

The effects of a mindfulness-based program on the incidence of injuries in young male soccer players

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1 Running Head: MINDFULNESS TRAINING AND SPORT INJURY PREVENTION

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29 **Effectiveness of a Mindfulness-Based Program Aimed at Reducing the Incidence of**
30 **Injuries in Young Male Soccer Players**

31 Injuries are a common major adverse event during a soccer player's career (Stubbe et al.,
32 2015). It is estimated that 65% to 95% of international level male soccer players suffer at
33 least one injury each year (Hägglund, 2007) and the injury incidence ranges from 2 to 19.5
34 injuries per 1000 hours of soccer practice (Pfirrmann, Herbst, Ingelfinger, Simon, & Tug,
35 2016). Sport injuries have high financial costs for the health care system, club, and player
36 (Ekstrand, 2013), and may lead to unsuccessful performance and early retirement from the
37 sporting career (Drew, Raysmith, & Charlton, 2017). Injured athletes can experience a
38 number of negative psychological and emotional consequences that may include depression,
39 anxiety, sadness, isolation, irritation, lack of motivation, anger, frustration, disordered eating,
40 sleep disturbance, disengagement, or substance use/abuse (Brewer & Redmond, 2017;
41 Putukian, 2016). Therefore, sport injury prevention strategies are needed with the purpose of
42 decreasing the risk of injury and the negative repercussions that may follow.

43 To explain the relationship between acute (traumatic) sport injuries and psychological
44 factors, Williams and Andersen (1998) proposed the model of stress and athletic injury.
45 According to this model, a potentially stressful situation (e.g., an important competition) may
46 lead to a stress response, which varies in intensity depending on how the athlete evaluates the
47 situation. This evaluation is known as cognitive appraisal. The more a situation is appraised
48 as threatening, the more intense the athlete's stress response will be (Williams & Andersen,
49 1998). The model also considers that personality factors (e.g., trait anxiety, sense of
50 coherence, locus of control, hardiness), history of stressors (e.g., major-life-event stresses,
51 daily hassles, previous injury history), and athlete's coping strategies and available resources
52 (e.g., psychological skill use, social support) may influence the intensity of the stress
53 response and the subsequent likelihood of injury (Rogers & Landers, 2005; Williams &

54 Andersen, 1998). Such increase in athletes' susceptibility to injury is thought to occur due to
55 changes in physiological (e.g., increased muscle tension, fatigue, impaired timing and motor
56 coordination) and attentional (e.g., narrowing of visual field, distractibility, loss task relevant
57 cues) processes (Brewer & Redmond, 2017). A recent meta-analysis demonstrated that this
58 framework had an acceptable fit to published data and explained 7.3% of the variance in
59 injury rates (Ivarsson et al., 2017), supporting its relevance for injury prevention.

60 Until recently, little attention has been paid to psychosocial strategies in injury
61 prevention. In the last 20 years, results of the few psychological intervention studies based on
62 the Williams and Andersen (1998) stress and athletic injury model suggest that interventions
63 directed at the stress response have the potential to decrease the risk of occurrence of acute
64 sport injuries (Ivarsson et al., 2017; Ivarsson, Johnson, & Edvardsson, 2015; Johnson,
65 Ekengren, & Andersen, 2005; Perna, Antoni, Baum, Gordon, & Schneiderman, 2003;
66 Tranaeus, Johnson, Engström, Skillgate, & Werner, 2015). The majority of these studies,
67 however, have considerable limitations, including lack of attentional control groups
68 (Edvardsson, Ivarsson, & Johnson, 2012; Perna et al., 2003; Tranaeus et al., 2015) and
69 preferential selection of athletes who are at risk of acute injury (Johnson et al., 2005; Perna et
70 al., 2003; Tranaeus et al., 2015). In injury intervention studies, selecting as participants only
71 athletes who are at risk of suffering an injury is particularly problematic, because doing so
72 can diminish the magnitude of the effects of the interventions and undermine generalizability.
73 In fact, when athletes who are less likely to be injured are included in the sample studies,
74 interventions can be less effective.

75 Despite the fact that research on mindfulness began in 1960s, the interest in mindfulness
76 as an acute sport injury prevention strategy is recent (Ivarsson, Johnson, Andersen, Fallby, &
77 Altemyr, 2015; Ivarsson et al., 2017). Mindfulness is defined as an ability to consciously and
78 intentionally maintain full attention and awareness to the present moment with a non-

79 judgmental attitude (Brown & Ryan, 2003). Different types of mindfulness interventions
80 have been administered in the sport context, but the application of the Mindfulness-
81 Acceptance-Commitment approach (MAC; Gardner & Moore, 2007) is particularly popular
82 in sport. This approach was developed in 2001 based on a combination of key concepts and
83 practice skills adapted from mindfulness-based cognitive therapy (Segal, Teasdale, Williams,
84 & Gemar, 2002) and acceptance and commitment therapy (Hayes, Strosahl, & Wilson, 2012).
85 This approach emphasizes the promotion of a non-judging present-moment awareness, the
86 acceptance of one's internal cognitive and affective states, a focused attention on task-
87 relevant external stimuli, and an effortful values-driven commitment to behaviors that support
88 athletic goals (Gardner & Moore, 2007). A recent systematic review of 66 studies ($n = 3908$)
89 suggested that MAC approaches may improve performance, but further research is necessary
90 to confirm any causal claims of this relationship (Noetel, Ciarrochi, Van Zanden, &
91 Lonsdale, 2017).

92 Studies show that mindfulness practice may affect a variety of psychological
93 processes including improvement of executive functions, attention, and awareness (Brown &
94 Ryan, 2003), while decreasing anxiety and stress (Goldin & Gross, 2010). In addition,
95 mindfulness training may attenuate negative appraisals of potentially stressful situations (e.g.,
96 an upcoming competition) and facilitate the use of adaptive forms of coping (Weinstein,
97 Brown, & Ryan, 2009). According to Williams and Andersen (1998), paying attention to the
98 here-and-now (i.e., mindfulness) is part of our evolutionary heritage and it has had
99 tremendous survival value. Complex, distracting stimuli and internal thoughts prevent us
100 from being in the present moment and expose us to harm by thwarting the effective scanning
101 of the environment. Therefore, inappropriate changes in attentional processes such as
102 distractibility and loss of task relevant cues are thought to increase athletes' susceptibility to
103 injury (Brewer & Redmond, 2017).

