



## The association between mindfulness and mental health outcomes in athletes: testing the mediating role of autonomy satisfaction as a core psychological need

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1       **Title:** The Association Between Mindfulness and Mental Health Outcomes in Athletes:  
2       Testing the Mediating Role of Autonomy Satisfaction as a Core Psychological Need.

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29 **Title:** The Association Between Mindfulness and Mental Health Outcomes in Athletes:  
30 Testing the Mediating Role of Autonomy Satisfaction as a Core Psychological Need.

31 **Abstract**

32 Mindfulness may improve well-being through increasing one's ability to self-regulate  
33 stressors, which are common and multifaceted among the student-athlete population.  
34 However, the mechanisms for influencing such effects lacks a theoretical basis. Therefore,  
35 we sought to: (i) determine the relationship between mindfulness, well-being and stress in  
36 student-athletes, and: (ii) to assess the mediating role of autonomy satisfaction, an innate  
37 psychological need required for optimal well-being according to Self-Determination Theory.  
38 This was a cross-sectional study of 240 student-athletes (aged 20.5; SD=3.29; 53.7% males).  
39 Mindfulness and autonomy were regressed onto well-being (Model 1) and stress (Model 2) in  
40 multivariate regression models assessing direct and indirect mediating mechanisms. More  
41 than a third of athletes scored low on well-being, and only 3% high, and a significant  
42 proportion of variance was explained in both models (Model 1:  $R^2 = .40$ ; Model 2:  $R^2 = .37$ ).  
43 Mindfulness directly predicted autonomy satisfaction ( $\beta = .42, p < .001$ ), well-being ( $\beta = .26, p$   
44  $< .001$ ), and stress ( $\beta = -.21, p < .001$ ). Autonomy satisfaction also directly predicted well-  
45 being ( $\beta = .47; p < .001$ ) and stress ( $\beta = -.48; p < .001$ ), whilst partially mediating the association  
46 between mindfulness and well-being (indirect  $\beta = .19$ ) and stress (indirect  $\beta = -.20$ ). To  
47 conclude, mindfulness may improve well-being and reduce stress through increasing athletes'  
48 capacity to self-regulate, satisfying the psychological need for autonomy. Future research  
49 may consider designing a controlled trial of mindfulness interventions for student-athletes,  
50 underpinned and tested using SDT.

51 **Keywords:** meditation; self-determination theory; psychology; health; sport

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53

54 **Background**

55 Well-being is one dimension of a two continua model of mental health (Keyes, 2005), and  
56 defined as a state of optimal functioning (Ryan & Deci, 2017) characterised by psychological  
57 (e.g., a sense of purpose, realising one's potential), emotional (i.e., positive affective states,  
58 reduced negative affect) and social (i.e., relationships) dimensions. Well-being reliably  
59 produces positive mental health states (e.g., flourishing) (Keyes, 2005) and reduces  
60 incidences of mental illness (Huppert, 2009). In contrast, stress arises when demands on an  
61 individual exceed their personal resources and capacity to cope (Stephens, 1997), and is  
62 inversely related to well-being (Gu, Strauss, Bond, & Cavanagh, 2015). The student-athlete  
63 (or collegiate athlete) population are at risk of experiencing multiple sporting, academic and  
64 social stressors (discussed below) and subsequent mental health issues (Gavrilova, Donohue  
65 & Galante, 2017). Indeed, student-athletes demonstrate a higher clinical and sub-clinical risk  
66 for behavioural issues than non-athletes (e.g., substance misuse, eating disorders, gambling;  
67 Moreland, Cox & Yang, 2017), and most data indicate that student-athletes are at least as  
68 likely as non-athletes, or in some cases more likely, to experience mood disorders (Donohue  
69 et al., 2018). As such, there is consensus that innovative approaches to mental health  
70 promotion are required for the student-athlete population (Breslin, Shannon, Haughey,  
71 Donnelly & Leavey, 2017; Schinke, Stambulova, Si, & Moore, 2018; Moesch et al., 2018).

72 Student-athletes experience co-existing academic, social and sporting demands  
73 (Wilson & Pritchard, 2005; Bennet, 2007). For example, many student-athletes live away  
74 from home, and undergo academic assessment expectations, financial stressors and uncertain  
75 career prospects (Pitt, Opreescu, Tapia, & Gray 2017; Sudano, Collins & Miles, 2017) on top  
76 of sport participation. Surveys also indicate that sport competition demands (e.g., physical  
77 and technical preparation) negatively impact upon student-athletes' social life and  
78 relationships (Wilson & Pritchard, 2005), with some equating sporting participation to  
79 working in two full-time jobs (Bennet, 2007). As such, through feeling pressure to perform in

80 both academic and sporting pursuits, student-athletes report having a constrained social life  
81 and relationship difficulties (Abedalhafiza, Althaynehb & Al-Haliqc, 2010; Gavrilova et al.,  
82 2017). Furthermore, due to the physical and often aggressive nature of sport, student-athletes  
83 are likely to sustain injury, and experience emotional and physical fatigue from competition  
84 and over-training (Putukian, 2015). When not managed appropriately, the presence of such  
85 multifaceted stressors can result in impaired functioning and maladaptive coping (e.g.,  
86 gambling, substance misuse) (Moreland et al., 2017). Collectively, the above evidence  
87 highlights the need for mental health self-management strategies.

