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Enhance Sport Performance of Elite Athletes: The Mindfulness-Based Interventions[1]

Optimización del Rendimiento Deportivo en los Atletas de Elite: Las Intervenciones Basadas en la Atención Plena

Otimização da Performance em Atletas de Elite: As Intervenções Baseadas no Mindfulness

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ABSTRACT

The purpose of this review is to summarize the empirical findings on the effectiveness of mindfulness-based programs to enhance elite athletes sport performance. A literature research was undertaken using Medline, Psych info, Web of Science, Cochrane, Ebscohost, Isi Web of Knowledge databases and references of retrieved articles. The search included original articles published from 1985 to March 2017. The main search terms were mindfulness programs, sport performance, elite athletes, in different combinations as needed. All articles were coded for their design, type of control, study population, and outcome measures. Search returned 26 articles, and set out 2 main mindfulness-based interventions on the field of elite sport performance. Despite methodological limitations in the research design, the results show MAC and MSPE programs as effective on enhancing elite athlete's sports performance. To confirm these preliminary results, further research, with improved experimental designs, is recommended. Findings yielded mindfulness programs as an important factor on elite sport performance.

Keywords: Mindfulness-based interventions, performance, elite athletes.

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RESUMEN

El propósito de esta revisión es resumir los resultados empíricos sobre la efectividad de los programas basados en la atención plena para mejorar el desempeño deportivo de los atletas de elite. Se realizó una investigación bibliográfica utilizando las bases de datos Medline, Psych info, Web of Science, Cochrane, Ebscohost, Isi Web of Knowledge. La búsqueda incluyó artículos originales publicados entre 1985 y Marzo de 2017. Los principales términos de búsqueda fueron programas de atención plena, rendimiento deportivo, atletas de élite, en diferentes combinaciones según sea necesario. Todos los artículos fueron codificados para su diseño, tipo de control, población de estudio y medidas de resultado. La búsqueda devolvió 26 artículos, y fijó 2 intervenciones principales basadas en la atención plena en el campo del deporte de élite. A pesar de las limitaciones metodológicas en el diseño de la investigación, los resultados muestran que los programas de MAC y MSPE son eficaces para mejorar el rendimiento deportivo de los deportistas de élite. Para confirmar estos resultados preliminares, se recomienda realizar más investigaciones, con diseños experimentales mejorados. Los resultados arrojaron programas de atención plena como un factor importante en el desempeño del deporte de élite.

Palabras clave: Intervenciones basadas en la atención plena, rendimiento deportivo, atletas de élite.

RESUMO

O objetivo desta revisão é sintetizar os resultados empíricos que retratam a eficácia dos programas baseados no *mindfulness* na optimização da performance em atletas de elite. Para a realizacão deste estudo, efetuou-se uma pesquisa bibliográfica de artigos originais publicados com fator de impacto entre 1985 e Março de 2017, recorrendo às bases de dados Medline, Psych info, Web of Science, Cochrane, Ebscohost, Isi Web of Knowledge. A pesquisa focou-se nas intervenções baseadas no *mindfulness*, performance desportiva, atletas de elite e, por último, nas diferentes combinações de conceitos. Todos os artigos foram reunidos tendo em conta o design, tipo de controlo, população, instrumentos e resultados. No total, foram selecionados 26 artigos condicentes com os critérios metodológicos do presente estudo, verificando-se maioritariamente a implementação dos programas MSPE e MAC no campo da Psicologia da performance desportiva. Apesar das limitações do presente estudo, os resultados evidenciam que os programas MAC e MSPE são eficazes na otimização do desempenho desportivo de elite. Com efeito, e para confirmar os resultados preliminares, recomenda-se investigação adicional, com desenho experimental e controlo rigoroso.

Conclui-se que, os programas baseados no *mindfulness* são um fator importante na otimização da performance em alta competição.

Palavras chave: Intervenções baseadas no *mindfulnes*s, otimização da performance, atletas de elite.

Introduction

Sports performance can be thought of as a noun or verb. As a noun, sports performance describes an isolated event where the athlete presents the development of a specific set of knowledge, skills and abilities. As a verb, sports performance describes the process of developing an action plan for the implementation of psychological and physical skills during an event. Thus, the performance means using the knowledge, skills or abilities, not just possessing them (Serpa, 2002). Sport performance is a situation of self-evaluation and of evaluation by others, regulated and influenced by emotional and cognitive factors (Hook, Valentiner, & Connelly, 2013; Howle & Eklund, 2013).

Recently, mindfulness training has gained traction as a viable alternate approach to facilitate optimal performance (De Petrillo, Kaufman, Glass, & Arnkoff, 2009; Gardner & Moore, 2004, 2006, 2007, 2012; Gross, Moore, Gardner, Wolanin, Pess, & Marks, 2016; Thompson, Kaufman, De Petrillo, Glass, & Arnkoff, 2011). Mindfulness is thought to have two distinctive facets and definitions, namely 1) the self-regulation of attention in the present-moment and 2) the openness, willingness, and awareness of experiences in the present-moment (Bishop et al., 2004; Brown & Ryan, 2003; Kabat-Zinn, 2013; Siegel et al., 2010).

Mindfulness-based interventions have been used in various forms across clinical and health practice, including Mindfulness-Based Stress Reduction – MBSR (Kabat-Zinn, 2003, 2013), Mindfulness Based Cognitive Therapy – MBCT (Segal, Williams, & Teasdale, 2002; Teasdale, Segal, & Williams, 2003), Compassion Focused Therapy (Guilbert & Irons, 2005) and Acceptance Commitment Therapy – ACT (Hayes, Strosahl, & Wilson, 1999). In athletic contexts and more recent work, the fundamentals of these models have been integrated into Mindfulness Acceptance Commitment Program – MAC (Gardner & Moore, 2007, 2012, Gross, Moore, Gardner, Wolanin, Pess, & Marks, 2016), and Mindfulness Sport Performance Enhancement - MSPE (Kaufman, Glass, & Pineau, 2018; Kaufman, Glass, & Arnkoff, 2009, Thompson, Kaufman, De Petrillo, Glass, & Arnkoff, 2011). The theory behind and mindfulness-based programs concepts, which are taught in each of these models, are relatively consistent, the difference lying mainly in application. For example, the MAC approach draws on ACT, incorporating brief meditations, while also focusing on the nonjudgmental observation of the ongoing stream of internal and external stimuli, goal-directed behavior and values. In contrast, MSPE draws on the Mindfulness Based Stress Reduction program format and relies Tightly on different meditation practices, placing emphasis on somatic awareness and Hatha Yoga.