104 Mindfulness training can have an important clinical impact on athletes' susceptibility
105 to injury. In a 6-month study with 41 high school Swedish soccer players, Ivarsson, Johnson,
106 Andersen, et al. (2015) reported no statistically significant difference in injury incidence
107 between the mindfulness intervention group and a control group. However, the intervention
108 had a medium effect size (adjusted Cohen's $d = -0.59$) on injury incidence, a clinically
109 meaningful outcome: the mindfulness group had almost half the number of injuries of the
110 control group (8 vs. 15, respectively). The Ivarsson, Johnson, Andersen, et al. (2015) study
111 had a small sample size that limited generalization of the results. Moreover, they did not
112 assess trait mindfulness at baseline to control for between groups differences. Based on the
113 above, the purpose of our study was two-fold. First, we investigated the extent to which a
114 mindfulness training program could decrease the number of acute sport injuries in young elite
115 soccer players. Second, we explored the role that changes in trait and state mindfulness, trait
116 sport anxiety, stress, and attention control can play in the rate of acute sport injuries. Hence,
117 the current study expanded on that of Ivarsson, Johnson, Andersen, et al. (2015) by
118 considering a number of psychological variables that may mediate the effects of mindfulness
119 training on injury susceptibility. Furthermore, we also controlled for athlete-exposure as it
120 changes the probability of the occurrence of injuries. We hypothesized that mindfulness
121 practice would reduce trait sport anxiety and stress, improve attentional processes, and reduce
122 acute sport injury occurrence. In addition, we expected that the level of sport anxiety and
123 stress in injured athletes would be higher than those of the uninjured athletes. We also
124 expected that the levels of attention and state and trait mindfulness would be lower in injured
125 athletes than in uninjured athletes. Finally, using a mediation model, we hypothesized that
126 trait and state mindfulness, perceived stress, trait sport anxiety, and attentional process would
127 mediate the association between mindfulness training and sport injury.

128

129 **Method**

130 **Study Design**

131 Prospective study conducted during one season from July 2016 to May 2017 in

132 **(Blind)**.

133 **Participants**

134 One hundred sixty-eight junior soccer players aged 16 to 19 years old (mean age =
135 17.1 ± 1.1 years) participated in the study and were recruited from eight clubs certified by the
136 **(Blind)**. The clubs were selected by the local soccer association. Of the participants, 21%
137 (two clubs) played at the highest junior level and the remaining 79% (six clubs) competed at
138 the senior elite level in **(Blind)**. Teams had at least two regular soccer training sessions and
139 one match per week. Athletes participated in soccer related activities for 8 to 12 hours per
140 week.

141 To be eligible to participate in the study, athletes had to attend at least 90% of their
142 practice sessions and provide information about their injuries. After completion of the
143 baseline measures and obtaining all medical clearances, eligible participants were randomly
144 allocated into mindfulness ($n = 84$; age = 17.44 ± 1.12 years; height = 171 ± 5.78 cm; BMI =
145 19.1 ± 1.47) or control ($n = 84$; age = 17.6 ± 1.23 years; height = 172 ± 5.74 cm; BMI =
146 18.68 ± 1.43) groups.

147 Three participants from the intervention group and five participants from the control
148 group did not complete the minimum of sessions required, therefore they were excluded from
149 the study and their data were not considered for further analysis. The final sample consisted
150 of 160 athletes, 79 in the control group and 81 in the intervention group.

151 The sample size was calculated assuming an injury incidence of 63% reported in a
152 previous study with 16 to 19 year-old males (Stubbe et al., 2015). An a priori sample size

153 calculation estimated that 168 participants (i.e., 84 per group) were required to provide 80%
154 power to detect a 50% effect size in the intervention group (alpha set at 5%).

155 **Data Collection**

156 ***Injury recording.*** An injury was defined as any physical complaint incurred during a
157 competition or training directly related to soccer that resulted in four or more days of absence
158 from practice, including the day the injury was reported. The player was considered injured
159 until deemed apt to return to training and competition by the medical staff. The severity of
160 the injury was classified according to the duration of complaints and absence from matches
161 and training sessions: mild, when there was an absence of 4-7 days or complaints for more
162 than 2 weeks; moderate, when there was an absence for 8-28 days; and severe, when there
163 was an absence of more than 28 days (Fuller et al., 2006). If the injury was caused by
164 repetitive microtrauma without a distinguishable traumatic event, it was considered an
165 overuse injury and was excluded from our study.

166 ***Comprehensive Inventory of Mindfulness Experiences*** (CHIME; Bergomi, Tschacher,
167 & Kupper, 2014). CHIME is a 37-item inventory that assesses trait mindfulness. The
168 inventory describes various behaviors or experiences participants may have had during the
169 previous two weeks. Participants were asked to rank their mindful engagement on a six-point
170 Likert scale, ranging from 1 (*almost never*) to 6 (*almost always*) in each of those scenarios.
171 Bergomi et al. (2014) supported the reliability (internal consistency and retest-reliability) and
172 validity (construct, criterion, and incremental) of the CHIME and reported satisfactory
173 psychometric properties.

174 ***Toronto Mindfulness Scale*** (TMS; Lau et al., 2006). TMS is a state mindfulness
175 measure that captures the extent to which participants experienced a feeling of heightened
176 awareness, as well as the quality of such awareness. It includes 13 items on 5-point Likert

177 scales, ranging from 0 (*not at all*) to 4 (*very much*). Higher total scores indicate higher overall
178 state mindfulness. Reliability and validity of TMS were supported by Lau et al. (2006).

179 ***Sport Anxiety Scale-2*** (SAS-2; Smith, Smoll, Cumming, & Grossbard, 2006). This scale
180 consists of 21 items that measure the competitive trait anxiety experienced by athletes before
181 or during competition. SAS-2 includes three subscales comprised of four items each: worry
182 (e.g., “I worry that I will not play well”), somatic anxiety (e.g., “My body feels tense”), and
183 concentration disruption (e.g., “It is hard to concentrate”). Participants were asked to indicate
184 on 4-point Likert scales, ranging from 1 (*not at all*) to 4 (*very much*), how they generally feel
185 before or during sporting competitions. An overall trait anxiety score is calculated as the sum
186 of all items and varies from 21 to 84, with high scores indicating high trait anxiety. Smith et
187 al. (2006) obtained support for the reliability and validity of the SAS-2, indicating sound
188 psychometric properties.

