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5 Development and Initial Validation of the Endurance Sport Self-efficacy Scale (ESSES)

6

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## 14 Abstract

15 Self-efficacy is likely to be an important psychological construct for endurance sport  
16 performance. Research into the role of self-efficacy, however, is limited as there is currently  
17 no validated measure of endurance sport self-efficacy. Consequently, the purpose of the  
18 present research was to develop and validate the Endurance Sport Self-Efficacy Scale  
19 (ESSES). In Study 1, an initial item pool was developed following a review of the literature.  
20 These items were then examined for content validity by an expert panel. In Study 2, the  
21 resultant 18 items were subjected to exploratory factor analyses. These analyses provided  
22 support for a unidimensional scale comprised of 11 items. Study 2 also provided evidence for  
23 the ESSES's convergent validity. In Study 3, using confirmatory factor analyses, further  
24 support was found for the 11-item unidimensional structure. Study 3 also provided evidence  
25 for the ESSES's convergent and concurrent validity. The present findings provide initial  
26 evidence that the ESSES is a valid and reliable measure of self-efficacy beliefs in endurance  
27 sports.

28 Keywords: endurance, performance, belief, questionnaire, efficacy

29

## Introduction

30 Endurance sports are characterised by the performance of continuous, dynamic, and  
31 whole-body exercise tasks (Burnley & Jones, 2007). These tasks are commonly seen in  
32 activities such as running, cycling, and swimming, or in a combination of these (e.g.,  
33 triathlon). The duration of these events can range from minutes to days. During these periods,  
34 endurance athletes must maintain high levels of effort and perseverance in order to counteract  
35 both physical and cognitive fatigue (Marcora, Bosio, & de Morree, 2009; Marcora, Staiano,  
36 & Manning, 2009). Alongside persevering with fatigue, endurance athletes must also engage  
37 in effective self-regulation strategies relating to pacing (Renfree, Martin, Micklewright, & St  
38 Clair Gibson, 2014), attention (Brick, MacIntyre, & Campbell, 2014), and coping (Kress &  
39 Statler, 2007; Zepp, 2016). A recent review identified several psychological determinants of  
40 endurance performance (McCormick, Meijen, & Marcora, 2015). One key psychological  
41 factor highlighted by McCormick et al.'s review, and which has been consistently linked with  
42 self-regulation, attention, and coping, is self-efficacy (Bandura, 1997).

### 43 Self-Efficacy

44 Self-efficacy refers to the “belief in one’s capabilities to organize and execute the  
45 courses of action required to produce given attainments” (Bandura, 1997, p.3) and represents  
46 the behaviours and skills an individual believes they can successfully perform. Importantly,  
47 self-efficacy beliefs are not just in reference to the skills or abilities an individual possesses  
48 but rather what they believe they can do with them (Bandura, 1997). For example, an athlete  
49 may possess a high level of physical fitness, but if they do not believe they are capable of  
50 utilising this fitness in a competitive environment it will count for little towards their self-  
51 efficacy.

52 Self-efficacy beliefs are formed through a series of cognitive processes involving the  
53 selection, interpretation, and integration of several sources of information (Bandura, 1997).

54 These sources include past performance experiences, vicarious influences, social and verbal  
55 persuasions, and perceptions of physiological and emotional states (see Samson & Solmon,  
56 2011 for a review). In addition to an understanding of the task demands and the perceived  
57 ease and difficulty of the task, these sources will help provide an individual with an  
58 understanding of their own capability (Gist & Mitchell, 1992). Once these beliefs are formed  
59 they can have a powerful effect on an individual's cognitions and behaviour. For example,  
60 individuals high in self-efficacy typically set more challenging goals (Locke & Latham,  
61 2002), put more effort into tasks (Hutchinson, Sherman, Martinovic, & Tenenbaum, 2008),  
62 and are more willing to persevere when faced with difficulties (Feltz, Short, & Sullivan,  
63 2008).

#### 64 **Self-Efficacy and Endurance Performance**

65 Self-efficacy has been associated with better performance in several endurance sports.  
66 Burke and Jin (1996) reported that self-efficacy was a stronger positive predictor of Ironman  
67 triathlon performance than performance history, maximal oxygen consumption, and sport  
68 confidence. Similarly, Okwumabua (1985) reported that pre-event self-efficacy explained  
69 40% of the variance in marathon performance. Other studies have also established that self-  
70 efficacy is associated with better performance in track running (LaGuardia & Labbé, 1993),  
71 cross country running (Martin & Gill, 1995) and swimming (Miller, 1993).