Hence, mindfulness-based interventions differ from the traditional implementation of psychological skills training in sport psychology, with the main skills including goal setting, arousal regulation, visualization, and self-talk. Such cognitive behavioral interventions are focused primarily on intentionally controlling one's thoughts, feelings and behaviors, and not regulate them as a mindset mode of being (Galluci, 2008; Gardner &

Moore, 2004; Moore, 2009; Solé, Carraça, Serpa, & Palmi, 2014).

According to the models explaining sport performance (e.g., Birrer, Röthlin, & Morgan, 2012), there is a relationship between self-regulatory beliefs, such as self-efficacy, and mindfulness. Mindfulness is likely to prompt self-regulatory cognitions (Gardner & Moore, 2012). Crucial traits of mindfulness are nonjudgmental acceptance, openness to experiences and insight (Walach, Buchheld, Buttermuller, Kleinknecht, & Schmidt, 2006). Mindfulness contributes to both high levels of awareness and acceptance of in the moment reality (Kabat-Zinn, 1994, 2013; Kaufman et al., 2018; Solé, Carraça, Serpa, & Palmi, 2014). Aligned with the core tenant of mindfulness is the concept of acceptance, which can be conceptualized as "taking a stance of nonjudgmental awareness and actively embracing the experience of thoughts, feelings and bodily sensations as they occur" (Hayes, Strosahl, Bunting, Twohig, & Wilson, 2004). The hypothesized link between mindfulness and performance may refer to the altering perceptions of barriers and sense of control over oneself and the environment. Jon Kabat-Zinn et al. (1985) are the first on record to use mindfulness meditation training within sport. Rowers preparing for the Olympics independently practiced mindfulness training for two to seven weeks prior to the Olympic Games. Kabat-Zinn et al. (1985) reported that some of the U.S. Olympic team rowers who medaled reported the usefulness of mindfulness meditation in helping them optimize performance when racing. Sappington and Longshore (2015) in a similar review, examining mindfulness-based interventions with athletes, considers all approaches while focusing primarily on ACT. MAC and MSPE, as these were the most common methods noted in the literature. However, due to the relatively recent nature of these approaches in sport, there have also been a few studies applying a mindfulness-based intervention outside of these protocols (see Aherne Moran, & Lonsdale, 2011; Baltzell, Caraballo, Chipman, & Hayden, 2014).

The purpose of this literature review was to explore the potential benefit of mindfulness-based interventions for enhancing performance on elite athletes, and it does expand and reinforces the conclusions of Gardner and Moore (2012) and Sappington and Longshore (2015) reviews. Also, it consists an effort to more comprehensively evaluate the efficacy of mindfulness-based interventions and considers limitations in the present empirical evidence.

Methods

Utilizing a comprehensive search strategy, we conducted electronic searches of multiple electronic databases for randomized and nonrandomized control trials that evaluated mindfulness based interventions; that target populations of elite-athletes. A literature search was conducted using MEDLINE (PubMed), SAGE journals online, Psychoinfo, web of Science, Ebscohost, PsycArticles, Psychology and Behavioural Collection, Journal of Contextual Behavioral Science (JCBS) database, Redalyc, the ISI Web of Knowledge databases, the Cochrane database, and the references of retrieved articles. The

search included articles published from 1985 to March 2017. The search strategy considered only studies published in Portuguese, French, Spanish, Italian, and English languages. The main search terms were mindfulness-based interventions, self-compassion, psychological flexibility, flow, elite athletes, and sport performance, in various combinations as needed. All articles were coded for their design, type of control, study population, and outcome measures.

The development of a search strategy within a systematic review is an iterative process, essentially refining a strategy from a series of preliminary searches, which are evaluated, and discussed and/or reflected upon (Smith, 2010). To begin this review, a list of keywords was created by breaking down the research question (Smith, 2010) and trialed in a preliminary search on the databases. The returns from this search where then sampled (e.g., every 3 months from December 2013 to March 2017 we return examined and assessed for relevance), and looked for alternative keywords that were most relevant and widely used in the literature (Weed, Coren, & Fiore, 2009). Findings from this exploratory search were reviewed, and the process was repeated until the most efficient and effective search terms were identified (i.e., those returning the most relevant and specific studies). This process also identified a number of irrelevant terms, which were repeatedly returned (e.g., sporting activity and drug use; weight and flow state, mindfulness and psychosis) and were therefore noted within the search strategy as 'limiters' to be removed from the final results. The databases deemed to be most relevant (based on accessibility and relevance to the topic area). Hand searching was also conducted by drawing from the reference lists of identified studies and chapters (Smith, 2010).

Outcome measures

The primary outcome measures were: the comparison between the Cohen's *d* calculated on pre- and post-test stress values related to mindfulness based interventions on elite athletes compared to the values related to the inactive treatment; the comparison between the Cohen's d calculated on pre- and post-treatment spirituality values related to Mindfulness based programs compared to the values related to the inactive treatment (3º wave psychological interventions intended as an overall sense of connection with optimizing sport performance or as a particular attitude characterized by openness to, self-compassion, awareness and acceptance on sport present experience); and both previously reported measures performed on the comparison between Sport Mindfulness based programs and a further active traditional psychological skills training (PST).