189 ***Kessler Psychological Distress Scale*** (K10; Andrews & Slade, 2001). K10 is a 10-item
190 questionnaire designed to measure different types of psychological stress responses
191 participants might have experienced during the last 30 days, such as “feeling tired out for no
192 good reason” or “sad or depressed.” Responses are scored on 5-point Likert scales ranging
193 from 0 (*none of the time*) to 4 (*all of the time*). The total score varies between 0 and 40, with
194 higher scores indicating higher levels of psychological distress. The K10 is a valid and
195 reliable measure of psychological distress and its psychometric properties are consistent
196 across a variety of sociodemographic subsamples (Andrews & Slade, 2001; Kessler et al.,
197 2002).

198 ***D₂ Attention Endurance Test (d₂-attention)***. The d₂ attention test is a paper-and-pencil
199 version test used to determine the capacity to focus on one stimulus, while suppressing
200 awareness of competing stimuli. Participants were asked to cross out any letter "d" with two
201 marks above it or below it in any order, while ignoring distractors, which are similar to the

202 target stimulus (e.g., "p" with two marks or a "d" with one or three marks). This test consists
203 of 14 rows with 47 randomly presented "p" and "d" letters in each line. Participants' scores
204 were determined by the total number of letters processed (TN), total number of letters
205 correctly marked (CP), and percentage of errors (errors of omission and commission) (E %).
206 TN was an indicator of processing speed and amount of work completed, CP was an indicator
207 of concentration, and E% was an indicator of quality of attention (Bates & Lemay, 2004). In
208 a series of test-retests, d_2 test indices TN, TN-E, and CP demonstrated satisfactory to good
209 reliability ($r > .70$). In our study, we used the average of z scores of the d_2 attention test as a
210 measure of attention. We calculated the d_2 attention test score as follows: Total score of
211 attention test = (z score of d_2 -TN + z score of d_2 -CP + z score d_2 -E %) /3. In previous
212 research, internal consistency coefficients (Cronbach's alpha) ranging from .93 to .96 and
213 reliability coefficient (ICC) from .69 to .89 for athlete participants were observed (Caglar &
214 Koruc, 2006). In addition, Barkley (1991) reported that paper-and-pencil tests, rather than
215 computer-administered versions, have resulted in higher correlations between children's test
216 scores and parent and teacher ratings of attention.

217 **Athletes' and Coaches' Intervention Satisfaction Questionnaire**

218 Coaches and athletes were asked to respond to a researcher-administered questionnaire
219 based on 7-point Likert scales. Coaches' questions included: (a) to what extent did the
220 mindfulness program interrupt your training plan? (1 = *never* to 7 = *always*), (b) how
221 satisfied are you with the effects of the mindfulness program on your soccer players'
222 performance? (1 = *extremely dissatisfied* to 7 = *extremely satisfied*), and (c) how willing are
223 you to use such interventions in the future? (1 = *extremely unwilling* to 7 = *extremely*
224 *willing*).

225 Athletes' answered the following questions: (a) how do you rate your level of
226 satisfaction with the mindfulness program delivery? (1 = *extremely dissatisfied* to 7 =

227 *extremely satisfied*); (b) how do you rate your level of understanding of the information
228 provided in the sessions (1 = *poor* to 7 = *excellent*); (c) how do you rate the quality of the
229 communication with the psychologist (1 = *poor* to 7 = *excellent*); (d) how do you rate your
230 level of improvement of the skills taught (1 = *poor* to 7 = *excellent*); (e) how well are you
231 able to apply the skills learned in training and competition (1 = *poor* to 7 = *excellent*), and (f)
232 to what extent did the mindfulness program improve your soccer performance (1 = *poorly* to
233 7 = *excellent*).

234 **Mindfulness Intervention Program**

235 The mindfulness intervention was developed according to Gardner and Moore's (2007) MAC
236 approach and its contents are illustrated in supplementary file 1 (Gardner & Moore, 2007;
237 Ivarsson, Johnson, & Edvardsson, 2015; Plemmons, 2015). The mindfulness intervention
238 consisted of seven sessions, one 45-minute session per week. All sessions started with a
239 shared discussion among participants about their experiences, feelings, and thoughts
240 concerning the previous session, followed by the instructor's personalized feedback to each
241 athlete. This feedback pertained to information provided during the shared discussion and
242 helped develop or reinforce an understanding of the content presented in the previous
243 meeting. Each session included a specific topic in line with the MAC manual (Gardner &
244 Moore, 2007), followed by a presentation concerning the mechanisms of the MAC approach
245 and participants' discussions. All sessions ended with mindfulness exercises, specific to the
246 session topic. At the end of each session, an audio mindfulness exercise was sent
247 electronically to the participants' mobile phones and/or e-mail addresses. Participants were
248 required to listen to the audio to complement their training.

249 **Attention Control Intervention Program**

250 In the attention control group (CG), participants attended seven sessions of
251 presentations about the psychology of sport injury. As in the mindfulness group, participants

252 in the control group met once weekly for 45 minutes. Contents for this group were developed
253 based on a book on the psychology of sport injury and it included the topics illustrated in
254 supplementary file 2 (Brewer & Redmond, 2017).

255 **Procedure**

256 This study was reviewed and approved by the Institution Review Board of (**Blinded**) and
257 all procedures were in accordance with the Declaration of Helsinki. In order to access and
258 speak to potential participants, we contacted team coaches and set a time and place for a
259 meeting. At this meeting, coaches allowed us to inform the players and their parents about the
260 study. Then, participants, coaches, and parents of participants who were under 18 years of
261 age signed an informed consent form.

262 First, all players completed a face-to-face guided interview history form to collect
263 information regarding participants' demographic information and previous acute sport injury
264 history (i.e., the number of injuries suffered in the previous season of 2015-2016). The injury
265 information allowed participants to be matched and allocated to either the control or the
266 experimental groups. In addition, groups were matched based on team's competition level.
267 None of the teams had a physician, physiotherapist, or psychologist.