72 There exist several possible psychological and physiological mechanisms through  
73 which self-efficacy may enable better endurance performance. On a psychological level, both  
74 perception of pain (Astokorki & Mauger, 2014; Mauger, 2014) and perception of effort (   
75 Marcora, Bosio, & de Morree, 2008) have been suggested to be key determinants of  
76 endurance performance. Attesting to the possible role of self-efficacy in influencing these  
77 perceptions, self-efficacy has been associated with improvements in pain tolerance (Johnson,  
78 Stewart, Humphries, & Chamove, 2014) and also with reductions in perceptions of effort

79 (McAuley & Blissmer, 2000). On a physiological level, running economy and maximal  
80 oxygen consumption (VO<sub>2</sub>max) are two key physiological determinants of endurance  
81 performance (Joyner & Coyle, 2009). Again, self-efficacy has been associated with  
82 improvements in running economy (Stoate, Wulf, & Lewthwaite, 2012) and maximal oxygen  
83 consumption (Montes, Wulf, & Navalta, 2017).

84 Self-efficacy appears to be an important factor for endurance performance. The  
85 assessment of this importance, however, is contingent on being able to adequately measure  
86 relevant self-efficacy beliefs. Here several limitations are evident in the existing literature.  
87 First, previous studies have not followed recommendations for self-efficacy scale  
88 development (Bandura, 1997, 2006). For example, Stoate, Wulf, and Lethwaite (2012)  
89 measured self-efficacy using a scale which conceptualised self-efficacy in the form of “will”  
90 rather than “can”. This is problematic because “will” generally refers to an individual’s  
91 intention as opposed to an individual’s perceived capability (Bandura, 2006).

92 Second, for those studies which have employed multi-item scales, self-efficacy was  
93 typically assessed in terms of ascending or descending performance times (Burke & Jin,  
94 1996; LaGuardia & Labbé, 1993) or distances (Bueno et al., 2008). Such scales are known as  
95 hierarchical self-efficacy scales (Feltz et al., 2008). Whereas this approach is common in  
96 sport and exercise settings, Feltz and colleagues (2008) cautioned against an overreliance on  
97 such scales as they result in an oversimplification of complex performances. Hierarchical  
98 scales are popular as they typically report high levels of scale score reliability (Feltz et al.,  
99 2008) and they do not require a deep understanding of the demands in that domain and,  
100 therefore, they can easily be adapted to various study designs and scenarios.

101 Whereas such scales have helped provide evidence for the link between self-efficacy  
102 and performance, they often possess limited practical benefit for practitioners, coaches, and  
103 athletes. For instance, two athletes could both perceive themselves as not capable of

104 achieving a certain time for a race/to cover a certain distance in a given time. For one athlete,  
105 this may be due to the belief that they are unable to pace themselves appropriately, whereas  
106 for the other athlete this may be due to the belief they are not capable of tolerating exercise-  
107 induced pain. A hierarchical scale would not allow us to differentiate between these two  
108 reasons and instead would merely suggest that both athletes perceive themselves incapable of  
109 achieving that time or covering that distance. This approach thus limits the possibility of  
110 accurate interventions (Bandura, 1997; Feltz et al., 2008). The measurement of these  
111 behaviours and skills would be best served through the use of a non-hierarchical scale.

112 Non-hierarchical scales look to assess an individual's self-efficacy across the full range  
113 of subskills that underpin performance in that domain (Feltz et al., 2008). Given the  
114 similarities in the demands and determinants of performance across endurance sports (Brick,  
115 MacIntyre, & Campbell, 2016; McCormick et al., 2016; Renfree et al., 2014), it is likely that  
116 there are common subskills which underpin performance across all endurance sports.  
117 Therefore, the development of a endurance sport-specific scale would be beneficial because it  
118 would provide practical implications for the design and delivery of self-efficacy  
119 interventions, as well as allowing further exploration of both the theoretical determinants  
120 (e.g., coaching, task difficulty, perceived fatigue) and outcomes (e.g., perception of effort,  
121 perseverance, performance) of self-efficacy beliefs.