Inclusion/Exclusion Criteria

Inclusion/exclusion criteria were employed to ensure that the boundaries of the review were clearly defined, and that the search strategy would identify all literature relevant to the three key aims of the review (Smith, 2010). The studies included in this review needed to: (i) be peer-reviewed research studies; (ii) be published in the English, Portuguese, Spanish, Italian, and French languages only; (iii) have gathered original empirical evidence; (iv) be published before 15th March 2017 (when the formal search was finished); (v) contain specific references

to mindfulness based interventions, self-compassion, psychological flexibility, sport performance, flow, in either the title or abstract; (vi) explicitly relate to elite participants, defined as those competing on the principal professional leagues/Olimpics (Jackson & Kimiecik, 2008), county level (Callow & Hardy, 2001), or national/international level (Sheard & Golby, 2010) and above, and either needed to use samples containing entirely elite participants, or a separable/discreet elite sample (e.g., comparing elite participants to non-elite); (viii) include data that was relevant and compatible with the three aims of this study (e.g., a study using elite-athletes and mentioning mindfulness based interventions, but with no relevance to the aims, could be excluded).

Search Returns

The search process was finalized on 15th March 2017, and initially returned 950 potentially relevant studies. After duplicates were removed, and the titles were assessed for relevance, this number was reduced to 188 and the abstract for each article was obtained where possible (no abstracts for empirical or includable inclusive studies were unobtainable obtainable). 94 studies where 36 were then excluded based on assessment of their abstract against the inclusion/exclusion criteria, leaving a total of 58 studies eligible for full-text retrieval. Subsequently 27 studies were excluded, often because they are literature reviews or contained non-elite samples, and 5 further studies were excluded for not presenting data that was reconcilable with the aims of the study (i.e., criteria viii). Hence 26 studies met the inclusion criteria.

Data Synthesis

Once the final 26 included studies had been identified, each was repeatedly read in full by the lead researcher in order to become familiar with, and immersed in the data in order to fully appreciate what it was saying (Maytuk & Morehouse, 1994). This was followed by a two-stage process of thematic analysis, which "comprises the identification of the main, recurrent or the most important issues or themes arising in a body of evidence. It is typically the method used for identifying, grouping and summarizing findings from included studies" (Pope, Mays, & Popay, 2007). First, deductive analysis was deployed to sort data from different studies into each of the three organizing constructs (experience, influences, and controllability). As Center for Reviews and Dissemination suggested: "once the relevant studies have been data extracted, the first step is to bring together, organize and describe their findings" (2009), for which inductive thematic analysis was used. Following this: "there is a clear attempt to explore relationships between: (a) characteristics of individual studies and their reported findings; and (b) the findings of different studies" (CRD, 2009, p. 48-53).

The data were extracted from the original reports. Variables not completely described in the text or described only in a narrative fashion were extracted and calculated from the tables reported in the articles. The quality of controlled studies was assessed using the Jadad Scale (Jadad, Moore, Carroll, Jenkinson, Reynolsds, & Mcquay, 1996). For the measures, a score >_3 is considered to be indicative of a high quality study.

A commonly used three-item, five-point quality scale was used to rate the quality of the papers design (Jadad et al., 1996). The minimum score possible for inclusion of a study in the review was 2 (one point each for randomization and double blinding). The maximum score possible was 5 (2 points for descriptions of randomization, 2 points for descriptions of double blinding, and 1 point for descriptions of withdrawals). Statistical analysis was performed on the completers' (finishers) samples, in accordance with data provided by the authors. Furthermore, when studies included in the analysis failed to report the standard deviation, it was imputed as the weighted average from other studies included in the present review that employed the same scale.

Peer debrief

This process involves the review of data and the research process by someone who is familiar with the research or the phenomenon being explored, and who provides support, plays devil's advocate, challenges the researcher's assumptions, and pushes the researcher to the next step methodologically, including questioning the methods used and the resulting interpretations (Creswell & Miller, 2000). This process took place between the lead researcher (first author) and the second, and third author, who provided guidance on the process of conducting systematic reviews, and of research on mindfulness based interventions in sport performance. Peer debrief took place throughout this study, by way of regular formal meetings and informal discussions.

Results

The results of the review are therefore presented in nine separate categories, one for each aim, and the subheadings reflect the themes discussed within the papers. Table 1 presents a summary of the participants and methods used in each study, and the relevant aim(s) to which each study pertained.

Table 1. Summary of included studies

Study	Intervention/comparison	Participants	N	Duration (Weeks/months)	Design/analysis	Measures	Findings	Jadad Scale
Gross, Moore, Gardner, Wolanin, Pess, & Marks (2016).	Mindfulness-Acceptance-Commitment (MAC) approach versus traditional Psychological Skills Training (PTS).	National Collegiate Athletic Association Division III female student athletes (basketball)	18	7 weeks (1h session week)	RCT. Pre-post design and 1month follow-up. ANOVA and Correlational analysis.	AAQ-II (Bond et al., 2011), DERS (Gratz & Roemer, 2004), MAAS (Brown, & Ryan, 2003), SPQ (Wolanin, 2005), MC-C (Reynolds, 1982), WAI-S (Tracey & Kokotovic, 1989)	MAC participants demonstrated reduced Generalised Anxiety, Eating Concerns, and Psychological Distress, as well as increased psychological flexibility from post-intervention to one-month follow-up. As per coach ratings, MAC participants also evidenced improved sport performance from pre-intervention to post-intervention.	5
Scott-Hamilton, Schutte, & Brown (2016)	Mindfulness-integrated Cognitive Behaviour Therapy Program (MiCBT).	Elite male cyclists	47	8 weeks, one mindfulness workshop a week, one hour per session, with mindful spin-bike training, and home-meditation practice.	RCT. Pre-post design. Covariance and Correlational analysis.	MAAS (Brown & Ryan, 2003), FSS-2 (Jackson & Eklund, 2004).	Results suggest that mindfulness-based interventions tailored to specific athletic pursuits can be effective in facilitating flow experiences.	5
Demarzo et al. (2015)	Mindfulness Based Stress Reduction Program (MBSR).	High performance male Brazilian athlete (Olympian runner)	1	23 weeks	Case report. Pre-post design.Correlational analysis	HRV frequency, PSS (Cohen,1994), QOLS (Burckhardt & Anderson, 2003)	The analysis of quantitative and qualitative data suggests that the athlete has shown improvements in physiological and psychological parameters.	2
Haase et al. (2015)	Mindful Performance Enhancement, Awareness and Knowledge (mPEAK).	Elite male USA BMX (Bicycle Motocross) Cycling Team	7	7 weeks. 2 modules per day, 3 h per module, over two consecutive days) with 6 weekly follow-up foundational practice sessions (90 min per session)	Pre-post design with control group. Correlational analysis.Convenience sampling	FFMQ(Haxby, 2012), MAIA (Mehling et al., 2012), TAS(Bagby et al., 1994), Visual Analog Scale and Functional MRI Inspiratory Breathing Load (IBL Task).	This pilot study suggests that mPEAK training may lead to increased attention to bodily signals and greater neural processing during the anticipation and recovery from interoceptive perturbations. This association between attention to and processing of interoceptive afferents may result in greater adaptation during stressful situations in elite athletes.	3