268 Then, the Comprehensive Inventory of Mindfulness Experiences (CHIME) was
269 administered to control for the effect of trait mindfulness on stress, anxiety, and rate of injury.
270 Moreover, the Toronto Mindfulness Scale (TMS), Sport Anxiety Scale-2 (SAS-2), and
271 Kessler Psychological Distress Scale (K10) were administered before the intervention (pre-
272 test) and monthly, for five months after the end of the intervention, to assess changes in the
273 state mindfulness, trait anxiety, and stress during the season. The post-test measurements
274 used in the analysis were taken immediately before the injury had occurred. The use of the
275 last score before the injury avoids the confounding negative effect of the injury on the

276 psychological constructs studied. All psychological questionnaires were administered by a
277 trained researcher.

278 Prior to initiating the mindfulness intervention sessions, participants of both groups were
279 divided into smaller groups containing 15 or 16 participants to maximize active participation,
280 opportunities to receive feedback and acquisition and transfer of information. To facilitate
281 interaction during the sessions, intervention leaders led group discussions using experiential
282 learning techniques and encouraged participants to share their experiences and opinions. All
283 sessions were conducted at the clubs' facilities from April to May 2016. A Ph.D. clinical
284 psychology student and an MSc sport psychology student delivered both programs. During
285 the seven weeks, participants were required to incorporate mindfulness into their daily
286 activities and to practice at least 10 minutes daily. Participants recorded their daily practice in
287 a logbook and all of them reported practicing at least 30 minutes per day.

288 After the initial data collection, players were followed throughout the season (July 2016
289 to May 2017) in practice and competition. One physical therapist and one medical student
290 recorded all injuries that met our operational definitions. When an injury was reported, the
291 player or the coach was contacted by the physiotherapist or the medical student to complete a
292 standardized interview on the circumstances of the injury. To maintain updated injury
293 records, at the end of each week, all athletes answered questions concerning match exposure,
294 training exposure and time-loss injuries. All injuries were described in relation to their type
295 and location, date of injury occurrence, date of return to full participation in practice, and the
296 duration of subsequent limitation in match participation.

297 Athlete-exposure was operationally defined as the athlete's participation in scheduled
298 team practices or competitions during the course of the season. In each session, coaches
299 quantitatively recorded athlete-exposure, and whether or not the warm-up had been
300 conducted and the athletes who had participated in it. Coaches recorded this information on a

301 weekly registration form and sent it by e-mail to the research coordinator. Therefore, athlete-
302 exposure represents a unit of susceptibility to injury during which the athlete is exposed to
303 the possibility of injury. The more the athlete is exposed to the possibility of injury, the more
304 likely the athletic injury will occur. For this reason, the amount of athlete-exposure was
305 controlled in both groups, allowing for between-group comparisons of the frequency of sport
306 injury. In other words, we ensured that group differences in injury were not due to differences
307 in athlete-exposure.

308 **Data Analyses**

309 All statistical analyses were conducted using SPSS statistical software (Version 18.0,
310 SPSS Inc., Chicago, IL). Injury incidence was calculated by dividing the number of injuries
311 by the total number of athlete-exposures and reported as injuries per 1000 athlete-exposures.
312 Descriptive statistics (frequencies, means, and standard deviations) were calculated for all
313 variables. Independent *t*-tests were used to compare demographic data between the control
314 group and mindfulness group for pretest, posttest and pretest posttest different. χ^2 tests were
315 used to compare the frequency of injuries between groups. Mixed repeated-measures
316 ANOVAs were used to evaluate the within- and between-subject differences in psychological
317 factors between the mindfulness and attention control groups. Additionally, we used an
318 independent *t*-test to compare the average change of psychological factors from pretest to
319 posttest between injured and non-injured participants.

320 To better understand the magnitude of training gains in the independent groups *t*-test,
321 Cohen's d_z , expressing the effect size of the between-groups differences, were calculated
322 with values of $\leq .19$, $.20-.49$, $.50-.80$, and $\geq .81$ representing trivial, small, medium, and large
323 effects, respectively. Additionally, partial η^2 was reported as an effect size for the repeated-
324 measures ANOVA, with $.01$, $.09$, and $.25$ corresponding to small, medium, and large effects.

325 A mediation model was used to assess the effects of the mindfulness intervention on
326 sport injury occurrence and the potential indirect effects of psychological factors on this
327 relationship. The SPSS macro PROCESS (Hayes, 2013) was used to implement a parallel
328 mediation model. Following standard procedures described by Hayes (2013), we formally
329 tested whether the indirect or mediated effect - the difference between the total effect (path c)
330 and the direct effect (path c') - was different from zero using the bootstrapping method (5,000
331 bootstrap samples) and 95% confidence intervals (CIs). For these analyses, the outcome
332 variable was sport injury (injured or non-injured), the predictor variable was group
333 classification (mindfulness training or control group), and the mediator variables were state
334 mindfulness, trait anxiety, perceived stress, and attention.

335 The alpha level was set at $p < .05$, but for multiple comparisons we applied the
336 Bonferroni adjustment and established statistical significance at $p < .01$ by dividing the
337 common probability level of .05 by 5 (i.e., the number of psychosocial variables).

338 **Results**

339 Results of the intervention satisfaction interview showed that coaches did not consider
340 that the mindfulness program interfered with their training plan ($3.76 \pm .84$, out of 7) and they
341 were very satisfied with the effect of the intervention on players' performance ($6.24 \pm$
342 1.13 , out of 7). Coaches reported that they were willing to promote such a program in the
343 future (6.12 ± 1.02). Regarding soccer players' responses, the mean scores for satisfaction
344 with the program (6.14 ± 1.13), ability to understand sessions (5.76 ± 1.23), quality of
345 communication with the psychologist (6.39 ± 1.12), perceptions of their improvement in the
346 skills taught (5.87 ± 1.13), and generalization to training and competition (6.14 ± 1.12) were
347 highly favorable.