## 122 **The Present Research**

123 There is currently no validated non-hierarchical scale of self-efficacy for endurance  
124 sports. Given the potential importance of self-efficacy in endurance performance, the  
125 development of such a scale would be beneficial for both practical and theoretical reasons.  
126 Consequently, the aim of the present research was to develop the Endurance Sport Self-  
127 Efficacy Scale (ESSES) that measures self-efficacy specific to the endurance sport domain.

128 We also sought to provide preliminary evidence for the validity and reliability of the ESSES.  
129 In so doing, a series of three studies are presented.

### 130 **Study 1**

131 The purpose of Study 1 was for initial item and scale development. First, in line with  
132 Bandura's (2006) recommendations for self-efficacy scale development, factors relating to  
133 endurance performance were identified through literature searches and the research teams'  
134 own conceptual knowledge, and items relating to these factors were developed. Next, the  
135 items and scale were subjected to an expert panel for review in order to ensure high levels of  
136 content validity.

### 137 **Method**

#### 138 **Development of the Initial Item Pool**

139 In the construction of self-efficacy scales, Bandura (2006) urged that scales should be  
140 specific to the chosen domain, and researchers should attempt to identify the key factors  
141 relating to performance in these domains. Once these key factors have been identified, items  
142 relating to these factors should be created allowing the measurement of specific self-efficacy  
143 beliefs. This approach can help promote a scale which demonstrates improved sensitivity to  
144 individual differences in self-efficacy beliefs and promotes a greater level of validity in that  
145 domain (Bandura, 2006).

146 Performance in endurance sport is a complex mixture of physical, technical, and  
147 psychological factors (Taylor et al., 1995). Relating to the physical factors, endurance  
148 athletes aim to ensure they are physically prepared for their endurance sport (Jones & Carter,  
149 2000) and they aim to manage exercise-induced sensations such as exercise pain, injury pain,  
150 discomfort and exertion (Christensen, Brewer, & Hutchinson, 2015; Samson, Simpson,  
151 Kamphoff, & Langlier, 2017; Schumacher, Becker, & Wiersma, 2016). In regards to the  
152 technical aspect, endurance athletes must ensure they pace themselves appropriately to help



153 ensure high levels of performance (Renfree et al., 2014), ensure appropriate technique and  
154 form (Novacheck, 1998), and they must also be able to maintain high levels of concentration  
155 to aid this and other related decision-making processes (Brick, MacIntyre, & Campell, 2014).  
156 Psychologically, endurance athletes must cope with a variety of stressors (Fletcher, Hanton,  
157 & Mellalieu, 2006; Martin, 2002; McCormick et al., 2016), and ensure they manage any  
158 unwanted thoughts (Holt, Lee, Kim, & Klein, 2014) and emotions (Lane & Wilson, 2011)  
159 which may impede their performance.

160 From these physical, technical, and psychological factors, and based on relevant  
161 literature, we developed an initial pool of 20 items. Following Bandura's (2006) guidance, we  
162 ensured that these items were related to behaviours and skills that were rooted in the context  
163 of performing in endurance sport. Rather than focusing on a specific situation, we instead  
164 opted for a general domain focus. Although several self-efficacy researchers have cautioned  
165 against attempts to measure "general" self-efficacy which exists across domains (Bandura  
166 1997; Maddux & Gosselin, 2003), domain specific self-efficacy scales are a common  
167 approach to conceptualisation and measurement of self-efficacy beliefs (Bandura, 2006; Feltz  
168 et al., 2008). In a sport setting the Coaching Self-efficacy Scale (Feltz et al., 1999), the  
169 Collective Team Efficacy Scale (Short et al., 2005), and the Refereeing Efficacy Scale  
170 (Myers et al., 2012) all utilise a similar domain approach. Furthermore the development of a  
171 more general domain scale can in turn inform and facilitate the development of more specific  
172 self-efficacy scales (e.g., a running self-efficacy scale, or triathlon self-efficacy scale). For  
173 example, the Coaching Self-efficacy Scale (Feltz et al., 1999) has been successfully adapted  
174 to be specifically focused on high school coaches (Myers et al., 2008) and youth sport  
175 coaches (Myers et al., 2011).

