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Development and Preliminary Validation of the Sport Injury-Related Growth Inventory

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26 **Development and Preliminary Validation of the Sport Injury-Related Growth Inventory**

27 Over their sporting careers, athletes' experience injuries that prevent them from training and
28 competing, and could even change their lives (Brewer, 2009). Although the negative aspects of
29 incurring an injury have been systematically evidenced for several decades (e.g., depression, anxiety,
30 and loss of identity; Brewer et al., 2002; Wiese-Bjornstal et al., 1998), the positive by-products of
31 injury have more recently been studied to complement and problematise previous research to provide
32 a more nuanced understanding of athletes' experiences of sport injury (e.g., how distress can co-exist
33 with positive by-products; Wadey, 2021; Wadey et al., 2021). With positive by-products, we mean
34 increased mental strength, improved self-awareness, and more positive relationships with other
35 people, all of which have been reported following injured athletes' return to competitive sport. Some
36 antecedents may favour the emergence of these positive outcomes: for instance, hardiness personality
37 trait, adequate social support, reflective practice, and prior experience of adversity have been
38 identified as underlying mechanisms of growth (see Wadey & Everard, 2021). Collectively, these
39 positive-by products have recently been referred to as sport injury-related growth (SIRG; Roy-Davis
40 et al., 2017; Wadey & Everard, 2021) which is defined as:

41 "... a context-specific form of meanings made that can be defined as the end-results of inner
42 (i.e., psychological, physical, embodied) and/or outer (i.e., observable actions) changes that
43 give meaning to a sport injury experience(s) as a result of certain environmental factors (e.g.,
44 physical resources) and a cognitive, relational, and cultural meaning-making process" (Wadey
45 & Everard, 2021, p. 193).

46 This definition reflects how SIRG is sport- and context-specific, how it is multidimensional
47 (e.g., embodied, psychological, behavioural), and how the meaning making process leading to SIRG
48 is cognitive, relational and cultural in nature.

49 A pursuit of the empirical landscape on SIRG soon reveals that much of the research has been
50 qualitative in nature. For example, researchers have explored the meaning and experiences of SIRG
51 (e.g., Udry et al., 1997), as well as the personal (e.g., personality traits), situational (e.g., social

52 support), and mechanisms (e.g., emotional disclosure) that impact and lead to SIRG (e.g., Salim &
53 Wadey, 2018; Wadey et al., 2011). While this research has greatly helped our understanding of the
54 phenomenon, it is important that future researchers shift to a more inclusive research landscape (cf.
55 Wadey, 2021) and enable quantitative researchers who adhere to a positivist research philosophy to
56 examine this concept and open another way of knowing. Yet, a quantitative measure of SIRG does
57 not exist. Up until now, a few researchers have used the PTGI (Tedeschi & Calhoun, 1996) and SRGS
58 (Park et al., 1996) to assess SIRG (e.g., Brewer et al., 2017; Salim et al., 2015; Wadey et al., 2016).
59 But these measures were not developed for injured athletes, so they lack content validity, and do not
60 include many of the experiences reported in the qualitative literature (e.g., new appropriation and
61 outlook on sport and expanding one's sporting intelligence). Additionally, it should be noted that
62 most of research on this topic has been developed in westernised countries, where "growth following
63 adversity" or "get out stronger" are common storylines. With this in mind, quantitative measurement
64 instrument would also allow for cross-cultural comparison, if properly translated and adapted. As
65 Wadey and Everard (2021) reported, "A new measure developed specifically for injured athletes that
66 represents their experiences would significantly extend the current research landscape and help
67 provide a platform for research" (p. 199). On an applied perspective, an instrument allowing for the
68 exploration of individual differences and context-specific aspects can contribute to physical training
69 and sporting contexts (see Bertollo et al., 2022; Jeffries et al., 2022).

70 Informed by the theory of scale development (DeVellis, 2016; MacKenzie et al., 2011;
71 Tenenbaum et al., 2012), The purpose of this multi-study investigation was to construct a measure
72 of SIRG. Specifically, Study 1 aims to synthesize the literature to identify items for measure
73 development and organise them in themes. Study 2 aims to have the pool of the items evaluated by a
74 panel of experts in terms of relevance, clarity, and specificity with regards to each theme (content
75 validity). Study 3 aims to test the factor structure of the questionnaire and its psychometric properties
76 (i.e., concurrent validity and reliability). Taken all together, the three studies will support the construct
77 validity of the proposed instrument.