348 A series of mixed repeated-measures ANOVAs were conducted to compare trait and
349 state mindfulness, stress, trait anxiety, and attention scores between groups. The main effects

350 of time were significant for all psychological variables and subscales ($p \leq .05$). Regarding the
 351 main effects of group, there were no significant group differences for psychological variables
 352 ($p > .05$) except for the trait sport anxiety ($p \leq .05$). Findings revealed a significant time \times
 353 group interaction for state mindfulness, $F(1,158) = 9.36, p = .003, \eta^2_p = .05$, and trait
 354 mindfulness, $F(1,158) = 7.52, p = .007, \eta^2_p = .04$, indicating higher state and trait
 355 mindfulness after the intervention for the mindfulness group compared to the control group.
 356 There was also a significant time \times group interaction for the attention score, $F(1,158) =$
 357 $11.52, p = .001, \eta^2_p = .07$, indicating better attentional processes after the interventions for the
 358 mindfulness group compared with the control group. There was also a significant time \times
 359 group interaction for stress, $F(1,158) = 14.34, p = .001, \eta^2_p = .08$, and trait sport anxiety, F
 360 $(1,158) = 15.23, p = .001, \eta^2_p = .08$, indicating, lower levels of stress and trait anxiety after
 361 the intervention for the mindfulness group compared with the control group. The range of the
 362 partial η^2 effect size was from .04 to .08, indicating that mindfulness training had small to
 363 medium effects on the psychological variables for the participants in the mindfulness group.
 364 Descriptive statics and repeated-measures ANOVA results are displayed in Table 1.

365

366 INSERT Table 1 ABOUT HERE

367

368 The total (5,942 units vs. 5,887 units), game (1,351 vs. 1,403), and practice (4,591 vs.
 369 4,485) athlete-exposure for MG and CG, respectively, were similar ($p > .05$). The absolute
 370 frequency of injuries in the MG was significantly lower than the absolute frequency of
 371 injuries in the CG (22 vs. 36; $\chi^2 = 5.09, p = .02$). In addition, the number (218 vs. 516) and
 372 mean (9.88 ± 8.56 vs. 14.32 ± 12.28) of days lost to injury in the MG was significantly lower
 373 than those in the CG, $t(1, 158) = 3.01, p = .03$. Injury severity was not significantly different
 374 between the MG and the CG, $\chi^2 = 1.34, p = .47$, while the incidence of injury per 1000

375 athlete-exposures was significantly lower in the MG than in the CG, $t(1, 158) = 2.76, p = .03$.
376 This indicates that MG athletes experienced fewer acute sport injuries than MG athletes in the
377 same amount of soccer participation time (1000 athlete-exposures; Table 2).

378

379 INSERT Table 2 ABOUT HERE

380

381 For the mediation analysis, we followed the four-step procedure to test the mediation
382 effect and estimated psychological factors for the mediation effect with PROCESS macro by
383 Hayes (2013). This model included mindfulness training as the antecedent variable
384 (mindfulness intervention group = 1, control group = 0), injury as the outcome variable
385 (injury = 1; non-injury = 0), and pretest-posttest changes in state mindfulness, attention, trait
386 anxiety, and perceived stress as mediators. In addition, we used pre-test scores of state
387 mindfulness, attention, trait anxiety, and perceived stress and number of athlete-exposures as
388 covariates. Results show that mindfulness training was negatively related to trait sport
389 anxiety ($b = -3.36, p < .001$) and stress ($b = -1.41, p < .001$), and positively related to
390 attention ($b = .57, p < .001$), state mindfulness ($b = 2.37, p < .001$), and trait mindfulness ($b =$
391 $3.40, p < .01$). When the model controlled for mindfulness training, all psychological
392 variables were significantly related to sport injury ($p < 0.05$) except trait mindfulness ($b = -$
393 $.10, p = .06$) and stress ($b = -.41, p = .07$).

394 The final model showed a significant total effect of mindfulness training on acute
395 sport injury, model LL = 157.82, $p < .001$, explaining 72% of the variance. The direct effect
396 of mindfulness training on sport injury was significant, 2.61, bootstrap SE = 0.98 (95% CI:
397 0.68, 4.53). In addition, a bias-corrected bootstrap test indicated a significant total indirect
398 effect of mindfulness training on injury through the psychological variables, -5.10 (95% CI: -
399 806.69, -4.13). Considering direct and indirect effects have opposite signs and the direct

400 effect is larger than the total effect, that's an inconsistent mediation model and it provides
401 evidence of suppression effects. We identified the attention through additional analysis as
402 suppressor variable that removing it from the mediation model, the suppression effect
403 disappears (direct effect = 1.03, non-significant; indirect effect = -1.70; and the total effect =
404 -0.67). Specific indirect effects of mindfulness training on acute sport injury through state
405 mindfulness, -.56 (95% CI: -73.01, -0.05), attention, -2.17 (95% CI: -3374.06, -1.42), and
406 trait sport anxiety, -1.41 (95% CI: -200.04, -0.87) were statistically significant. Considering
407 the percentage of the total indirect effect of the mindfulness training on sport injury
408 accounted for by the indirect effect of each mediating variable, the indirect effects
409 represented 10.98% for state mindfulness, 27.64% for trait sport anxiety, and 42.54% for
410 attention, of the corresponding total effects. The remaining 18.84% of the indirect effects of
411 the mindfulness training on sport injury related to trait mindfulness and stress. Finally, the
412 indirect effect of attention was significantly higher than the indirect effect of state
413 mindfulness, 1.08, bootstrap SE = .79 (95% CI: -.18, 3.17).

414

415 INSERT Fig 1 ABOUT HERE

416

417

Discussion

418 The purpose of this study was to investigate the extent to which a mindfulness
419 intervention could decrease the number of acute sport injuries in young soccer players. The
420 main finding of the present study is that mindfulness-based training may be an effective
421 strategy to reduce the incidence of acute sport injuries in young soccer players during one
422 season. More specifically, the intervention reduced the number of injuries and the mean time
423 lost to injury during the season. In addition, mindfulness training reduced anxiety and stress,
424 and improved attention and state mindfulness in young soccer players. These changes were

425 small to medium in magnitude ($.04 < \eta^2 < .08$). In addition, the mediation model showed that
426 changes in psychological variables such as state mindfulness, attention, stress, and trait sport
427 anxiety were significant mediators of the effects of mindfulness training on the risk of acute
428 sport injury. Our results show that mindfulness training is twice more likely to reduce the risk
429 of acute sport injury than no training through the positive effects of mindfulness on
430 psychological variables.