88         Mental health self-management is defined as an ability to self-monitor how one's  
89 mental health is impacting upon personal functioning, and use of strategies that protect and  
90 promote mental health (Wolf, 1996; Shannon et al., 2019a). However, many student-athletes  
91 report that they do not have the awareness and knowledge required to self-manage mental  
92 health (Eisenberg, Golberstein & Gollust, 2007; Hunt & Eisenberg, 2010). One self-  
93 management intervention that is receiving increasing cultural support among athletes is  
94 mindfulness (Noetel, Ciarrochi, Van Zanden, & Lonsdale, 2017). Mindfulness is defined by  
95 Brown and Ryan (2003) as being attentive to and aware of present events and experiences.  
96 The benefits of mindfulness to mental health are diverse (Creswell, 2017), with a variety of  
97 interventions helping individuals alleviate depression and anxiety symptoms, and improve  
98 emotional well-being (Chiesa & Serretti, 2011; Keng, Smoski & Robins, 2011; Creswell,  
99 2017). Mindfulness may also help individuals direct motivations and intentions into health  
100 behaviour change (Chatzisarantis & Hagger, 2007).

101         Mindfulness is increasingly being used in sport psychology (Noetel et al., 2017) on  
102 the basis that mindfulness improves sport-related mental states among athletes (e.g., reducing  
103 performance anxiety, improving flow) (Sappington & Longshore, 2015). However, despite  
104 the advent of several recent position and consensus statements on athlete mental health

105 (Reardon, Hainline, Aron, Baron, Baum & Bindra, 2019; Breslin et al., in press; Schinke,  
106 Stambulova, Si, & Moore, 2018; Moesch et al., 2018), a systematic review established that  
107 mindfulness studies in sport have focused on performance-related outcomes, with few  
108 centered on mental health (Noetel et al., 2017). Furthermore, of the few mental health studies  
109 that have been conducted (e.g., Vidic, Martin & Oxhandler, 2017; Vidic, Martin &  
110 Oxhandler, 2017), there has been little attention to the precise mechanisms driving the effects  
111 of mindfulness on mental health outcomes.

112 To ascertain how mindfulness may relate to improved mental health, theoretical  
113 constructs can be modelled to study the indirect effect of a predictor variable ( $X$ ) on an  
114 outcome ( $Y$ ) through one or more mediating variables ( $M$ ) (Kok, Schaalma, Ruiters, Van  
115 Empelen & Brug, 2004). Through Self-Determination Theory (SDT), Ryan & Deci (2000)  
116 contend that satisfaction of one's innate psychological need for autonomy is an essential  
117 requirements for optimal well-being. Autonomy satisfaction is defined as having volitional  
118 actions or beliefs that are self-endorsed by the individual (Ryan & Deci, 2000), and research  
119 indicates that autonomy satisfaction is related to mental health outcomes and self-  
120 management behaviours (Ryan & Deci, 2017). Whilst SDT's other core psychological needs  
121 of competence (i.e., sense of effectiveness) and relatedness (i.e., sense of belonging) needs  
122 satisfaction are relevant to mental health self-management (Wolf, 1996), autonomy  
123 satisfaction has a particularly close theoretical alignment, such that when one's need for  
124 autonomy is satisfied, one experiences a sense of personal volition regarding their selection  
125 of mental health-related behaviours (e.g., help-seeking), through to endorsing values (e.g.,  
126 importance of mental health) at a high level of awareness (Ryan & Deci, 2017). From a SDT  
127 perspective it is well established that socio-environmental support can facilitate  
128 psychological needs satisfaction. Yet, mindfulness is also viewed as an internal support  
129 mechanism that individuals can avail of to satisfy basic needs such as autonomy (Weinstein

130 & Ryan, 2011; Ryan & Deci, 2017), yet such hypotheses lacks comprehensive empirical  
131 inquiry.

132 In SDT it is proposed that autonomy satisfaction can be supported by mindfulness,  
133 insofar as mindful states provide individuals with a greater awareness of ongoing events and  
134 subsequent purposeful selection of need-satisfying experiences (Campbell et al. 2015;  
135 Campbell et al., 2017) that is consistent with one's values, motives and interests (Brown &  
136 Ryan, 2003; Schultz et al., 2015). In contrast, less mindful individuals are assumed to have a  
137 reduced capacity to satisfy their need for autonomy and self-regulate their actions, making  
138 them more reactive or impulsive under controlled conditions, resulting in subsequent needs  
139 frustration (Brown, Ryan & Cresswell, 2007). Scant research has examined the association  
140 with mindfulness and autonomy satisfaction however (Parto & Besharat, 2011), with only  
141 one study to our knowledge among athletes; (Chang, Chang, & Chen, 2018). Both  
142 aforementioned studies supported the mechanism that autonomy satisfaction mediated the  
143 relationship between mindfulness with psychological well-being. However with replication  
144 being a cornerstone of the scientific method in prevention science (Valentine et al., 2011),  
145 further research is required to determine sufficient rigor in the understanding of the  
146 mindfulness and mental health relationship. Furthermore , those studies included a sample of  
147 717 seventeen year old at-risk students not involved in competitive sport (Parto & Besharat,  
148 2011), or among Eastern athletes (Chang et al., 2018) which raises the methodological issue  
149 of extrapolable of the data to Western athletes (Schumaker & Lomax, 2004), particularly  
150 given the cultural prevalence and acceptance of meditative practices in Eastern populations,  
151 that is not as evident in Western populations (Cresswell, 2017) Furthermore, stress which is a  
152 significant factor implicated in mental health (Huppert, 2009; Gu, Strauss, Bond, &  
153 Cavanagh, 2015), has yet to be studied in current SDT research on mindfulness, suggesting a  
154 gap in current theoretical understanding.