78 Study 1: Thematic Synthesis

79 A thematic synthesis (Nicholson et al., 2016; Thomas & Harden, 2008) was conducted, which
80 firstly involved a systematic review to identify relevant articles from the following journals :
81 *International Journal of Applied Sport Science (2000-2021)*, *International Journal of Sport and*
82 *Exercise Psychology (1970-2021)*; *Journal of Applied Sport Psychology (1989-2021)*; *Journal of*
83 *Sport and Exercise Psychology (1988-2021)*; *Journal of Sport Behaviour (1978-2021)*; *Journal of*
84 *Sport Sciences (1983-2021)*; *Psychology of Sport and Exercise (2000-2021)*; *Research Quarterly in*
85 *Sport and Exercise(2000-2021)*; *Sport Exercise and Performance Psychology (2012-2021)*; *The*
86 *Sport Psychologist (1984-2019)*; *Qualitative Research in Sport, Exercise and Health (2011-2021)*;
87 *Qualitative Research in Sport and Exercise(2009-2010)* and online databases PsycINFO,
88 PsycARTICLES, SPORTDiscus, Scopus, Science Direct, and Google Scholar. The search was
89 limited to articles published in English with no restriction in terms of the date range. To ensure an
90 exhaustive search of the literature was conducted, a Librarian with more than 10 years of experience
91 in search databases was consulted to assist with searching for and retrieving qualitative studies (cf.
92 Barroso et al., 2003). The primary search was conducted using the following combination of search
93 strings:

94 String 1: Post-traumatic growth* OR Stress-related growth* OR Adversarial growth* OR
95 Benefit finding* OR Perceived benefits* OR Positive outcomes* OR Thriving* OR Well-being*

96 String 2: Sport* OR Sport injury* OR Athlete/athletes* OR Injured athlete/injured athletes*

97 The second method of searching for relevant studies a strategy known as pearl growing
98 (Papaioannou et al., 2010), which consists in examining the reference lists of the eligible full texts to
99 identify any additional studies that might meet the inclusion criteria. Potentially appropriate papers
100 were, therefore, evaluated by title, abstract, and full text, and those studies that did not meet eligibility
101 requirements were excluded.

102 Criteria for Inclusion and Exclusion

103 Following recommended guidelines for systematic reviews (Weed, 2005), inclusion and
104 exclusion criteria were refined, and the identified articles were screened using the following criteria:
105 (a) qualitative research methods of data collection were used; (b) participants had sustained a sports-
106 related injury. A sports injury was defined as a bodily tissue or function impairment that had occurred
107 in consequence of sport-related activities such as training, competition, and recreational engagement
108 (Wiese-Bjornstal et al., 2018); and (c) the paper had explored the psychological response to sport
109 injury and identified aspects of growth.

110 **Item Generation**

111 From the studies identified in the systematic review, a pool of items were generated and reduced
112 in four steps (see Table 1) according to guidelines for scale development (DeVellis, 2016; MacKenzie
113 et al., 2011). Items were initially generated by extracting study participants' statements from direct
114 citations or their reports from paraphrased citations. Statements and reports were drawn from
115 interviews (i.e., unstructured, semi-structured, structured) and focus groups conducted with athletes
116 or relevant others, e.g., parents or coaches. Step 1 involved extracting data according to item selection
117 criteria: ambiguity, leading questions, reverse coding, negative wording, double negatives, jargon,
118 colloquialism, acronyms, prestige bias, social desirability, acquiescence bias, athlete-specific factors
119 (i.e., items that seemed specific just for some athletes). It should be noted that, according to DeVellis
120 (2016), redundancy was not considered a criterion for exclusion at this stage of questionnaire
121 development. Similarly, according to MacKenzie and colleagues (2011), double-barrelled items were
122 not necessarily removed, but they may have been split in two or more different items.

123 Step 2 involved removing any of the items if they did not align with the definition of SIRG
124 (Wadey & Everard, 2021). In fact, Wadey and Everard's (2021) definition was considered to provide
125 a suitable conceptual grounding for the development of the present questionnaire. In particular, at this
126 step items were removed if they, for example, described the meaning making process rather than the
127 results. For instance, items stating "I had more time for the relationship with my boyfriend/girlfriend"

128 or “The injury allowed me to spend more time with my family” were considered to provide the context
129 to nurture growth rather than the end results of the meaning making process.