431 In our study, the total effect of mindfulness training on acute sport injuries was -2.49
432 and the indirect effect was -5.10. However, the direct effect was positive with a magnitude of
433 2.61 in the unanticipated direction. That is, direct and indirect effects have opposite signs and
434 the direct effect is larger than the total effect. This is known as an inconsistent mediation
435 model and it provides evidence of suppression (MacKinnon, Krull & Lockwood, 2000). That
436 is, a third variable is influencing the magnitude of the relationship between the dependent and
437 the independent variables resulting in a pathway in which mindfulness training is associated
438 with an increase in acute sport injuries. Therefore, we tested a variety of models, alternately
439 removing each mediator from the analysis, and observed that removing attention and anxiety
440 from the mediation model, the suppression effect disappears (direct effect = 1.03, non-
441 significant; indirect effect = -1.70 and the total effect = -0.67). As this suppression effect of
442 attention is likely to be a statistical artifact, and attention is theoretically meaningful as a
443 mechanism through which mindfulness affect injury rates along with other mediators, we
444 proceed with the discussion of the indirect effects.

445 Nevertheless, surprisingly, the direct effects of the mindfulness intervention in sport
446 injury are contrary to what was expected. A positive relationship between mindfulness
447 training and injury was observed; however, the total effects were according to expectations,
448 so that mindfulness training positively influenced attention and state mindfulness and
449 negatively influenced trait anxiety and perceived stress, which in turn was associated with

450 decreased sport injury. These findings are consistent with the results of studies that
451 investigated the effects of psychological skills training (Tranaeus et al., 2015), cognitive
452 behavioral therapy (Edvardsson et al., 2012), and mindfulness (Ivarsson, Johnson, Andersen,
453 et al., 2015) in the reduction of acute sport injury in soccer players. Although the
454 interventions may vary slightly in terms of implementation, their goals are often similar:
455 stress management, emotion control, and attention regulation. Therefore, given that the
456 mindfulness intervention has a role in stress management, emotion control, and attention
457 regulation, we suggest that some processes through which mindfulness may help reduce
458 injury are improved attention and a decreased tendency to perceive situations in stress-
459 inducing ways.

460 Several potential explanations can be proposed to justify the lower injury rate reported in
461 the mindfulness group compared to the control group. First, the present study shows that
462 mindfulness training seems to have decreased the susceptibility to injury through
463 improvements in attentional processes, which in turn were associated with decreased sport
464 injury. Specifically, participants in the mindfulness group experienced improved speed and
465 accuracy of information processing. Perceptual and attentional deficits (e.g., “tunnel vision”)
466 are known antecedents of sport injury. Inability to pay attention to the task and to real time
467 decision making is associated with an increased risk of acute sport injury (Rogers & Landers,
468 2005), hence, improved attention might have helped participants identify and react quicker to
469 relevant stimuli, allowing them to function safely within the environment. It may be that
470 mindfulness produced functional changes in attention-related brain areas (Fox, Corbetta,
471 Snyder, Vincent, & Raichle, 2006), such as reduction of stress-related brain activations, with
472 implications in a variety of cognitive functions such as attention, decision making, and
473 neurocognitive reaction time (Goldin & Gross, 2010; Perna et al., 2003). Studies have
474 reported that mindfulness practice, where improvements of attention have been observed,

475 were associated with changes of the anterior cingulate cortex (Hölzel et al., 2011; Hölzel et
476 al., 2007). Overall, such changes can improve the ability of soccer players to pay attention to
477 task-relevant stimuli during the competition and training and prevent attentional deficits.

478 Second, participants in the mindfulness group demonstrated decreases in trait anxiety
479 and perceived stress compared to the control group. In addition, changes in trait anxiety and
480 perceived stress were significant mediators of the relationship between the intervention and
481 sport injury, such that decreases in trait anxiety and stress as a result of the intervention were
482 associated with decreases in sport injury. Trait anxiety and perceived stress accounted for
483 61.5% and 27.5% of the total effect of mindfulness on decreased sport injury, respectively.
484 These results are important because according to the stress and athletic injury model, athletes
485 who experience higher levels of stress and anxiety are at greater risk of acute sport injury
486 (Williams & Andersen, 1998). Interventions that target stress appraisals or the stress response
487 can be useful in reducing the risk of acute sport injury (Brewer & Redmond, 2017) due to a
488 less intense stress response. Considering that trait anxiety is a relatively stable personality
489 characteristic, the idea of reductions of trait anxiety after a 7-week intervention may seem
490 counterintuitive. However, these findings replicate research showing increased trait
491 mindfulness and reductions in sport-related trait anxiety in recreational runners (De Petrillo,
492 Kaufman, Glass, & Arnkoff, 2009) and mixed-sport training in collegiate athletes (Glass,
493 Spears, Perskaudas, & Kaufman, 2018). The present results may suggest that, after a 7-week
494 mindfulness training, the subscales of trait sport anxiety, worry, and concentration disruption
495 decreased in the mindfulness group relative to pretest but not in the control group. Therefore,
496 consistent with the findings of Jain et al. (2007), mindfulness training can help athletes to
497 control the negative concerns about potential negative personal often expressed in ruminative
498 thoughts and catastrophizing.

499 Third, participants in the mindfulness group and non-injured athletes reported increases
500 in state and trait mindfulness. Moreover, mediation analysis suggests that the negative
501 indirect effects of state mindfulness accounted for 16.8% of the total effects of mindfulness
502 on the decreased risk of sport injury. Its indirect effects were the smallest of all the mediators,
503 but it is possible that state mindfulness may act through its influence on other variables. For
504 example, mindfulness practice may reduce emotional interference during sports training and
505 competition (Ivarsson, Johnson, Andersen, et al., 2015) through increased attention to the
506 current context and decreased continued processing of emotional stimuli (Ortner, Kilner, &
507 Zelazo, 2007). Increased state mindfulness after mindfulness training may help reduce the
508 detrimental experiences of sport-related anxiety (Scott-Hamilton & Schutte, 2016) and
509 improve future outcome expectations and attention. In addition, individuals varied
510 significantly their rates of change in state mindfulness after interventions, and these
511 individual trajectories predicted pre-post intervention changes in trait mindfulness and
512 distress (Kiken, Garland, Bluth, Palsson, & Gaylord, 2015). Other studies have also found
513 that, on average, mindfulness-based interventions increase trait mindfulness, which
514 contributes to psychological health (Carmody, Reed, Kristeller, & Merriam, 2008; Shapiro,
515 Oman, Thoresen, Plante, & Flinders, 2008).