176 Additionally, whereas situation specific self-efficacy scales report greater predictive  
177 power for performance (Moritz et al., 2000), they in turn possess less generalisability, and

178 instead can reflect more on the task and transient information (e.g. weather, perceptions of  
179 energy), rather than the underlying self-efficacy beliefs (Bandura, 2006). As the primary aim  
180 of the scale was not solely the prediction of performance, but instead to allow the  
181 examination of theoretical determinants and outcomes, we felt justified in adopting this  
182 general domain focus. In order to promote a high level of content validity, we operationalised  
183 self-efficacy in our scale through the use of ‘can’ (Bandura 2006). In regards to the response  
184 scale, we opted to use a 0-100 response scale separated with 10 point intervals. Such a scale  
185 is commonly used in self-efficacy research (Bandura, 2006; Feltz et al., 2008) and has been  
186 suggested to report higher levels of predictive power than those scales which use fewer  
187 intervals (Pajares, Hartley, & Valiante, 2001). Considering the general domain focus, the use  
188 of the word ‘can’ and the 0-100 response scale, the scale stem which proceeded the items  
189 was:

190 “Below you will find a list of actions and skills that are important for endurance  
191 performance. When you are taking part in your endurance sport, how confident are you  
192 that can do the following things. In each case please rate your degree of confidence  
193 from 0 (cannot do at all) to 100 (completely certain can do).”

#### 194 **Expert Review**

195 For the purpose of content validation, two steps were undertaken. First, and in line  
196 with best practice for the development of psychological questionnaires (e.g. Hill, Appleton, &  
197 Mallinson, 2016), the question stem, the initial list of items, and the response options was  
198 submitted to an independent panel of experts via email. The panel consisted of three  
199 academics and two endurance sport coaches. The three academics were from different  
200 institutions than the research team, and had published research either relating to endurance  
201 psychology ( $n = 2$ ) or self-efficacy scale development ( $n = 1$ ) in international peer reviewed  
202 journals. The two endurance sport coaches had 18 and 22 years of coaching in running and

203 triathlon respectively. This step was conducted to obtain information on each item's  
204 perceived clarity and relevance, as well as highlighting any possible missed items (Dunn et  
205 al., 1999).

206         Alongside this, following institutional ethical approval, interviews were conducted to  
207 gain insight into how endurance athletes understood, processed, and responded to the  
208 question stem, generated items, and response options (Dietrich & Ehrlenspiel, 2010). This  
209 was deemed a particularly important aspect of the scale development, as endurance athletes  
210 would be the end-user of the scale. Six competitive endurance athletes (runners = 2, cyclists =  
211 2, triathletes = 2), who had been competing in their endurance sport for an average of 11.85  
212 years ( $SD = 2.81$ ) were recruited at this stage. To facilitate this process of understanding,  
213 verbal probing was employed. Verbal probes were aimed at comprehension and interpretation  
214 (e.g., what does this mean to you?), and at judgment and decision making (e.g., how did you  
215 arrive at your answer?).

## 216 **Results and Discussion**

217         Comments from the expert panel supported the inclusion of 17 of the 20 items  
218 submitted. Two items were suggested to be removed due to perceived similarity (e.g., 'Taper  
219 appropriately' was deemed too similar to 'Prepare physically' and therefore 'Taper  
220 appropriately' was removed), and one item was removed due to a perceived lack of relevance  
221 across endurance sports ('Deal with difficult terrain'). Additionally, feedback from the expert  
222 panel suggested the splitting of one item "Ensure appropriate nutrition and hydration" into  
223 two separate items - "Ensure appropriate nutrition" and "Ensure appropriate hydration".  
224 Although some further items were recommended for inclusion into the scale (e.g., Respond to  
225 other competitors pacing decisions), we decided against this, as we felt that these were not  
226 common across the endurance sport domain. The scale stem and response scale were deemed  
227 to be satisfactory.



253 The 18-item ESSES was administered with the same question stem and response  
254 format as listed during Study 1. As there are no other validated measure of endurance self-  
255 efficacy, we opted to use other measures which we hypothesised would be correlated with  
256 endurance self-efficacy in order to assess the convergent validity of the ESSES. The  
257 following four instruments were used:

258 **General Self-Efficacy Scale (GSES).** The GSES is a 10-item scale that is designed to  
259 assess optimistic self-beliefs to cope with a variety of difficult demands in life (e.g. “I can  
260 solve most problems if I invest the necessary effort”) (Schwarzer & Jerusalem, 1995).  
261 Participants responded to each item on a four-point Likert scale which ranges from 1 (Not  
262 true at all) to 4 (Exactly true). The scale reported acceptable scale score reliability ( $\alpha = .78$ ).