130 Steps 3 and 4 were encompassed in the phases of codebook thematic analysis (TA; Braun et al.,
131 2016; Braun & Clarke, 2022). In Step 3, items were grouped according to their content. The process
132 of doing the codebook TA involved six phases (Braun et al., 2016). The first phase – data
133 familiarisation through the process of immersion – entailed forming ideas about patterns in the data
134 by reading and re-reading the dataset. This phase was done independently by the authors. In the
135 second phase, codes (i.e., segments of data that appear interesting to the authors) were constructed
136 from the dataset that were identified as relevant to the study. In the third phase, the codes were
137 clustered together to develop themes or domain summaries. Specifically, this phase entailed going
138 back and forth with the previous phases (e.g., further data immersion), comparing and contrasting
139 with previous research, and exploring other fields of research of relevance. In the fourth phase –
140 reviewing and refining the themes – a collaborative approach was taken between authors to strive for
141 consensus between us (Braun et al., 2016; Braun & Clarke, 2022). Here, the co-authors acted as a
142 “critical-friend” to the first author to challenge his construction of the themes. Specifically, the first
143 author presented his interpretations of the data on a regular basis to the co-authors who provided a
144 sounding board to encourage reflection upon, and exploration of, alternative explanations and
145 interpretations. As part of this process of dialogue, the first author was required to make a defensible
146 case that the available data supported his interpretations. Here, statistical criteria were adopted for
147 further item reduction (Step 4). That was, subscales with less than 6 items were removed in order not
148 to create problems for future statistical analyses (DeVellis, 2016; Froman, 2001). This cut-off was
149 decided to avoid problems of reliability and identification of the factor structure in the final scale; in
150 fact, a minimum of three items is recommended in the final questionnaire (Froman, 2001), and
151 DeVellis (2016) suggests that, at the stage of item generation, is preferable to have the double of
152 items desired in the final scale. In the fifth phase, themes were defined to show each theme’s scope
153 and boundaries. Finally, the sixth phase involved writing up the report (Braun et al., 2016).

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Results

155 The systematic review identified 19 qualitative research papers spanning across 22 years of
156 publications (i.e., Bianco et al., 1999; Ford & Gordon, 1999; Galli & Reel, 2012; Galli & Vealey,
157 2008; Hurley et al., 2007; Ievleva & Orlick, 1991; Podlog & Eklund, 2005; 2006; 2009; Podlog et
158 al., 2012; Podlog et al., 2013; Rose & Jevne, 1993; San Jose, 2003; Tamminen et al., 2013; Tracey,
159 2003; 2011; Udry et al., 1997; Wadey et al., 2011; Wadey et al., 2013). Altogether these studies
160 involved a large number of athletes (i.e., 246), coming from a variety of sports and competitive levels
161 as well as sustaining different types of injury. A pool of 301 items was initially extracted from these
162 studies.

163 This pool of items was reduced to 236 items in Step 1, 65 items of which were removed based
164 on the selection criteria. Specifically, 46 of the items were removed because of their ambiguity. For
165 example, the item “I learned how strong I am” did not specify if it was mental or physical strength;
166 10 items were removed because athlete-specific factors, such as “I am more independent from my
167 sister” as not all athletes have a sister; 5 items were removed because they were double negatives, for
168 example: “I have learnt that I am not indestructible”. Two items were removed because of their
169 colloquialism, as slang words and phrases may be interpreted differently from respondents of
170 different countries or geographical areas (Ford & Scandura, 2018). At step 2, based on the alignment
171 with the definition of SIRG, 159 items were retained and 77 items were removed. For example, those
172 items were removed which described opportunities that the athlete had during the rehabilitation (e.g.,
173 “I had more time for the relationship with my boyfriend/girlfriend” or “The injury allowed me to
174 spend more time with my family”) and not considered SIRG.