Salazar, & Ballesteros, (2015)	Acceptance Commitment Therapy Program (ACT).	Bogota elite rowers (males and females, with an average age of 16.70 years, and a range between 15 and 20 years old, belonging to the Bogotá Athletics League)	10	4 weeks (1h session week)	Pre-post design with control group. Correlational analysis.Convenience sampling	3000-meter test, AAQ-II (Bond et al., 2011).	The posttest results indicate a greater aerobic resistance in the 3000-meter test and a greater acceptance for negative internal events for the test group in comparison to the control group.	3
Furrer, Moen, & Firing (2015)	Mindfulness-Training Program (MTP).	Olympic Athlete Program-Junior Elite athletes from biathlon, cross-country skiing and shooting (average age of 18.50 years)	29	12 weeks, Divided into 4 continuous periods of three weeks (2-hours mindfulness class)	Qualitative analyses	Semi-structured interviews.	Qualitative analyses showed that the mindfulness intervention had a positive impact on the athletes' awareness and recovery. The authors also discuss positive effects on the athletes' focus and performances.	2
Baltzell & Akhtar (2014)	Mindfulness Meditation Training (MMTS).	Division I soccer and rowing female athletes. The women's soccer team represented the intervention group, while the women's rowing team served as the comparison for the study	42	6 weeks (session for sport (MMTS), twelve-session, 30-minute mindfulness intervention versus control group.)	Pre-post design. Correlational analysis.Convenience sampling.	PWBS (Ryff, 1995), MAAS (Brown & Ryan, 2003), PANAS (Watson, Clark, &Tellegen, 1988), SWLS (Diener, Emmons, Larson, & Griffin, 1985).	MMTS was effective in increasing mindfulness and was related to dampening reported negative emotions experienced by the intervention group compared to the control group. MMTS has preliminarily been shown to provide benefits for athletes including factors related to enhanced performance.	3
Bernier,Thienot, Pelosse, Emilie, & Fournier (2014)	Mindfulness training inspired in Mindfulness-Based Stress Reduction (MBSR).	Elite Figure Skaters	2	8 weeks. 9 sessions, and daily meditation work with a CD record.	Pre-post design. Correlational analysis.Convenience sampling and qualitative analysis.	MAAS (Brown & Ryan, 2003), and qualitative interviews.	The two case studies presented demonstrate how the young skaters developed their mindfulness skills and how these skills benefited their performance.	2

Goodman, Kashdan, Mallard, & Schuman (2014).	Brief mindfulness-based intervention (MBSR).	Participants were 26 athletes (*M* age _ 20.23, *SD* _ 1.53). For the experimental group, an entire NCAA Division I male Varsity team (13 athletes) participated in the intervention (*M* age _ 20.08, *SD* _ 1.26). Eleven (84.6%) of the participants were African American, 1 (7.7%) participant was Caucasian, and 1(7.7%) participant identified as other.	26	5 weeks. Eight 90-min group intervention immediately followed by 1-hr Hatha yoga sessions.	Pre-post design. Correlational analysis. Nonrandomized control group	MAAS (Brown & Ryan, 2003), TNASS (Bernstein & Brantz, 2012), AAQ-II (Bond et al., 2011), AHS (Snyder et al., 1991), PSS (Cohen, Kamarck, & Mermelstein, 1983), VLQ (Wilson et al., 2011), GRIT-S (Duck-Worth & Quinn, 2009), DDS (Forman et al., 2012), DASS-21 (Henry & Crawford, 2005), and written feedback- two free-response questions.	Participants reported greater mindfulness, greater goal-directed energy, and less perceived stress than before the intervention. Several players indicated that the intervention could be improved by including more active, experiential exercises. This study has limitations, including a lack of randomization and differences in recruitment.	3
Awamleh, Mansi, & Ermeley (2014).	Mental training skills program on self-compassion and mindfulness. Intervention group received 60-minute exercise classes three times per week.	Female gymnastics from the University of Jordan, their ages (M = 19.2 years, and SD = 0.71)	32	12 weeks	Pre-post design. Correlational analysis.	SCS (Neff, 2003), FFMQ (Baer et al., 2006)	Findings indicated that female students who used mental training program in connection with their gymnastics practice reported significant increases in self-compassion and mindfulness.	4

Mosewich, Crocker, Kowalski, & DeLongis (2013).	Self-compassion intervention consisted of a psycho- education sessions and writing components completed over a 7-day period.	women athletes who self-identified as being self-critical were randomly assigned to a self-compassion intervention (*n* = 31) or attention control group (*n* = 29). Thirty-one athletes in the intervention group and 26 athletes in the attention control group showed up for the intervention and started the study. Of these, 29 athletes (*M*age = 20.28, *SD*age = 2.25) in the self-compassion intervention (experimental) group and 22 athletes (*M*age = 20.27, *SD*age = 1.08) in the attention control group completed all three phases of the study.	51	5 week.	RCT. Pre-post design. Correlational analysis.	SCS (Neff, 2003[a]), Sport-MPS-2 (Gotwals & Dunn, 2009)	The findings demonstrate the effectiveness of the self-compassion intervention in managing self-criticism, rumination, and concern over mistakes. Fostering a self-compassionate frame of mind is a potential coping resource for women athletes dealing with negative events in sport.	4
Moghadam, Sayadi, Samimifar, & Moharer (2013).	Mindfulness training on competitive anxiety.	Professional Badminton players (male Premier League).	40	4 weeks	RCT.	MAAS (Brown & Ryan, 2003), CSAI (Martnz et al.,1990),	Findings suggest that the wide pried awareness training techniques, variable rates-the process of change was found a significant increase (12/16 = F; 001/0> p).	4