263 **Coping Self-Efficacy Scale (CSES).** The CSES is a 26-item scale that is designed to  
264 assess a person's perceived ability to cope effectively with life challenges and to employ  
265 effective use of coping strategies (Chesney, Neilands, Chambers, Taylor, & Folkman, 2006).  
266 It has three subscales: use of problem-focused coping (e.g. “I can make a plan of action and  
267 follow it when confronted with a problem”), use of emotion-focused coping (e.g. “I can keep  
268 from feeling sad), and received social support (e.g. “I can get friends to help me with the  
269 things I need”). Participants responded to each item on a ten-point scale ranging from 1  
270 (Cannot do at all) to 10 (Completely certain can do). All the subscales were internally  
271 consistent ( $\alpha = .77 - .85$ ).

272 **Barriers to Training Self-Efficacy Scale (BTSES).** The BTSES is an 18-item scale  
273 (Bandura, 2006) that is designed to assess a person's perceived ability to maintain training  
274 when faced with various stressors (e.g. “After recovering from an injury that prevented me  
275 from training”). Participants responded to each item on an eleven-point scale ranging from 0  
276 (Cannot do at all) to 100 (Completely certain can do). Good levels of internal consistency  
277 were reported ( $\alpha = .91$ ).

278           **Athletic Coping Skills Inventory (ACSI-28)**. The ACSI-28 is a 28-item scale that is  
279 designed to measure coping use and effectiveness in athletes (Smith, Schutz, Smoll, &  
280 Ptacek, 1995). It comprises seven sport specific subscales: coping with adversity (e.g. “I  
281 handle unexpected situations in my sport very well”), peaking under pressure (e.g. “To me,  
282 pressure situations are challenges that I welcome), goal setting and mental preparation (e.g. “I  
283 set my own performance goals for each training”), concentration (e.g. “It is easy for me to  
284 direct my attention and focus on a thing”), freedom from worry (e.g. “I worry quite a bit  
285 about what others think of my performance”), confidence and motivation (e.g. “I feel  
286 confident that I will perform well”), and coachability (e.g. “I improve my skills by listening  
287 carefully to advice and instruction from coaches and peers”). Participants responded to each  
288 item on a four-point scale ranging from 0 (Almost never) to 3 (Almost always). All the  
289 subscales were internally consistent ( $\alpha = .72 — .93$ ).

## 290 **Data Analysis**

291           In order to ascertain the factor structure of the ESSES, exploratory factor analysis  
292 (EFA) was conducted in line with common recommendations (e.g., Costello & Osborne,  
293 2005; Fabrigar et al., 1999; Tabachnick & Fidell, 2007). Factor solutions and retention was  
294 explored using principal axis factoring (PAF) with a promax rotation, and was assessed using  
295 parallel analysis (using O’Connor, 2000). PAF was chosen as it is not dependent on  
296 assumptions of multivariate normality (Costello & Osborne, 2005). A promax rotation was  
297 chosen as self-efficacy beliefs are hypothesised to be correlated (Bandura, 1997). Such a  
298 rotation is commonly used in self-efficacy scale development (e.g., Chesney et al., 2006;  
299 Feltz et al., 1999). Factor solutions were then assessed upon theoretical interpretability,  
300 structural and pattern coefficients ( $> .40$ ), interpretability of cross-loadings, and  
301 communalities ( $> .20$ ) (Tabachnick & Fidell, 2007).

302 Reliability was assessed using Cronbach's  $\alpha$  (Kline, 1998). Initial convergent validity  
303 was assessed using correlational analysis between the ESSES, GSES, CSES, BTSES, and  
304 ACSI-28. Cohen's (1992) guidelines of small ( $r = .10$ ), medium ( $r = .30$ ), and large ( $r = .50$ )  
305 were used when interpreting correlations.