155 Hence, in response to recent consensus statements (Schinke et al., 2018; Breslin et al.,  
156 in press) that innovative and theoretically-driven approaches are required for athlete mental  
157 health promotion, the present study sought to understand the role of mindfulness in  
158 promoting well-being and reducing stress among student-athletes, through the mediating role  
159 of autonomy satisfaction. The findings will contribute to theoretical advancement of SDT,  
160 and towards evidence-based recommendations for mental health promotion among the  
161 student-athlete population.

162 *Study hypotheses*

163 In accordance with SDT hypotheses (Ryan & Deci, 2000; see Figure 1 below) and extant  
164 mindfulness research applying SDT (Chang et al., 2018), two models were tested assessing  
165 (1) well-being, and (2) stress as dependent variables ( $Y$ ), with mindfulness as the independent  
166 variable ( $X$ ) and autonomy satisfaction ( $M$ ), as the mediating variable.

167 In Model 1, mindfulness was hypothesised to directly and positively predict well-  
168 being (Hypothesis 1;  $H_{1a}$ ) and autonomy satisfaction (Hypothesis 2;  $H_2$ ). Autonomy  
169 satisfaction was also hypothesised to directly and positively predict well-being (Hypothesis 3;  
170  $H_3$ ). Given mindfulness may exert a direct and indirect link to well-being through a variety of  
171 biopsychosocial self-regulatory mechanisms (Brown & Ryan, 2000; Brown et al., 2007; Gu  
172 et al., 2015), the link between mindfulness and well-being was hypothesised to be partially,  
173 rather than fully mediated through autonomy satisfaction (Hypothesis 4;  $H_{4a}$ ). In Model 2, all  
174 of the above hypotheses were repeated ( $H_{1b}$ ,  $H_2$ ,  $H_3$ ,  $H_{4b}$ ), replacing well-being with stress as  
175 the dependent variable, and each of the relationships predicting stress were hypothesised to  
176 be negative.

177 ***Please insert Figure 1: Multivariate regression model assessing direct and indirect***  
178 ***association between mindfulness ( $X$ ) on well-being/stress ( $Y$ ) through autonomy satisfaction***



179 (M).

## 180 **Method**

### 181 *Study design, size, setting and participants*

182 The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE)  
183 guidelines were adopted (see von Elm, Altman, Egger, Pocock, Gøtzsche, Vandenbroucke, et  
184 al., 2007). Ethical approval was granted from Ulster University. Data collection was  
185 conducted in the institution through online SurveyMonkey software. Inclusion criteria was  
186 based on students reporting 'yes' to the following question consistent with the definition of  
187 sport, 'Are you an athlete involved in a structured, competitive physical activity?' (Rejeski &  
188 Brawley, 1988).

### 189 *Variables and measurement*

#### 190 *Demographic variables*

191 Two hundred and forty student-athletes took part. The mean age of the sample was 20.50  
192 years (SD=3.29), 57.3% percent were males and 42.7% were females. A broad range of  
193 sports were represented in the sample, with the most common being Gaelic Sports (42%),  
194 Football (22.5%), Rugby (5.8%), Hockey (5.1%), Basketball (3.6%), Netball (2.9%), Irish  
195 Dancing (2.9%), and other sports (15.2%; e.g., Athletics, Combat, Rowing).

#### 196 *Mindfulness*

197 The Mindfulness Attention Awareness Scale (MAAS; Brown & Ryan, 2003) was used to  
198 measure mindfulness disposition. The MAAS is a 15-item scale constructed through a uni-  
199 dimensional factor, designed to assess an individual's attention to, and awareness of, day-to-  
200 day internal and external experiences. An example item is: 'I could be experiencing some  
201 emotion and not be conscious of it until some time later'. A 6-point Likert scale scoring  
202 method ranging from 'almost always' (1), to 'almost never' (6) is used, wherein higher scores

203 reflect higher mindfulness. Several studies have demonstrated the validity and reliability of  
204 the MAAS, including support for a unidimensional factor structure (Brown & Ryan, 2003;  
205 MacKillop & Anderson, 2007), including those in sport with athlete samples (Araya-Vargas  
206 et al., 2009). Cronbach's alpha within the present sample was .88.

207 *Autonomy satisfaction*

208 The Perceived Choice and Awareness of Self Scale (PCASS), or as formerly labeled the  
209 'Self-Determination Scale' (Sheldon, Ryan & Reis, 1996), was used to measure autonomy  
210 satisfaction, specifically to the degree of volition one experiences over their behaviours and  
211 sense of self. The PCASS is a 10-item measure with items scored on a 5-point Likert scale on  
212 a structured alternative format. Participants selected if 'only A feels true' (1 point) through to  
213 'only B feels true' (5 points). The PCASS is a valid and reliable measure of autonomy  
214 satisfaction (Sheldon et al., 1996; Thrash & Elliot, 2002). An example item includes: 'A. I  
215 always feel like I choose the things I do', or 'B. I sometimes feel that it's not really me  
216 choosing the things I do'. The PCASS has been psychometrically tested with athletic  
217 populations (Mouratidis & Michou, 2011). Cronbach's alpha within the present sample = .82.

218 *Well-being*

219 The Warwick-Edinburgh Mental Well-being Scale (WEMWBS; Tennant et al., 2007) was  
220 used to assess student-athletes' levels of well-being. The WEMWBS is a valid and reliable  
221 tool for measuring well-being (Tennant et al., 2007; Stewart-Brown et al., 2011), and has  
222 been used extensively in athletic populations (Appelqvist-Schmidlechner et al., 2018).  
223 Cronbach's alpha analysis yielded .90 within the present sample. The measure comprises 14-  
224 items through a uni-dimensional factor structure, with statements designed to measure both  
225 hedonic (e.g., happiness and life satisfaction), social (i.e., relationships) and eudemonic (i.e.,  
226 self-actualisation) well-being components. Each item is positively worded and scored on a 5-

227 point Likert scale ranging from ‘none of the time’ (1), to ‘all of the time’ (5). Total scores can  
228 range from 14 through to 70, with higher scores indicating higher well-being. Previous  
229 research (Fat et al., 2017) has established three well-being profiles from the measure scores,  
230 including ‘low’ (i.e., 14–42); ‘medium’ (i.e., 43–60) and ‘high’ (i.e., 61–70).