Ruiz & Luciano (2012).	Brief ACT protocol- 4-hr intervention based on acceptance and commitment therapy (ACT) during 7-months versus a no-contact control condition in improving the performance of international-level chess players.	International title chess players. Three participants were Latin Americans, and the remaining two were Spaniards; all of them were men who ranged from 23 to50 years of age. All the participants were top-ranked players in their respective countries.	10	7 months	Pre-post design. Correlational analysis.	(Elo, 1978), AAQ-II (Bond et al., 2011), CCRQ (Ruiz & Luciano, 2009), Private events `interference and believability rating.	Results show that a brief 4-hr ACT intervention can be sufficient for reducing counterproductive reactions during chess competitions and for improving performance. That brief acceptance-based interventions could be useful for improving human performance when experiential avoidance, in a context of cognitive fusion, is present during performance.	3
Jonh, Verma, & Khanna (2011)	Mindfulness Meditation therapy (MMT).	Healthy male elite level shooters with mean age of (29.5±4.3years).	96	4 weeks	RCT.Pre-post design. Descriptive statistics.	Salivary Cortisol (SC), a reliable physiological marker of HPA-axis.	Results indicated that relaxation therapies such as MMT may decrease PCS and will enhance PS.	5
Aherne, Moran, & Lonsdale (2011).	Mindfulness training inspired in Mindfulness-Based Stress Reduction (MBSR). 6 sessions, and daily meditation work with a CD record.	University elite athletes, average experience of 8,69 years. Participants of different sports (ex: swimming, basketball). Experimental group: 6 (33,3% woman's, M= 21 years) Control group: 7 (28,5% woman's, M= 21 years)	13	6 weeks	RCT. Pre-post design.Correlational analysis.	CAMS-R (Feldman, Hayes, Kumar, Greeson, & Laurenceau, 2007), FSS-2 (Jackson & Eklund, 2004).	Flow: significant increase ($p<0.05$) in the experimental group (CAMS-R y FSS-2).The increase in FSS-2 global scores from Time 1 to Time 2 was large ($p<0.01$) for the experimental group and non significant ($p>0.05$) for the control group. Additional research is needed to investigate the cognitive benefits of mindfulness training and its potential to increase sport performance	3

Thompson, Kaufman, De Petrillo, Glass, & Arnkoff (2011)	Evaluate the long-term effects of mindful sport performance enhancement (MSPE), a program designed to improve athletic performance and psychological aspects of sport. * See De Petrillo et al, 2009 and Kaufman et al, 2009	Follow-up sport participants, 14 were men and 11 were women, ranging in age from 18 to 72 years (M = 48.28 years). Twenty-three athletes were Caucasian, one was African-American, and one was Asian/Pacific Islander.	52	4 weeks (1 session per week, 3 hours per session).	Quasi-Experimental. Pre-post design. Correlational analysis.	AQ (Kaufman et al, 2009), GQ (Kaufman et al, 2009), RQ (De Petrillo et al., 2009), CEM (Kaufman et al., 2009), FQ (De Petrillo et al., 2009), FQ-R (De Petrillo et al., 2009), KIMS (Baer, Smith, & Allen, 2004), TOQS (Hatzigeorgiadis & Biddle, 2000), SAS (Smith, Smoll, & Schutz, 1990), CSCI (Manzo, Silva, & Mink, 2001), DFS-2 (Jackson & Eklund, 2002), MPS (Frost, Marten, Lahart, & Rosenblate, 1990)	Performance: athletes' scores were significantly lower during the year after the workshop: p=0.041 in golfers and p=0.038 in long-distance runners. In a Likert scale from 0-5 asking about the performance's change during the last year, the mean result was 3,62 and most of them (3 in the Likert scale) said that the changes could be attributed to the MSPE workshop. Psychological skills: significant increase (p=0.034) in flow levels (DFS-2), Mindfulness levels (p<0.01) measured with KIMS and significant decrease (p<0.05) of anxiety (SAS).	4
Mahoney & Hanrahan (2011).	A brief educational intervention using acceptance and commitment therapy (ACT) approach.. Intervention include: cognitive defusion, mindfulness, acceptance, and values. The sessions were standardized so each participant was exposed to the same material.	Elite injured soccer, sailing, and squash athletes (2 males, 2 females; age 18–49 years) during ACL rehabilitation.	4	4 weeks (weekly one-on-one sessions with a trained therapist)	Case studies. Pre-post-design. Correlational analysis.	AAQ-II (Bond et al.,2010), MAAS (Brown, & Ryan, 2003), SIAS (Brown & Ryan, 2003).	Main findings showed that an adapted ACT approach on athletes could be useful on at least a basic level to help injured athletes accept private events, commit to rehabilitation behaviours.	2
Jonh, Verma, & Khanna (2010)	Mindfulness Meditation therapy (MMT) and Music Therapy.	Healthy male elite level shooters with mean age of (29.5±4.3years).	100	5 weeks	RCT.Pre-post design and follow-up. Descriptive statistics.	Body Mass Index (BMI), Heart Rate (HR), Respiratory Rate (RR), Blood Pressure Diastolic (BPD), Blood Pressure Systolic (BPS)	Results indicated that relaxation therapies have an effect on HPA-Axis by decreasing the level of SC as a reliable physiological marker of PCS.	5