## 306 **Results and Discussion**

### 307 **Exploratory Factor Analysis**

308 The initial analyses based on the parallel analysis suggested the possibility of either a  
309 one, two, or three factor solution (actual  $\lambda_1 = 6.19$ ,  $\lambda_2 = 1.42$ ,  $\lambda_3 = 1.27$  vs.  $\lambda_1 = 1.42$ ,  $\lambda_2 =$   
310  $1.34$ ,  $\lambda_3 = 1.28$  from parallel analysis). All possible factor solutions were investigated  
311 considering item-loadings and the theoretical interpretability of the factors. Ultimately, we  
312 decided to adopt a one factor (i.e. unidimensional) solution. This decision was based on several  
313 reasons. First, in all the possible factor solution combinations, most of the items primarily  
314 loaded onto the first factor. Second, the other items tended to display high levels of cross-  
315 loading with this first factor. Third, although both the second and third factors were  
316 theoretically interpretable, they were only formed from four and three items respectively.

317 In the process of scale refinement, we removed seven items. These items related to  
318 skills and behaviours that are carried out prior to performance (e.g. Item-16 "Prepare physically  
319 for demanding events"). Once removed, the unidimensional scale related to a variety of  
320 behaviours and skills which are carried out during endurance sport performance. This included  
321 behaviours and skills relating to psychological factors (e.g. Item-8 "Manage my thoughts  
322 during events), physical factors (e.g. Item-1 "Deal with non-injury related pain), and technical  
323 factors (e.g. Item-12 "Pace myself appropriately"). The final 11-item one-factor solution is  
324 presented in Table 1.

325

326

## 327 **Reliability and Validity**

328           After establishing the factor structure of the ESSES, the next stage was to assess the  
329 reliability and validity of the scale. In terms of scale score reliability, the ESSES displayed  
330 acceptable Cronbach's alpha ( $\alpha = .88$ ). In terms of convergent validity, correlations between  
331 the ESSES, the CSES, GSES, BTSES, and ACSI-28 are presented in Table 2. Examination of  
332 the correlations between the ESSES and other scales revealed significant positive relations,  
333 and these relations were typically medium and medium-to-large in size. This provides initial  
334 evidence for the convergent validity of the ESSES.

335           In conclusion, Study 2 provided initial evidence for the ESSES as a measure of self-  
336 efficacy for endurance sport. The unidimensional scale demonstrated good levels of scale  
337 score reliability and convergent validity.

## 338 **Study 3**

339           Study 3 had **two aims**. First, we aimed to confirm the 11-item unidimensional  
340 structure of the ESSES using confirmatory factor analysis (CFA). Second, we aimed to  
341 provide further evidence for the validity of the ESSES. Specifically, we assessed the scale for  
342 concurrent and criterion-related validity, by examining the relation between marathons  
343 completed and maximal oxygen uptake ( $VO_{2max}$ ) with the ESSES, using structural equation  
344 modelling (SEM).

## 345 **Method**

### 346 **Participants and procedures**

347           As in Study 2, following institutional ethical approval, participants completed an online  
348 survey which was hosted on the Bristol Online Survey system. Participants were recruited  
349 through social media (Facebook & Twitter) and contacting endurance sport clubs in the  
350 United Kingdom.



351 Participants for Study 3 consisted of two samples. Sample 1 consisted of 115  
352 marathon runners (89 males) with a mean age of 39.84 years ( $SD = 10.25$ ) who had been  
353 competing in distance running for 12.47 years ( $SD = 11.59$ ). Sample 2 consisted of 105  
354 endurance athletes (63 males) with a mean age of 42.38 years ( $SD = 11.78$ ). Thirty six of the  
355 endurance athletes were runners, 17 were cyclists, 45 were triathletes, five were swimmers  
356 and three were racewalkers. The athletes had been competing in their endurance sport for an  
357 average of 11.32 years ( $SD = 10.03$ ).

### 358 **Measures**

359 The 11-item ESSES was administered with the same question stem and response  
360 format as listed during Study 1 and Study 2. In addition, in Sample 1, marathon runners were  
361 asked to indicate their completed number of marathons. The purpose of this was to help  
362 provide criterion validity for the ESSES, as experience is hypothesised to be a key  
363 determinant of self-efficacy beliefs (Bandura, 1997).