### 231 *Stress*

232 The Perceived Stress Scale (PSS; Cohen, Kamarck, & Mermelstein, 1994) was used to  
233 measure student-athlete’s appraisal of stress in day-to-day experiences. The PCSS is  
234 constructed through a uni-dimensional factor, and includes 10-items, each scored on a 5-point  
235 Likert scale ranging from 0 ‘never’ to 4 ‘very often’. The PCSS demonstrates excellent  
236 psychometric properties across a range of samples including students (Roberti, Harrington &  
237 Storch, 2006; Lee, 2012). The PSS has been tested in mindfulness intervention studies with  
238 athletes (Vidic, Martin & Oxhandler, 2017), and Cronbach’s alpha was high (.83) within the  
239 present sample. Scoring methodology for the PCSS (Cohen et al., 1994) indicates a uni-  
240 dimensional structure, with a total score reflecting stress levels, and lower scores indicate less  
241 stress.

### 242 *Statistical methods and bias*

#### 243 *Data management*

244 Raw scores were transferred into Statistical Package for Social Sciences (SPSS version 22).  
245 Two researchers inspected the data set for outliers. For each scale, Little’s Missing  
246 Completely at Random (MCAR; Little, 1988) was conducted to determine if missing data  
247 was in random order. MCAR analyses revealed the data was indeed missing at random ( $p$   
248  $>.05$ ), with missing responses ranging between 2-5%. Subsequently, the Expectation  
249 Maximisation (EM) algorithm was conducted on each individual scale, using inter-correlated  
250 items for estimating missing values (Field, 2013).

251 *Data analyses*

252 Descriptive statistics were calculated for each scale, with mean scores and standard  
253 deviations produced. A correlation matrix was produced for each of the outcome variables.  
254 Low, moderate and high well-being profiles were created based on the scoring methodology  
255 for the WEMWBS (Tennant et al., 2007).

256 Hayes' (2015) PROCESS macro for SPSS was used to test the study hypotheses (see  
257 Figure 1). To produce standardised beta coefficient ( $\beta$ ) values, all variables were standardised  
258 as z-scores. In Model 1, mindfulness was specified as the independent variable ( $X$ ), and  
259 regressed onto autonomy satisfaction ( $M$ ) and well-being (dependent variable;  $Y$ ). In Model  
260 2, stress replaced well-being as the dependent variable ( $Y$ ; depicted in Figure 1). To examine  
261 indirect relationships, a bootstrapping technique was conducted with 5000 samples to  
262 improve model accuracy and parameter reliabilities (Byrne, 2001). Results show if the  
263 relationship between  $X$  and  $Y$  is (i) non-significant; (ii) direct with non-mediation (i.e.  
264 mediator does not influence relationship); (iii) fully mediated (i.e. direct effect is no longer  
265 significant after controlling for mediators' effect); (iv) partially mediated (i.e. direct effect is  
266 significant alongside an indirect effect) or, (v) indirect (i.e. no direct effect, but significant  
267 indirect effects: Hayes, 2009). Associations between the variables were determined  
268 statistically significant ( $p < .05$ ) on the basis of confidence intervals not crossing zero (Field,  
269 2013). Two figures were produced to visually illustrate Model 1 and 2 (see Figures 3 & 4  
270 respectively), including completely standardised beta ( $\beta$ ) coefficient values for each direct  
271 path, and  $R^2$  values for proportion of total predicted variance in the model on the dependent  
272 variable, mediators and the  $R^2$  mediated effect size.

273 **Results**

274  
275 *Outcome data*

276 Mean scores and standard deviations for psychometric scales are presented in Table 1.

277 Categorisation of the sample based on well-being scores showed that 35% of participants

278 scored low, 62% medium, and 3% high.

279 **Please insert Table I: Mean scores, correlation matrix and Cronbach's alpha values for the**  
280 **study outcomes.**

### 281 **Main results**

#### 282 *Model 1: Well-being as the dependent variable*

283 Results from Model 1 indicated that mindfulness ( $X$ ) significantly and directly predicted  
284 autonomy satisfaction ( $M$ ;  $\beta=.42$ ,  $p < .001$ , 95% CI's = [.304 to .506];  $R^2= .18$ ), and well-  
285 being ( $Y$ ;  $\beta=.26$ ,  $p < .001$ , 95% CI's = [.158 to .377]), supporting  $H_{1a}$  and  $H_2$ . In support for  
286  $H_3$ , autonomy satisfaction also directly and positively predicted well-being ( $Y$ ;  $\beta= .47$ ,  $p$   
287  $< .001$ , 95% CI's = [.361 to .580]). When exploring the indirect relationship between  
288 mindfulness and well-being through autonomy satisfaction, analyses revealed that while the  
289 direct relationship remained significant, indirect associations were also present, suggesting  
290 partial mediation through autonomy satisfaction. Specifically, and in support for  $H_{4a}$ ,  
291 mindfulness ( $X$ ) in sequence with autonomy satisfaction ( $M$ ) resulted in a significant indirect  
292 association with well-being ( $Y$ ;  $\beta=.19$ , 95% CI's = [.120 to .289]), and an  $R^2$  mediated effect  
293 size of .16. Factoring in all of the variables in Model 1 resulted in a significant proportion of  
294 variance predicted for well-being ( $R^2= .40$ ). See Figure 2 for a visual description of Model 1,  
295 including specific  $\beta$  coefficients for significant paths.