Bertollo, Saltarelli, & Robazza (2009)	Mindfulness Acceptance and Commitment (MAC) aapplied exercises-preparation strategies and coping responses across pre-, during, and post-competition periods.	Pentathlon elite athletes, six women and eight men, ranged in age from 21 to 33 years (M= 27.43, SD=3.08).	14	8 weeks (1 session per week, 45 minutes per sesión. Exercises to do between sessions)	Pre-pos design. Correlational analysis, and qualitative analysis.	Qualitative interviews using an in-depth, open-ended, and semi-structured approach. The qualitative data were then hierarchically content analyzed.	The MAC emphasises mindful (non-judgmental) present-moment awareness, contingencies required for optimal performance, and prevent efforts at internal self-control, a task-irrelevant focus of attention, and dysfunctional behaviours.	3
Bernier, Thienot, Codron, & Fournier (2009)	Mindfulness and Acceptance approaches (MAC) in sport performance. Applied exercise was implemented during the competition period.	Case study 1: 10 elite swimmers. 40% women. Case study 2: 7 elite young golfers (experimental group). 28,5% women, 6 elite young golfers (control group). 16,6% woman.	17	4 introductory sessions (1 session every month).	Quasi-Experimental. Pre-post design. Correlational analysis. Qualitative interviews using an in-depth, open-ended, and semi-structured approach.	OMSAT-3 (Durand-Bush, Salmela , & Green-Demers, 2001), FSS (Jackson and Csikszentmihalyi, 1999) and qualitative interviews.	Case study 1: Improvement in the nine flow dimensions (Jackson and Csikszentmihalyi, 1999) and the finding of a new characteristic: the awareness and acceptance of their bodily sensations during the pre-performance moments. Case study 2: The coaches emphasized that the 57,1% of golfers in experimental group became more aware and lucid in their approach to golf and said the intervention was useful and relevant. The 66% of golfers in experimental group improved their national rankings.	2

De Petrillo, Kaufman, Glass, & Arnkof (2009)	MSPE- provides sport-specific rationale workshops for the use of mindfulness in athletics, and each session of the training contains exercises that are key elements of Kabat-Zinn (2003) and Segal et al. (2002) mindfulness programs.	Long distance runners (1 mile races to marathons), 10 mens and 15 womens, raging in age from 18 to 55	25	4 weeks (1 session per week, 2,5-3 hours per session)	Quasi-Experimental. Pre-post design. Correlational analysis	BQ (Kauffman, Glass, & Arnkoff,2009), SAS (Smith, Smoll, & Schutz, 1990), MPS (Frost, Marten, Lahart, & Rosenblate, 1990), TOQS (Hatzigeorgiadis & Biddle, 2000), KIMS (Baer, Smith, & Allen, 2004), CEM (Kauffman, Glass, & Arnkoff, 2009), TMS (Lau et al., 2006), P.Q. (De Petrillo et al., 2009), RPL (Kaufman et al.,	Findings suggest that MSPE may be a useful mental training intervention for improving mindfulness, sport-anxiety related worry, aspects of perfectionism in long-distance runners.	3

Kauffman, Glass, & Arnkoff (2009)	MSPE- provides sport-specific rationale workshops for the use of mindfulness in athletics, and each session of the training contains exercises that are key elements of Kabat-Zinn and Segal et al.'s mindfulness programs.	21 golfers/2 dropouts, 11 archers/1 dropouts	32	4 weeks (1 session per week, 2,5-3 hours per session). Only 11 athletes completed the 4 sessions.	Quasi-Experimental. Pre-post design. Correlational analysis.	BQ (Kauffman, Glass, & Arnkoff,2009), SAS (Smith, Smoll, & Schutz, 1990), MPS (Frost, Marten, Lahart, & Rosenblate, 1990), CSCI (Manzo, Silva, & Mink, 2001), TOQS (Hatzigeorgiadis & Biddle, 2000), KIMS (Baer, Smith, & Allen, 2004), DFS-2 ((Jackson & Eklund, 2000), CEM (Kauffman, Glass, & Arnkoff, 2009), TMS (Lau et al., 2006), DML (, Segal et al, 2002) DSPL (Kauffman, Glass, & Arnkoff,2009), FSS-2 (Jackson & Eklund, 2002), EXT (Kauffman, Glass, & Arnkoff,2009)	Findings: no significant differences pre-post intervention. The athletes' opinion about the workshop's influence on their performance was 6,62 (0-10), and their satisfaction level with their performance increased significantly ($p<0.01$) after workshop. In the archers significant diminution ($p<0.10$) of thought occurrence (TOQS), increase ($p<0.10$) of self-confidence (CSCI) and significant increase ($p<0.01$) of mindfulness levels (KIMS, TMS). Significant increase of mindfulness level in archers ($p<0.10$) and flow level in all athletes ($p<0.05$).	3

Schwanhausser (2009)	Mindfulness-Acceptance-Commitment (MAC) approach to performance enhancement (Gardner & Moore, 2004a, 2007) adapted for a teen elite springboard athlete.	12 year-old male, high level springboard and platform diver	1	9 weeks (1 session per week, 45 minutes per sesión)	Case study. Pre-post design. Correlational analysis.	PCQ (Wolanin, 2005), PHMS (Cardaciotto, Herbert, Forman, Moitra, & Farrow, 2008), SAS (Smith, Smoll, & Schutz, 1990), AAQ-2(Hayes et al., 2004), MAAS (Brown & Ryan, 2003) DFS-2, FSS-2 (Jackson & Eklund, 2004), and SCID screening (First, Spitzer, Gibbon, & Williams, 1997).	Results indicated increases in mindful awareness, mindful attention, experiential acceptance, flow, and diving performance from pre- to post-intervention. This case supports the applicability of the MAC protocol with an adolescent athlete population	2
Franco (2009)	Mindfulness Program- Flow Meditation.	Participants: 6% athletics, tennis 8% tennis, 13% swimming, 14% basketball, handball 16%, 21% volleyball and 22% soccer	41	10 weeks, 1 session per week, 1,5h per session and 40 minutes of daily mindfulness exercises	Experimental design. Pre-post and follow up.Correlational analysis.	IBD (Garcés de los Fayos, 1999), PVS (Hardiness Institute, 1985)	Findings: There was a significant improvement in the experimental group with respect to the control group in the three evaluated dimensions of resistant personality (control, commitment and challenge), and in two of the three dimensions of sport burnout (little personal satisfaction and emotional exhaustion). These differences were maintained five months after the end of the intervention.	4