364 For Sample 2, participants were asked questions to estimate  $VO_{2max}$ .  $VO_{2max}$  was  
365 estimated using formulas for men (Malek, Housh, Berger, Coburn, & Beck, 2005a), and  
366 women (Malek, Housh, Berger, Coburn, & Beck, 2005b). Reported age (years), weight (kg),  
367 height (cm), hours per week of exercise, duration that participants had consistently (no more  
368 than one month without exercise) been exercising (in years), and a typical session rating of  
369 perceived exertion (6-20 scale) was used to determine the  $VO_{2max}$ .  $VO_{2max}$  is the  
370 maximum capacity of the body to consume oxygen during maximal exertion and is  
371 considered an important physiological determinant in endurance performance (Joyner &  
372 Coyle, 2008). As a further measure of concurrent validity, we hypothesised that the ESSES  
373 would correlate with estimated  $VO_{2max}$

### 374 **Data Analysis**

375 Model fit was assessed via confirmatory factor analysis (CFA) using Mplus 8.0  
376 (Muthén & Muthén, 2012) and robust maximum likelihood estimation. We used multiple  
377 indexes to assess model fit for the CFA:  $\chi^2(df)$  statistic, comparative fit index (CFI), tucker-  
378 lewis index (TLI), and root mean square error of approximation (RMSEA). The following  
379 criteria were indicative of acceptable model fit:  $>.90$  CFI,  $>.90$  TLI, and  $<.09$  RMSEA  
380 (Marsh, Hau, & Wen, 2004). We then used SEM to examine the relation between the number  
381 of marathons completed, estimated VO<sub>2</sub>max, and scores on the ESSES in each of the relevant  
382 samples.

## 383 Results and Discussion

### 384 Assessment of Factorial Structure

385 Our initial CFA provided an adequate fit to the data ( $\chi^2(df) = 108.47(44)$   $p < .001$ ,  
386 CFI = .92, TLI = .90, RMSEA = .08). These findings provide further support for the 11-item  
387 unidimensional structure of the ESSES. Moreover, an examination of the standardised  
388 parameter estimates from the CFA indicated that all loadings were significant and meaningful  
389 (i.e.  $> .04$ ). The factor loadings and uniquenesses of the CFA are reported in Table 3.

### 390 Validity

391 The results of the SEM based on Sample 1 revealed that the number of marathons  
392 completed significantly predicted scores on the ESSES ( $\beta = .28$ ,  $p = .025$ ). Additionally, the  
393 results of the SEM based on Sample 2 revealed that estimated VO<sub>2</sub>max significantly  
394 predicted scores on the ESSES ( $\beta = .32$ ,  $p = .001$ ). Taken together, these findings provide  
395 further evidence for the concurrent and criterion-related validity of the ESSES.

## 396 General Discussion

397 Self-efficacy is likely to be an important factor in endurance performance (e.g., Burke  
398 & Jin, 1996; LaGuardia & Labbé, 1992). To date, however, no non-hierarchical self-efficacy  
399 measure has been developed for the endurance sport domain. To address this deficit, we

400 developed and validated the Endurance Sport Self-Efficacy Scale (ESSES). Through three  
401 rigorous studies, aligned with best psychometric practice, we derived an 11-item scale that  
402 assesses self-efficacy beliefs related to endurance performance.

403         The ESSES captures the breadth of physical, psychological, and technical facets  
404 associated with endurance performance. For example, the management of exercise induced  
405 sensations is often identified as a key demand of endurance performance in both quantitative  
406 and qualitative research (Astokorki & Mauger, 2016; Marcora, 2009; McCormick et al.,  
407 2016; Simpson, Post, Young, & Jensen, 2014). Similarly, intrusive thoughts and unwanted  
408 emotions are commonly reported by endurance athletes and may interfere with performance  
409 (Holt, Lee, Kim, & Klein, 2014; Lane & Wilson, 2014). Self-efficacy to control and manage  
410 exercise induced sensations and intrusive thoughts and emotions is likely to be an important  
411 factor in understanding and enhancing endurance performance.

412         Although endurance performance is underpinned by several different performance-  
413 related facets, the ESSES was found to be unidimensional. This may be because of the  
414 overlap that exists between the facets associated with endurance performance. For instance,  
415 exercise-induced sensations have been demonstrated to be related to pacing decisions, ability  
416 to maintain concentration, and the occurrence of unwanted thoughts and emotions (Mauger,  
417 2014; McCormick, Meijen, Anstiss, & Jones, 2018; Whitehead et al., 2017). This level of  
418 overlap between the facets, means that it is unlikely to identify distinct separate factors, and  
419 that instead the ESSES can be best understood as relating to behaviours and skills which  
420 occur during performance. It is this level of overlap that also resulted in the removal of seven  
421 items generated in Study 1 that related to preparatory aspects of endurance performance. As  
422 the goal of the current research was to develop a self-efficacy scale for endurance sport  
423 performance, not preparation, we do not consider this to be a major limitation.