#### 296 *Model 2: Stress as the dependent variable*

297 Results from Model 2 were aligned with Model 1, to the extent that mindfulness ( $X$ )  
298 significantly and directly positively predicted autonomy satisfaction ( $M$ ;  $\beta=.42$ ,  $p < .001$ , 95%

299 CI's = [.304 to .506];  $R^2 = .18$ ), and in this case, negatively predicted stress ( $Y$ ;  $\beta = -.21$ ,  $p$   
300  $< .001$ , 95% CI's = [-.330 to -.105]), supporting  $H_{1b}$  and  $H_2$ . Autonomy satisfaction also  
301 directly and negatively predicted stress ( $Y$ ;  $\beta = -.48$ ,  $p < .001$ , 95% CI's = -.594 to -.370),  
302 supporting  $H_3$ . When exploring  $H_{4b}$ , specifically regarding the indirect association between  
303 mindfulness and stress through autonomy satisfaction, analyses revealed partial mediation.  
304 Specifically, the direct path remained significant, but mindfulness ( $X$ ) in sequence with  
305 autonomy satisfaction ( $M$ ) resulted in a significant indirect association with stress ( $\beta = -.20$ ,  $p$   
306  $< .001$ , 95% CI's = [-.282 to -.141]), and an  $R^2$  mediated effect size of .14. Factoring in all of  
307 the variables in Model 2 resulted in a significant proportion of variance predicted for stress  
308 ( $R^2 = .36$ ). See Figure 3 for a visual description of Model 2, including specific beta  
309 coefficients for significant paths.

310 *Please insert Figure 2: Model 1 showing the relationship between mindfulness (X) and well-*  
311 *being (Y) through autonomy satisfaction (M).*

312 *Please insert Figure 3: Model 2 showing the association between mindfulness (X) and stress*  
313 *(Y), through autonomy satisfaction (M).*

## 314 **Discussion**

315 This study was in response to calls that theoretically-driven research is needed for improved  
316 understanding of athlete mental health (Schinke et al., 2018; Moesch et al., 2018; Breslin et  
317 al., 2019). As such, mindfulness was examined as a predictor of mental health outcomes  
318 including stress and well-being, with autonomy satisfaction derived from SDT (Ryan & Deci,  
319 2000) used as a theoretical lens to understand the underlying mechanisms between  
320 mindfulness and mental health. As one of the pioneering mindfulness studies to incorporate  
321 SDT (Ryan & Deci, 2000) among a sporting population at-risk of mental health challenges  
322 (Shannon et al., 2019b), our study makes a number of contributions to the literature,  
323 specifically through outlining the indirect mechanisms driving the salutary associations

324 between mindfulness and mental health (Creswell, 2017). Overall, a significant proportion of  
325 variance was explained in both models (Model 1:  $R^2 = .40$ ; Model 2:  $R^2 = .37$ ), with results  
326 supporting the study hypotheses. Specifically, mindfulness predicted well-being and stress  
327 ( $H_{1a,b}$ ), and autonomy satisfaction ( $H_2$ ); autonomy satisfaction predicted well-being and stress  
328 ( $H_3$ ), and; autonomy satisfaction partially mediated the association between mindfulness and  
329 the mental health outcomes of well-being and stress ( $H_{4a,b}$ ). Taken collectively, the findings  
330 are of theoretical value to the mechanisms of mental health promotion through mindfulness,  
331 and are now discussed in relation to practical and theoretical considerations in further work.

332         As well-being is a key component of mental health (Keyes, 2002), it was notable that  
333 just 3% of the sample scored high, in contrast to the 35% that scored low and 62% at medium  
334 in the WEMWBS (Tennant et al., 2007). To provide context to these figures, comparisons  
335 with a UK sample ( $n = 27,169$ ) using the same measures (Fat et al., 2017), suggests lower  
336 well-being among student-athletes than the general population who scored 15% (low), 71%  
337 (medium), and 14% (high). The significant proportion of the sample (35%) reporting low  
338 well-being is of concern, particularly given that low well-being increases the likelihood of  
339 mental illnesses (Keyes, 2005; Huppert, 2009). Likewise, on average student-athletes  
340 reported higher stress levels ( $M: 18.13$ ) than various demographic groups in a sample based  
341 in the United States (US; Cohen & Janicki-Deverts, 2012), including those in unemployment  
342 ( $M: 16.46$ ). As such, it was of empirical value to test predictors of well-being and stress in  
343 the present study.

344         Results of Model 1 and Model 2 showed that mindfulness directly predicted well-  
345 being and stress ( $H_{1a,b}$ ). Given that the direct effects of mindfulness on well-being and stress  
346 remained significant in the model after accounting for the mediating influence of autonomy  
347 satisfaction, i.e., partial rather than full mediation (discussed below), mindfulness may have  
348 unique associations with mental health beyond psychological needs satisfaction. For

349 example, there are proposals that mindfulness improves somatic experiences which leads to  
350 greater positive effect, and less negative affect (Brown et al., 2007; Hölzel et al., 2011), and  
351 mindfulness results in better cognitive appraisal and reductions in rumination (Gu et al.,  
352 2017). Moreover, mindfulness may increase one's likelihood to convert intentions into health  
353 behaviours that promote well-being, such as physical activity (Chatzarakis & Hagger, 2007).