516 Although mindfulness training is not specifically mentioned in the Andersen and
517 Williams model, based on our study we argue that mindfulness training can reduce the stress
518 response by attenuating negative appraisals of potentially stressful athletic situations (e.g., an
519 upcoming competition) and facilitating the use of adaptive forms of coping, such as positive
520 reappraisals (Weinstein et al., 2009). Positive reappraisals refer to the adaptive process
521 through which stressful events are re-construed as benign, useful, and meaningful (Garland,
522 Gaylord, & Park, 2009). It is an active and meaning-based coping strategy, which often is the
523 first step towards productive reengagement with stressful events (Folkman, 1997).

524 Mindfulness training can help individuals develop positive reappraisals in the face of stress
525 a cognitive coping style (Garland, Gaylord & Fredrickson, 2011).

526 Garland et al. (2011), when individuals cognitively appraise situations as threats, they
527 may cope by decentering from this stress appraisal into a mindfulness mode, wherein
528 individuals attend to the dynamic process of consciousness itself rather than its contents. This
529 state of consciousness is “characterized by broadened attention, awareness, and increased
530 cognitive flexibility” (p. 60) that help the individual to disengage and withdraw from the
531 initial appraisal into a momentary state of metacognitive awareness that attenuates semantic
532 evaluations associated with the event. Henceforth, people can reframe their initial negative
533 circumstances as meaningful or even advantageous. With persistent engagement with this
534 metacognitive awareness, a mindful disposition may develop and a coping cognitive style
535 based on cognitive reappraisals may emerge, leading to reduced stress. Further supporting
536 this argument, in the current study, following mindfulness training, trait and state
537 mindfulness improved in the uninjured players compared to the injured players, with large
538 effect sizes suggesting important clinical benefits of the intervention. In addition, changes in
539 state mindfulness mediated the relationship between mindfulness training and soccer injury.
540 Nevertheless, in our study the role of cognitive reappraisals as a coping strategy for stressful
541 situations was not considered; therefore, this variable should be measured in future studies to
542 explore the extent to which it mediates the relationship between mindfulness and injury.
543 The current study has several limitations that should be noted. This study was conducted with
544 male soccer players between 16 and 19 years of age; hence, generalizability to other age and
545 gender groups is not possible. Age differences can be expected as a result of injury history
546 and a trend for older people to receive long-term interventions. Gender differences in the
547 occurrence of sports injuries may affect the effectiveness of the program (Powell & Barber-
548 Foss, 2000), although this program does not seem to be gender-specific; hence, we suggest

549 that this program can be offered to both male and female athletes. In our study, we
550 retrospectively obtained the injury data for the pre-intervention period (past season), by
551 means of an individual interview conducted by a physical therapist and a medical student.
552 Participants' reports might have been inaccurate due to reliance on memory, resulting in
553 underestimation or overestimation of the number of injuries occurred during the previous
554 season. However, to minimize this limitation, in the present study, we used a control group
555 and matched participants on number of previous injuries; this strategy was deemed relevant
556 because it has been reported that previous injuries are strong predictors of both re-injury and
557 new injuries (Hägglund, Waldén, & Ekstrand, 2006). Due to potential difficulties with the
558 recall of past injuries, in the current study we considered only the injuries that athletes had
559 experienced in the previous season. Nevertheless, major injuries from past seasons may also
560 have an impact on perceived stress and current injuries. Hence, a longer injury history should
561 be considered in future research. Another limitation refers to the operational definition of
562 injury, which led us to disregard those injuries that resulted in fewer than 4 days of loss time
563 for the participants. The instruments chosen to measure mindfulness were not sport-specific.
564 Because a sport-specific mindfulness measure (Thienot et al., 2014) at the time the study, we
565 selected instruments that have been successfully applied in studies in sport (Noetel et al.,
566 2017). In addition, we did not formally record the duration of the home-based mindfulness
567 exercises in the intervention group after the seven formal training sessions. The duration of
568 such engagement component is likely to influence the effectiveness of intervention. Also,
569 although athletes from the same team were allocated to different groups, we did not formally
570 control the possible exchange of information between them. Therefore, the potential for
571 knowledge exchange existed, which may have confounded the results of the intervention. To
572 analyze the indirect effects of the mindfulness program on injuries we used Hayes' (2013)
573 mediation analysis approach and used the pre-test scores of the mediators as covariates. A

574 stronger approach would be to utilize structural equation models to fully control for
575 measurement errors; however, this approach has larger sample size requirements.
576 Furthermore, the model proposed suggested the existence of a suppression effect caused by
577 attention. Therefore, further studies should be conducted to clarify the role of
578 attention. Finally, assessing the long-term benefits of this intervention can also be useful to
579 decide on its cost effectiveness, that is, whether the proposed cost of prevention is lower than
580 the costs associated with sports injuries. Hence, follow-up studies are needed. The results of
581 this study suggest that a mindfulness training program can reduce the occurrence of acute
582 sport injuries through improvements in attention, trait anxiety, perceived stress and state
583 mindfulness. To understand the value of these results, we recall Benjamin Franklin's
584 statement: "An ounce of prevention is worth a pound of cure." Given that mindfulness
585 exercises can be conducted prior to, during, or after physical practice and because athletes
586 and coaches were satisfied with the effect of mindfulness training and were willing to use
587 such a program in the future, it is suggested that athletes should incorporate these exercises
588 into their practice.

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744 Table 1. Repeated ANOVA results for comparison of psychological factors between the control and mindfulness groups.