Lutkenhouse, (2007)	MAC program.	19 year-old female lacrosse player classified as experiencing performance dysfunction by the Multilevel Classification System for Sport Psychology (MCS-SP)	1	8 weeks (8 sessions. Exercises to do between session's .Some contacts by e-mail after protocol).	Case study. Pre-post design. Correlational analysis.	SPQ (Raine, 1991), YSQ-SF (Young & Brown, 2003), PSWQ (Meyer et al., 1990, SAS (Smith, Smoll, & Schutz, 1990), AAQ-R (Hayes et al., 2004)	Performance: reduction of 25 seconds in her best mile runs time. A 61,5% increase in scores performance (SPQ). She no longer met criteria for Performance Dysfunction. Self –evaluation: personal and sportive growth and development, improvement of performance and her capacity to handle frustration.	2
Gardner & Moore (2004)	MAC program 5 phases: Psycho- education, Mindfulness, Value identification and commitment, Acceptance, Integration and practice	Case study 1: 22 year-old intercollegiate swimmer. The protocol was extended by 4 weeks during the competitive session. Case study 2: 37-year-old master's-level female power-lifter	2	12 weeks (1 hour per session)	Case study. Pre-post design. Correlational analysis	PSWQ (Meyer et al, 1990) , SAS (Smith, Smoll, & Schutz, 1990), AAQ-16 (Hayes et al., 2004)	Case study 1: Performance: best competitive season, winning two meets and achieving two personal-best times. Psychological skills: 39% less in anxiety (PSWQ, SAS) and a 38,2% less in experiential avoidance (AAQ) Case study 2: Performance: best performance and lifted 15% beyond her best master's level competitive performance Psychological skills: a reduction of 55,5% in anxiety (SAS) and 44,1% in experiential avoidance (AAQ)	2

Discussion

The 26 papers included in this systematic review comprised a total population size of 713 athletes, made up of 510 males and 203 females. The elite sports on the samples are basketball (Aherne et al., 2011; Bernier, Thienot, Codron, & Fournier, 2009; Gross, Moore, Gardner, Wolanin, Pess, & Marks, 2016; Franco, 2009; Kauffman, Glass, & Arnkoff, 2009), springboard (Schwanhausser, 2009), tennis, swimming, handball, volleyball (Gardner & Moore, 2004; Franco, 2009), golfers (Thompson, Kaufman, De Petrillo, Glass, & Arnkoff, 2011), skaters (Bernier, Thienot, Pelosse, & Jean, 2014), American football (Goodman, Kashdan, Mallard, & Shuman, 2014), soccer (Mahoney & Hanrahan, 2011; Baltzell & Akhtar, 2014; Franco, 2009), rowing (Baltzell & Akhtar, 2014; Salazar & Ballesteros, 2015), biathlon, skiing, shooting (Demarzo, Oliveira, Silva, Lessa-Moreno, Barceló, & Garcia-Campayo, (2015; Furrer, Moen, & Firing 2015), bicycle BMX and motocross (Haase et al., 2015), Lacross (Lutkenhouse, 2007), chess (Ruiz, & Luciano, 2012), power-lifting (Gardner & Moore, 2004), squash and sailing (Mahoney & Hanrahan, 2011), Pentathlon (Bertollo, Saltarelli, & Robazza, 2009), and cycling (Scott-Hamilton, Schutte, & Brown, 2016).

Nineteen studies are related to mindfulness-based interventions, psychological flexibility and anxiety (Baltzell & Akhtar, 2014; Bernier et al., 2014, 2009; Bertollo et al., 2009; De Petrillo et al., 2009; Franco, 2009; Furrer et al, 2015; Gardner & Moore, 2004; Goodman et al., 2014; Gross et al., 2016; Haase et al., 2015; Mahoney; & Hanrahan, 2011; Kaufman et al., 2009; Lutkenhouse, 2007; Moghadam et al., 2013; Ruiz, & Luciano, 2012; Salazar, & Ballesteros, 2015; Schwanhausser, 2009; Thompson et al., 2011). Four studies explore findings about the control and manipulation of physiological variables (Demarzo et al., 2015; Haase et al., 2015; Jonh et al., 2010, 2011), and two contained data relating to self-compassion, fear of failure, sport satisfaction, mindfulness and sport performance (Awamleh et al., 2014; Mosewich et al., 2013).

Nine studies (Aherne et al, 2011; Bernier et al., 2009; Bertollo et al., 2009; Franco, 2009; Gross et al., 2016; Kaufman et al., 2009; Schwanhausser, 2009; Scott-Hamilton et al., 2016; Thompson et al., 2011) using elite athletes to explored flow and mindfulness, the non-judgmental focusing of one's attention on the experience as it occurs in the present moment (Kabat-Zinn, 1994). This concept has its roots linked with mindfulness as a mediator of flow and is based on the proposal that mindfulness is linked to present-moment focus, similar to the flow dimension concentration on the task at hand. For example, Scott-Hamilton et al. (2016) attempted to explore this link to add conclusive data, about the importance to study how mindfulness and acceptance could specifically contribute to the attainment of optimal performance states in elite cycling sport contexts.

It is important to note that mindful athletes are more likely to experience flow, a state of energized focus and full involvement, during athletic performance (Bernier et al., 2009; Jackson & Csikszentmihalyi, 1999; Kee & Wang, 2008). In one study of 13 university athletes, a 6-week self-

administered mindfulness training exercise increased frequency and duration of flow states (Aherne et al., 2011). In another mindfulness-based intervention, athletes reported increases in trait mindfulness and flow and decreased task-related worries and task irrelevant thoughts (Thompson, Kaufman, De Petrillo, Glass, & Arnkoff, 2011). Moreover, this literature review showed that regular mindfulness practice is associated with improvements in cognitive processing, such as attention orientation, executive attention, and working memory (Jha, Stanley, Kiyonaga, Wong, & Gelfand, 2010; Van den Hurk, Giommi, Gielen, Speckens, & Barendregt, 2010).