354 Most relevant to our findings however, as the mindfulness construct has been shown  
355 to mediate effects of mindfulness programmes on mental health outcomes (Gu et al., 2015), it  
356 is worth aiming to effectively engage athletes with mindfulness practices to possibly improve  
357 mindfulness dispositions. Such provision may be better received when athletes feel the  
358 intervention is sensitive to the nuances of sports culture (Gavrilova et al., 2017). Examples  
359 like this can be seen in the Mindfulness-Acceptance-Commitment Programme (MACP;  
360 Gardner & Moore, 2004), which has been linked with both positive sporting and mental  
361 health outcomes (Gardner & Moore, 2007; Gross et al., 2018; Zhang, Chung, Si, &  
362 Gucciardi, 2016; Perry et al., 2017). Beyond the aforesaid direct associations between  
363 mindfulness and mental health outcomes, the present study sought to delve further into the  
364 mechanisms driving the salutary role of mindfulness.

365 Specifically, results of Model 1 and Model 2 showed that mindfulness directly and  
366 positively predicted autonomy satisfaction (H<sub>2</sub>). These findings lend support to the view that  
367 beyond interpersonal factors, mindfulness can act as mechanism from within which may  
368 satisfy one's innate psychological need for autonomy (Schultz et al., 2015; Ryan & Deci,  
369 2017). Specifically, the data support the hypotheses that mindfulness may facilitate a mental  
370 state that is attentive to the present, which helps individuals remain reflective to ongoing  
371 internal (e.g., strong emotions) and external (e.g., demanding tasks) prompts. Subsequently,  
372 athletes may be able to make dispassionate, autonomy-satisfying decisions during demanding  
373 and stressful experiences (Campbell et al. 2015; Campbell et al., 2017). For instance, a coach



374 may demand that their team behave aggressively during a sporting competition in order to  
375 intimidate other competitors, despite such behavior being inconsistent with many of the  
376 individual team members' autonomous values. Importantly, Schultz et al. (2014) have  
377 outlined that in these cases, mindful and less mindful athletes within the team will experience  
378 similar levels of autonomy frustration, however, the more mindful athletes will be more  
379 resilient to the control over their autonomy, and self-regulate and cope more effectively.  
380 Therefore, as autonomy satisfaction has been evidenced to be a core characteristic of healthy  
381 human functioning (Schultz et al., 2015; Ryan & Deci, 2017), cultivating mindfulness  
382 through meditative practices may have added value in increasing the likelihood of adaptive  
383 responses to the multiple stressors faced by student-athletes in sporting (e.g., injury,  
384 performance), social (e.g., peers) and academic (e.g., assessment demands) pursuits (Gross et  
385 al., 2018).

386         As mindfulness can be enhanced during short (Rosenkranz, Dunne, & Davidson,  
387 2019) and longer-term (Cayoun, 2011; Creswell, 2017) interventions, it may be worth aiming  
388 to effectively engage athletes with a range of mindfulness programmes for improving basic  
389 needs fulfillment. However, while most SDT theorists propose that the mindfulness construct  
390 precedes autonomy satisfaction, in addition to competence and relatedness satisfaction (e.g.,  
391 Brown et al., 2007; Schultz et al, 2015), it is worth raising the point that, in a temporal sense,  
392 the relationship between mindfulness and needs satisfaction has been mixed. For instance,  
393 some authors (Olfan, 2017; Shannon et al., 2019b) have found empirical support for needs  
394 satisfaction preceding the mindfulness construct, and thus may produce the energy to enable  
395 one to focus on the present. Whereas, others suggest that mindfulness is the precursor to  
396 needs satisfaction (Schultz et al, 2015; Chang et al., 2018). The cross-sectional nature of the  
397 present research study permits testing the temporal order of these events, and therefore,

398 future longitudinal intervention studies may consider this open question, which is of  
399 theoretical value.

400         Models 1 and 2 demonstrated that autonomy satisfaction positively predicted well-  
401 being, and negatively predicted stress (H<sub>3</sub>). The data therefore supports SDT hypotheses  
402 (Ryan & Deci, 2000), and a cogent body of research that autonomy satisfaction is robustly  
403 related to positive mental health (Sheehan, Herring & Campbell, 2018). While the present  
404 study supports the view that mindfulness be explored as a potential facilitator of autonomy  
405 satisfaction (Ryan & Deci, 2017), the multitude of interpersonal factors influencing student-  
406 athletes' sense of autonomy satisfaction should not be discounted. For example, the provision  
407 of input into sporting, social and academic matters by coaches (Ntoumanis, Quested, Reeve,  
408 & Cheon, 2017), peers (Moreland et al., 2017) and university tutors (Pitt, et al., 2017) may be  
409 as significant, or indeed more so, as mindfulness to student-athletes basic needs fulfillment.  
410 Thus, both intra and interpersonal support mechanisms should be considered in the context of  
411 mental health provision for student-athletes.

412         The mediating role exerted by autonomy satisfaction in the mindfulness and well-  
413 being and stress relationship (H<sub>4a,b</sub>) supports the SDT perspective (Brown & Ryan's, 2003;  
414 Weinstein & Ryan, 2011) and empirical evidence (Chang, Huang & Lin, 2015; Chang, et al.,  
415 2018) that the fulfillment of basic psychological needs can mediate the effects of mindfulness  
416 on mental health outcomes. Examined through the lens of eudemonic (e.g., realising one's  
417 potential), emotional (i.e., positive affective states, reduced negative affect) and social (i.e.,  
418 relationships) well-being dimensions, through mindfulness an athlete may be more capable of  
419 recognizing injury and ill-being symptoms stemming from their sporting participation  
420 (Gustafsson, Skoog, Davis, Kenttä & Haberl, 2015). In this example, an athlete might  
421 experience ongoing pressures from their coaching staff to continue training and competing  
422 under injury. However, the more mindful athlete may understand such attempts to control

423 their autonomy, and instead, decide to seek medical attention based upon the best interests of  
424 their mental and physical health, and sporting performance (Gross et al., 2018). Being better  
425 informed and reflective to such somatic information has been shown to prevent ill-being, and  
426 promoting longer-term wellness (Creswell, 2017). In contrast, with acting without  
427 mindfulness, an athlete may continue competing through painful injury, and despite  
428 achieving short-term introjected approval, struggle with the negative long-term effects on  
429 their health and sporting participation, sometimes resulting in burnout and withdrawal from  
430 their sport (Gustafsson et al. 2015).