424 Our findings illustrate that the ESSES may be a reliable and valid measure. Regarding  
425 reliability, we consistently reported high levels of scale score reliability. In addition, several  
426 forms of validity were supported. For convergent validity, endurance sport self-efficacy  
427 correlated positively with related self-efficacy beliefs (e.g. barriers to training) and use of  
428 coping skills during competition. This is line with research that has demonstrated that self-  
429 efficacy is associated with the use and maintenance of adaptive coping strategies during  
430 competition (Kane et al., 1996). Regarding concurrent validity, in line with previous research  
431 (e.g., Okwumabua, 1985), the number of marathons an athlete had completed predicted  
432 ESSES scores. This provides further evidence for the association between self-efficacy and  
433 prior experiences. This is important because prior success is hypothesised to be the key  
434 source of self-efficacy (Bandura, 1997; Feltz et al., 2008). Regarding criterion-related  
435 validity, estimated  $VO_{2max}$  was a significant predictor of endurance sport self-efficacy.  
436 Because of the physiological demands of endurance sports (Joyner & Coyle, 2009), the  
437 possession of high levels of physical fitness (e.g., high  $VO_{2max}$ ), are likely to lead to increased  
438 perceived capability. This provides further support for research linking levels of physical  
439 fitness and self-efficacy (Caruso & Gill, 1992).

#### 440 **Limitations and Future Research**

441 The present research has two main limitations. First, our measure was derived from  
442 cross-sectional data. This meant that we were unable to provide evidence for criterion or  
443 predictive validity. It also meant that we could not examine test-retest reliability. To address  
444 these issues, researchers should examine the predictive, criterion and test-retest reliability  
445 validity of the ESSES in future studies. Second, for all three studies, we used convenience  
446 sampling. Whereas this is common practice for research in sport, it may have biased the  
447 sample (i.e., resulted in only individuals who already had an interest in the psychological  
448 aspects of endurance performance participating in the study). In the same vein, it may be

449 possible that endurance athletes with low levels of self-efficacy, such as novices, lacked a  
450 strong athletic identity (Brewer, Van Raalte, & Linder, 1993), **which** may have meant that  
451 they would not have considered themselves “endurance athletes”, and therefore they would  
452 not have participated in the current research.

453         These limitations aside, the ESSES could make a valuable contribution to future self-  
454 efficacy research. In recent years, there has been an increased focus on the self-efficacy-  
455 outcome relationship at the within-person level (Gilson, Chow, & Feltz, 2012). The ESSES  
456 could be used to examine the relationship between self-efficacy and various outcomes such as  
457 performance, coping, and satisfaction. We are particularly interested to see how these  
458 variables change across a competitive season. This would help provide valuable insight into  
459 the malleability of self-efficacy beliefs and provide evidence for how they may change in  
460 response to factors such as training, tapering, and competitive performances (Feltz et al.,  
461 2008).

462         Alongside these directions for future research, the ESSES can act as a useful tool for  
463 practitioners, coaches, and athletes. Given the strength of the relations between self-efficacy  
464 and performance (Moritz et al., 2000), high levels of self-efficacy are likely to be desirable  
465 for athletes. The ESSES provides practitioners and coaches with the opportunity to identify  
466 low and/or weak self-efficacy beliefs relating to endurance performance. This can help  
467 provide the opportunity for more targeted interventions. Such interventions may result in  
468 greater performance benefits than common “one-size-fits-all” approaches (cf. McCormick et  
469 al., 2018).

## 470 **Conclusion**

471         The present research provides initial evidence for the validity and reliability of the 11-  
472 item Endurance Sport Self-Efficacy Scale (ESSES). The ESSES is the first non-hierarchical  
473 self-efficacy scale developed specifically for the endurance sport domain. Consequently, the

474 ESSES provides researchers, practitioners, coaches, and athletes with a means to assess and  
475 understand self-efficacy beliefs in endurance sport.

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