Our findings suggest a significant need to develop and implement more well-designed mindfulness-based intervention studies that target improvement of sport performance elite athletes, their teams and coaches, and post-injury psychological outcomes in order to assist successfully recovery from game to game, and the athletes with sport injury (Birrer et al., 2012; Demarzo et al., 2015; Haase et al., 2015; Solé et al., 2014).

Effectiveness of Mindfulness-Based Interventions on elite sports

Mental training of motor skills leads to changes in brain circuitry and behavior, just as physical training (Slager, Davidson, & Lutz, 2011). This literature review support that mental-skills training can prepare athletes for competition and improve psychological well-being such as improving anxiety management (Gross et al., 2016; Mamassis & Doganis, 2004), focus (Orlick & Partington, 1988), managing emotions (Lazarus, 2000), and dealing with pressure (Beilock, Afremow, Rabe, & Carr, 2001).

To our knowledge, in the present literature review we found eigth empirical studies conducted with MAC program (Bernier, Thienot, Codron, Fournier, 2009; Bertollo, Saltarelli, & Robazza, 2009; Gardner & Moore, 2004, Gross et al., 2016; Lutkenhouse, 2007; Mahoney & Hanrahan, 2011; Ruiz & Luciano, 2012; Schwanhausser, 2009), seven studies with adapted MBSR (Aherne, Moran, & Lonsdale, 2011**;** Awamleh, Mansi, & Ermeley, 2014; Bernier, Thienot, Pelosse, Fournier, & Jean, 2014; Scott-Hamilton, Schutte, & Brown, 2016; Demarzo et al., 2015; Goodman, Kashdan, Mallard, & Schuman, 2014; Haase et al., 2015), and two with MSPE **(** Kauffman et al., 2009; Thompson et al., 2011), that investigate mindfulness-based interventions with athletes.

In sum, there is empirical evidence that mindfulness is a performance-relevant trait in sports and that mindfulness-based interventions may be helpful for athletes (Sappington & Longshore, 2015). The results so far suggest that dispositional mindfulness is related to more flow, less fear, and fewer task-irrelevant thoughts (Sappington & Longshore, 2015; Solé et al., 2014). Mindfulness-based interventions seem to increase dispositional mindfulness. For a thorough assessment, however, more high-quality studies are needed (Sappington & Longshore, 2015). They should use randomized control group designs with active control groups or multiple baseline designs and measure performance as the dependent variable.

Conclusion

The use of mindfulness in sports psychology is very new and it's been focused in enhancing athletes' performance (Birrer et al, 2012) In our review we observed the next following findings: there are a few number of studies, with little samples and most of them are nonrandomized studies. We also find three case studies. Most of them use two new mindfulness-based interventions: MSPE and MAC, with a very well defined intervention protocols.

There is not yet sufficient evidence to determinate the magnitude of the effects of these interventions due to the methodological limitations of the studies (Gross et al., 2016; Sappington & Longshore, 2015). But the results could suggest that these two mindfulness-based interventions, the Mindfulness-Acceptance-Commitment-Based Approach (MAC) and Mindfulness Sport Performance Enhancement (MSPE), can be helpful to enhance performance in sport. They also increase the levels of mindfulness, concentration, acceptation, sense of control, awareness of bodily sensations and decrease the stress and anxiety levels (Bernier et al., 2014; Bertollo et al., 2009; Demarzo et al., 2015; Gross et al., 2016; Haase et al., 2015; Sappington & Longshore, 2015).

The results describe practical implications for athletes. Together those findings suggest that training elite athletes in mindfulness skills increases their mindfulness, and that has implications for athletes' experience of flow during sporting events, a state beneficial for athletes (Jackson & Kimiecik, 2008; Scott-Hamilton et al., 2016)

In sum, the findings suggest the necessity to replicate the studies with a larger and more diverse sample in order to clarify its effectiveness (Gross et al., 2016). However, to increase the feasibility of the application of these new protocols of intervention for high-performance athletes, a more evidence based mindfulness program content, adapted to specific trainings and competitions routines are recommended. Additionally, mindfulness techniques and exercises seem easily transferable and appropriate to the coach-training program or training session as Kabat-Zinn and colleagues (1985), Gardner and Moore (2004) demonstrate when they delivered sport-specific mindfulness training.

Limitations

Because the procedures in a systematic review are explicit and transparent, the values used to inform the review should be open to criticism and comment (Torgerson, 2003), hence it is important to note some of the possible flaws within the adopted approach. Some findings are based on the reports from only a few papers, small samples, and the review process inevitably identifies studies that are diverse in their design, methodological quality, specific interventions used, and types of athletes studied; all of which may affect validity.

Additionally, the inclusion/exclusion criteria employed may have excluded literature which could have been relevant to answering some of the aims of this review, but did not meet all criteria, for example, relating specifically to elite sport. However, some of these issues (e.g., the limited number of studies available in certain sections) are unavoidable due to

the nature (and limited amount) of research in the area, which this review was synthesized.

Furthermore, as a narrative approach to synthesis was adopted, procedures of enhancing trustworthiness were also employed (e.g., peer debrief, audit trail, advisory group) which aimed to overcome, or at least minimize, such issues. A final limitation is that there is no comparison group within this review (i.e., the focus was solely on elite athletes) and it is also interesting to question whether mindfulness intervention is experienced by individuals performing on a lower level, such as sport beginners or participants of health- oriented sports courses. By presenting a review of elite sport, future research can make comparisons between elite and lower level participants (e.g., by conducting a similar review on non-elite sport). Applied Recommendations although the emphasis should be on developing clear understanding and explanation of the phenomenon, practitioners may be able to use the findings emerging from this review to suggest ways of promoting mindfulness based interventions in their athletes. Specifically, we suggest a multi-faceted intervention, including because the skills involved should be matched to the causal influencing factors and dimensions of mindfulness. Based on the present findings, these could revolve around thorough preparation, task-focus, coping strategies, and goal-literature review of mindfulness-based intervention in elite sport setting. Because of the limited empirical data and despite the statistical challenges, we still need to investigated with randomized control group studies, active control groups, or multiple baseline designs and standardized intervention manuals if mindfulness-based interventions have a performance-relevant effect on athletes, and How can mindfulness-based interventions and traditional PST be combined.

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