431         Lastly, the present study was the first among athletes to evidence that autonomy  
432 satisfaction mediated the relationship between mindfulness and stress (H<sub>4b</sub>). In a practical  
433 sense, when student-athletes develop improved awareness through mindfulness, this may  
434 reduce stress through self-regulation, such that attention can be directed to behaviours and  
435 coping mechanisms that fulfil their needs, values and interests (Brown & Ryan, 2003). For  
436 example, athletes could draw upon mindfulness to satisfy their autonomy in social contexts  
437 that are controlling and stressful in nature, wherein peers may provoke them to display values  
438 (e.g., hedonistic) and behaviours (e.g., drug use) inconsistent with their basic need for  
439 autonomy (Reb, Narayanan, & Ho, 2015). Given mindfulness is characterized by a non-  
440 judgmental and open attention to the present, such athletes may be less likely to introject  
441 external values, or ruminate over whether to engage with approval-seeking behaviours  
442 (Creswell et al., 2007; Weinstein, Brown & Ryan, 2009).

443         The key contribution of the current study was the integration of SDT (Ryan & Deci,  
444 2000) into a predictive model of student-athletes mindfulness and mental health, who remain  
445 an understudied sporting population at-risk of mental health challenges (Shannon et al.,  
446 2019a). The findings provide several theoretical and practical considerations. For instance,  
447 the link found between mindfulness and mental health outcomes indicates that practitioners

448 may consider a proactive attempts to engage athletes with mindfulness interventions, whilst  
449 also paying attention to the remaining open questions regarding access and potential risks  
450 (see Creswell, 2017). Further, as autonomy satisfaction was found to mediate the association  
451 between mindfulness and well-being and stress, further research may consider integrating  
452 components of SDT into a mindfulness intervention to help determine the precise  
453 mechanisms of well-being promotion through mindfulness. Such work may consider  
454 assessing the temporal order of the mindfulness-needs satisfaction relationship, and be  
455 rigorously tested through a longitudinal, controlled study design. Despite these contributions,  
456 our study is not without its limitations. One limitation was that we could not infer causality  
457 from the data because of the cross-sectional design, and additional SDT components (i.e.,  
458 competence and relatedness satisfaction) were absent from the models. A future  
459 recommendation is that studies adopt a longitudinal experimental design with additional SDT  
460 components that consider these limitations.

461 To conclude, recent position statements (Schinke et al., 2018; Moesch, Kenttä,  
462 Kleinert, Quignon-Fleuret, Cecil & Bertollo, 2018; Breslin et al., in press) have indicated that  
463 theoretically-driven mental health research is needed among athletes. Therefore, the present  
464 study assessed the role of mindfulness in predicting well-being and stress in student-athletes  
465 through autonomy satisfaction, an innate psychological need according to SDT. Study  
466 hypotheses were supported, and the findings have led us to suggest that more mindful  
467 student-athletes may act with an awareness which may reduce stress and improve well-being  
468 through mechanisms reflective of autonomy satisfaction. To this end, mindful student-  
469 athletes may have a greater volitional capacity, in the sense that their attention can be  
470 directed to behaviours and coping mechanisms during times of stress, that can fulfil their  
471 needs, which may ultimately result in positive mental health (Brown & Ryan, 2003). As such,  
472 attempts to engage athletes with mindfulness interventions may be considered , with caution

473 to be given to the remaining open questions regarding accessibility and potential risks  
474 (Creswell, 2017). From a theoretical, practical and research standpoint, SDT may be  
475 considered in the design and evaluation of mindfulness interventions, in which researchers  
476 may consider employing a longitudinal controlled research design.

#### 477 **Declaration of interest statement**

478 All authors declare no conflict of interest. This research adhered to the ethical principles of  
479 the declaration of Helsinki. All participants provided informed consent prior to their  
480 involvement in the study.

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#### 734 **List of figures**

735 Figure 1: Multivariate regression model assessing direct and indirect effects of mindfulness  
736 (X) on well-being/stress (Y) through autonomy (M).

