiel et al. (2015)	Decision-Making, Cognitive Function	Psychological, Psychosocial and Other Factors That Require Monitoring	Mind-Body Dualism Mastery	Ultra-Trail Running
19. Kellman et al. (2001)	Mood Changes Stress-Recovery	Psychological, Psychosocial and Other Factors That Require Monitoring	Mind-Body Dualism	Rowing
20 Kress & Statler (2007)	Pain Perception, Self-Talk, Goal-Setting, Imagery	Pain Management; Psychological Skills & Strategies	Mastery Mind-Body Dualism	Cycling
21. Laaksonen et al. (2011)	Relaxation	Psychological Skills & Strategies; Psychological, Psychosocial and Other Factors That Require Monitoring	Mastery Mind-Body Dualism	Biathlon

Summary of Themes, Sub-Themes and Sports (4)

Author/Year	Open Coded Factors/Data	Sub-Themes	Themes	Sport
22. Lundqvist & Sandin (2014)	Wellbeing, Coach-Athlete Relations	Psychological, Psychosocial and Other Factors That Require Monitoring; Management of Perceptions	Mind-Body Dualism	Orienteering
23. Macquet et al. (2012)	Decision-Making, Pacing, Anticipation	Psychological Skills & Strategies	Mastery Mind-Body Dualism	Orienteering
24. Morgan & Pollock (1977)	Association & Dissociation, Trait Anxiety	Psychological Skills & Strategies; Psychological, Psychosocial and Other Factors That Require Monitoring	Mastery Mind-Body Dualism	Running
25. Morgan et al. (1987)	Association & Dissociation, Mood, Decision-Making, Motivation, Arousal	Psychological, Psychosocial and Other Factors That Require Monitoring; Psychological Skills & Strategies	Mind-Body Dualism Mastery	Running
26. Phillipe & Seiler (2005)	Association & Dissociation	Psychological Skills & Strategies	Mastery	Running, Cycling, Swimming
27. Purge et al. (2006)	Stress-Recovery	Psychological, Psychosocial and Other Factors That Require Monitoring	Mind-Body Dualism	Rowing
28. Renfree & St Clair Gibson (2013)	Pacing, Decision-Making	Psychological Skills & Strategies	Mind-Body Dualism Mastery	Running

Summary of Themes, Sub-Themes and Sports (5)

Author/Year	Open Coded Factors/ Data	Sub-Themes	Themes	Sport
29. Ruiz-Tendero & Salinero (2012)	Positive/Negative Perceptions, Motivation, Effort, Resources, Dedication, Support	Psychological, Psychosocial and Other Factors That Require Monitoring; Management of Perceptions	Mind-Body Dualism	Triathlon
30. Rushall et al. (1988)	Thought Control, Self-Talk, Task-Relevant Information	Psychological Skills & Strategies	Mastery	Cross-Country Skiing
31. Schneider et al. (2007)	Visualisation, Relaxation, Motivation, Self-Talk, Risk	Psychological Skills & Strategies; Psychological, Psychosocial and Other Factors That Require Monitoring; Management of Perceptions	Mastery Mind-Body Dualism	Adventure Racing
32. Silva & Appelbaum (1989)	Association & Dissociation, Self-Talk	Psychological Skills & Strategies; Pain Management	Mastery	Running
33. Simpson et al. (2007)	Confidence, Goal-Setting, Attentional Control, Pacing, Imagery	Psychological Skills & Strategies Psychological, Psychosocial and Other Factors That Require Monitoring	Mastery Mind-Body Dualism	UE Running
34. Skorski et al. (2014)	Stress-Recovery, Pacing, Decision-Making	Psychological, Psychosocial and Other Factors That Require Monitoring; Psychological Skills & Strategies	Mind-Body Dualism Mastery	Cycling

Summary of Themes, Sub-Themes and Sports (6)

Author/Year	Open Coded Factors/Data	Sub-Themes	Theme	Sport
35. Tammen (1996)	Association & Dissociation, Pacing	Management of Perceptions; Psychological Skills & Strategies	Mastery	Running
36. Tenenbaum et al. (2003)	Stress, Failure Adaptation, Coach-Athlete Perceptions, Support	Psychological, Psychosocial and Other Factors That Require Monitoring; Management of Perceptions	Mind-Body Dualism	Cycling
37. Terry et al. (2012)	Music, Motivation	Psychological Skills & Strategies	Mastery	Triathlon
38. Tracy (2011)	Applied Imagery, Motivation, Concentration, Anxiety Management, Motivation, Confidence, Personal Motivation Video	Psychological Skills & Strategies; Psychological, Psychosocial and Other Factors That Require Monitoring	Mastery Mind-Body Dualism	Mountain biking
39. Van Raalte et al. (2015)	Self-Talk, Association	Psychological Skills & Strategies	Mastery	Running
40. Vickers & Williams (2007)	Gaze Control, Attentional Focus, Pressure, Anxiety, Choking	Psychological Skills and Strategies; Psychological, Psychosocial and Other Factors That Require Monitoring; Management of Perceptions	Mastery Mind-Body Dualism	Biathlon