Variables	Time	Mindfulness Group (n=81)	Control Group (n=79)	Between Group Difference Mean (95% CI)	Time effects			Group effects			Time × group interaction		
					$F_{(1, 158)}$	p	η^2	$F_{(1, 158)}$	p	η^2	$F_{(1, 158)}$	p	η^2
Trait mindfulness	<i>Before</i>	134.52 ± 12.63	135.32 ± 12.56	-0.81 (-4.6; 3.1)	10.2	0.002	0.0	0.82	0.3	0.00	7.52	0.007	0.0
	<i>after</i>	139.94 ± 13.31	134.71 ± 13.28	3.21 (-0.8; 7.4)	1	*	6		7	5		*	4
State mindfulness	<i>Before</i>	24.15 ± 5.36	24.42 ± 6.41	-0.31 (-2.1; 1.5)	6.43	0.01*	0.0	1.10	0.3	0.01	9.36	0.003	0.0
	<i>after</i>	27.03 ± 5.73	24.32 ± 6.18	2.00 (0.2; 3.8)			4		0			*	5
Trait sport Anxiety	<i>Before</i>	35.03 ± 5.81	35.36 ± 5.83	-0.53 (-1.5; 0.2)	27.2	0.001	0.1	5.79	0.0	0.30	15.23	0.001	0.0
	<i>after</i>	31.15 ± 6.43	34.79 ± 5.93	-1.10 (-1.6; -0.1)	2	*	4		2			*	8
Stress	<i>Before</i>	10.84 ± 3.98	10.97 ± 4.36	0.09 (-1.4; 1.1)	26.7	0.001	0.1	1.88	0.1	0.01	14.34	0.001	0.0
	<i>after</i>	9.15 ± 3.83	10.71 ± 4.49	-1.42 (-2.9; -0.4)	8	*	4		7			*	8
Attention process	<i>Before</i>	3.28 ± 1.78	3.29 ± 1.82	-0.01 (-0.6; 0.5)	26.1	0.001	0.1	1.44	0.1	0.01	11.52	0.001	0.0
	<i>after</i>	4.14 ± 1.86	3.52 ± 1.91	0.62 (0.07; 1.2)	3	*	4		8			*	7

745 **Note.** * significant level at $\leq .01$.

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747 Table 2. Injury characteristics of the control and the mindfulness groups.

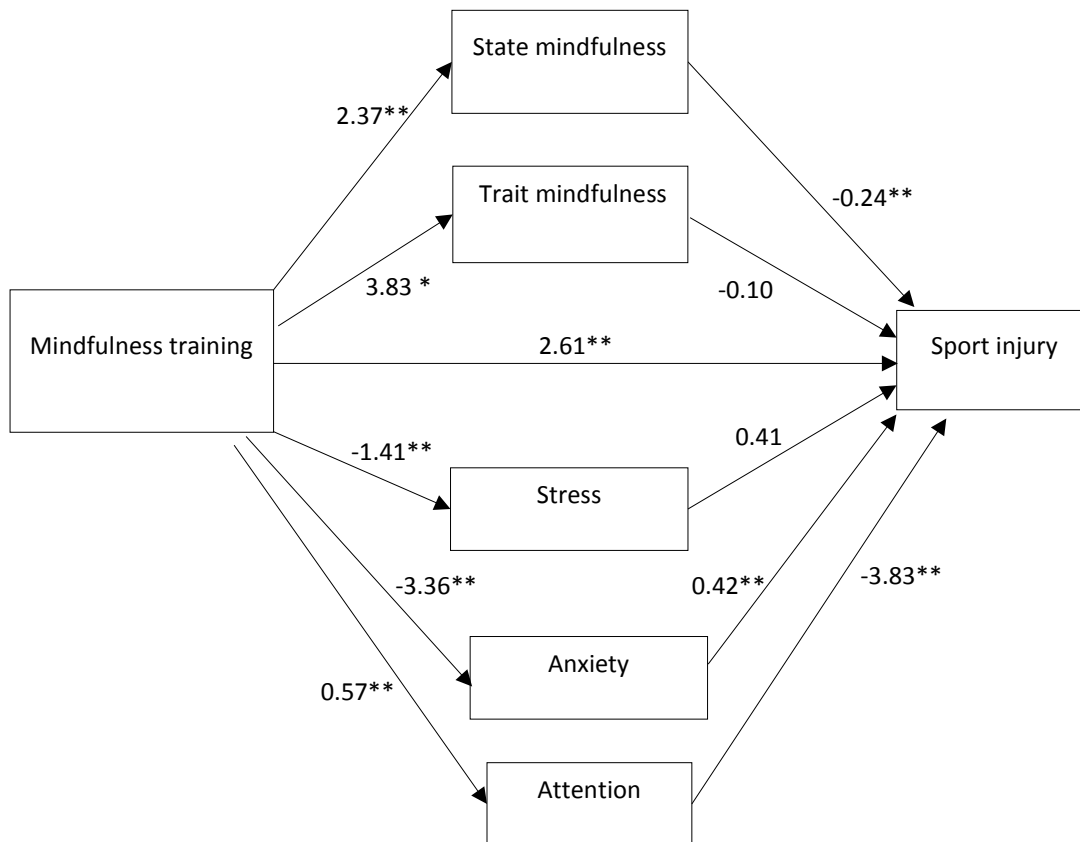
Variables	Mindfulness Group (n=81)	Control Group (n=79)	T or χ^2	p-value
<i>Number of athlete-exposure</i>				
Total	5942	5887		
Games	1351	1403		
Practices	4591	4485		
<i>Injuries, n [‡]</i>				
Total	22	36	5.09	0.02
Game	14	22	2.34	0.09
Practice	8	14	1.86	0.12
<i>Days lost to injury, n (mean \pmSD) [†]</i>				
	218 (9.88 \pm 8.56)	516(14.32 \pm 12.28)	4.1	0.03
<i>Injury intensity, n (%)[‡]</i>				
Mild	14 (63.47)	18 (50)	1.34	0.48
Moderate	6 (27.52)	15 (42)		
Sever	2 (9)	3 (8)		
<i>Incidence rate per 1000 athlete-exposure*</i>				
Total	3.67	6.12	2.76	0.03
Game	10.43	15.68		
Practice	1.72	3.13		

748 **Note.** [†] independent *t*-test analysis; [‡] chi-square analysis

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754 Figure 1. Path model of changes in psychological variables as mediators of the effects of
 755 mindfulness training on acute sport injury. **Note:** Sport injury was coded such that 0 = non-
 756 injured and 1 = injured. Group assignment was coded such that 0 = control group and 1 =
 757 mindfulness training. 5000 Bootstrapping samples from the original data set were generated
 758 by random sampling. Unstandardized coefficients are presented. * $p \leq .05$, ** $p < .01$, *** p
 759 $< .001$.

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