737 Figure 2: Model 1 showing the effect of mindfulness (X) on well-being (Y) through  
738 autonomy (M).

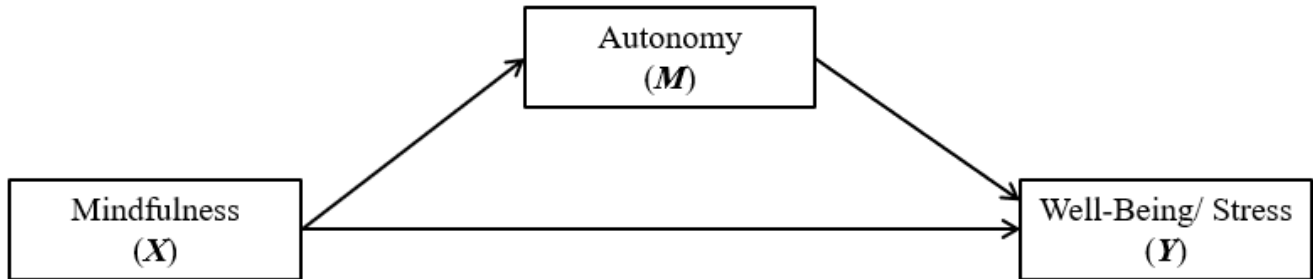


739 Figure 3: Model 2 showing the effect of mindfulness (X) on stress (Y), through autonomy

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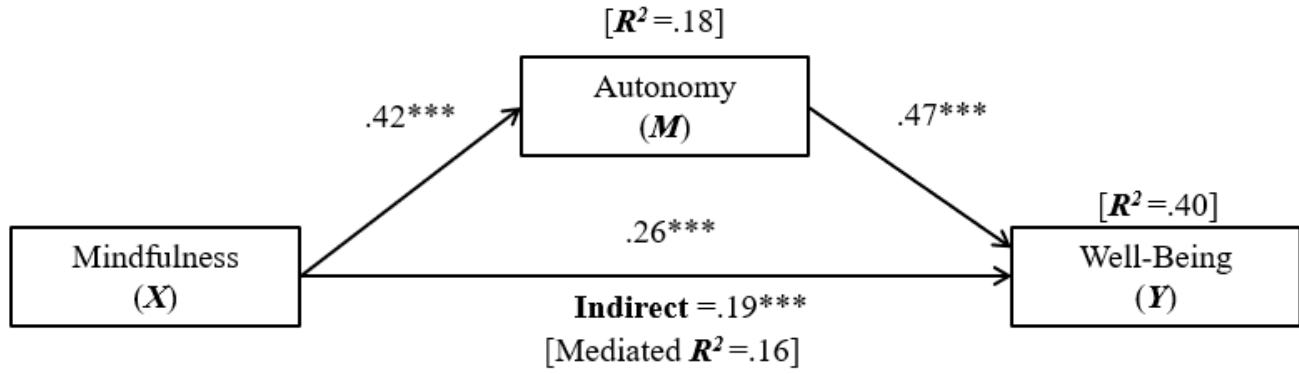
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742 **Figure 1:** Multivariate regression model assessing direct and indirect effects of mindfulness  
743 ( $X$ ) on well-being/stress ( $Y$ ) through autonomy satisfaction ( $M$ ).



744 **Note:** H4 refers to the indirect effect of mindfulness ( $X$ ) on well-being/stress ( $Y$ ) through autonomy ( $M$ ); each relationship  
745 predicting stress is hypothesized to be negative.

746 **Figure 2:** Model 1 showing the effect of mindfulness (X) on well-being (Y) through  
747 autonomy satisfaction (M).

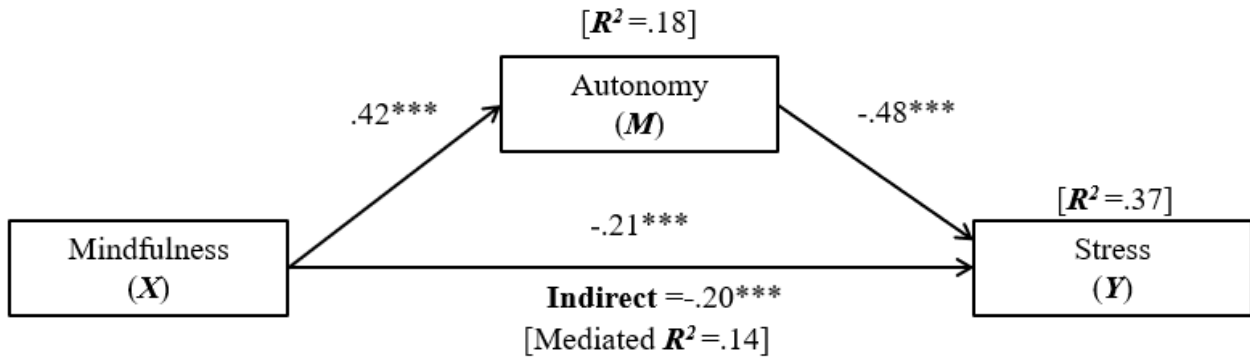


748 **Note:** \*= $p < .05$ ; \*\*= $p < .01$ ; \*\*\*= $p < .001$ .

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751 **Figure 3:** Model 2 showing the effect of mindfulness (X) on stress (Y) through autonomy  
752 satisfaction.



753 **Note:** \*=p<.05; \*\*=p<.01; \*\*\*=p<.001.

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756 **Table I:** Correlation matrix, Cronbach's alpha ( $\alpha$ ) internal consistency values, mean scores  
 757 and standard deviations (SD) for the study outcomes

	Mindfulness	Autonomy	Well-being	Stress
<b>Mindfulness</b>	1			
<b>Autonomy</b>	.42*	1		
<b>Well-being</b>	.47*	.58*	1	
<b>Stress</b>	-.42*	-.57*	-.72*	1
<b>Cronbach's <math>\alpha</math></b>	.88	.82	.90	.83
<b>Sample mean and SD</b>	54.91 (11.95)	37.32 (7.31)	44.63 (7.73)	18.13 (.36)

**Note:** standard deviations in brackets; \* denotes statistical significance at  $p < .001$

Key points

- Student-athletes can be prone to mental health difficulties, including high levels of stress and multiple sporting, academic and personal demands.
- Our study found that mindfulness may facilitate autonomy satisfaction, which consistent with Self-Determination Theory, predicted improved well-being and reduced stress, and mediated the relationship between mindfulness and well-being, and mindfulness and stress.
- Practitioners and researchers may consider designing and evaluating Self-Determination Theory-based mindfulness interventions for student-athletes, which could ultimately improve autonomy satisfaction and mental health outcomes.