175 At step 3, items were divided into themes based on their content. This categorization initially
176 led to 13 themes: mental toughness (51 items), improved relationships (18 items), injury-related
177 intelligence (18 items), self-concept (16 items), emotional ability (11 items), reappraisal of life (9
178 items), sport intelligence (8 items), reappraisal of sport (8 items), body awareness (6 items), nutrition
179 (4 items), self-encouragement (3 items), time management (3 items), and other aspects (4 items). At

180 step 4, subscales with less than 6 items were removed in order not to create problems for future
181 statistical analyses, this decision was made according to previous guidelines described above
182 (Froman, 2001; DeVellis, 2016). Therefore, the dimensions “nutrition”, “self-encouragement”, “time
183 management”, and “other aspects” were removed. One hundred forty-five items were maintained,
184 whereas 14 were removed. A definition for each of the remaining themes was subsequently elaborated
185 based upon the items’ content. These steps are summarised in Table 1.

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Discussion

187 Underpinned by a clear conceptual foundation, this study has extended the literature by
188 synthesising the qualitative research on SIRG that provides a rigorous evidence-base for scale
189 development. Nine themes were identified: mental toughness, improved relationships, injury-related
190 intelligence, self-concept, emotional ability, reappraisal of life, sport intelligence, reappraisal of sport,
191 and body awareness. Although some of these themes resonate with broader measures, it has also
192 identified several context- and population-specific themes (e.g., injury-related intelligence,
193 reappraisal of sport). Aligned with the growing consensus in the broader growth following adversity
194 literature, SIRG is a multidimensional concept that is context- (e.g., rehabilitation) and population-
195 specific (i.e., injured athletes).

196 To summarize, this study has interpreted and synthesized the research identifying aspects of
197 growth following sport injury. The results of the thematic analysis have produced an innovative
198 taxonomy, depicting SIRG as a multidimensional construct comprising of nine themes. This helps to
199 provide a conceptual foundation of SIRG and items for the subsequent development of a measure of
200 growth following sport injury.

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206 **Table 1**207 *Phases of item reduction.*

| Study | Phase | Outcome |
|----------------------------------------------------------|--------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Study 1: Thematic synthesis | Systematic review and item extraction | 301 items extracted from 19 scientific papers on psychological growth following sport injury. |
| | Step 1: Item selection criteria | 236 items (65 items removed based on item selection criteria, e.g., due to ambiguity in the wording). |
| | Step 2: Alignment with the definition of SIRG | 159 items (77 items removed because they did not align with the definition of SIRG). |
| | Step 3: Codebook thematic analysis | 159 items divided into 13 themes: mental toughness (51 items), improved relationships (18 items), injury-related intelligence (18 items), self-concept (16 items), emotional ability (11 items), reappraisal of life (9 items), reappraisal of sport (8 items), sport intelligence (8 items), body awareness (6 items), nutrition (4 items), self-encouragement (3 items), time management (3 items), other aspects (4 items). |
| | Step 4: Statistical criteria | 145 items divided into 9 themes: mental toughness (51 items), improved relationships (18 items), injury-related intelligence (18 items), self-concept (16 items), emotional ability (11 items), reappraisal of life (9 items), reappraisal of sport (8 items), sport intelligence (8 items), body awareness (6 items). Based on scale development guidelines, dimensions with less than 6 items were removed. A definition for each theme was elaborated. |
| Study 2: Expert panel assessment | 1st assessment (quantitative) | 90 items divided into 8 themes: mental toughness (25 items), improved relationships (15 items), injury-related intelligence (13 items), self-concept (9 items), emotional ability (9 items), reappraisal of life (6 items), reappraisal of sport (8 items), body awareness (5 items). The theme "sport intelligence" was removed because it remained with less than 3 items. |
| | 1st assessment (qualitative) | 76 items partially reorganised into 8 themes: "mental toughness" redefined as "sense of mastery" (6 items); "improved relationships" redefined as "positive relations with others" (12 items); "injury-related intelligence" redefined as "responsibility for one's health" (9 items); "self-concept" enriched with items from the previous "mental toughness" theme and redefined as "self-awareness" (10 items); emotional ability (6 items); "reappraisal of life" redefined as "purpose in life" and enriched with new items (6 items); "reappraisal of sport" enriched with items from the previous "mental toughness" theme and redefined as "purpose in sport" (14 items), "body awareness" enriched with new items (13 items). Elaboration of new definitions for each theme. |
| | 2nd assessment (quantitative) | 51 items divided into 8 themes: sense of mastery (4 items), positive relations with others (8 items), responsibility for one's health (7 items), self-awareness (4 items), emotional ability (4 items), purpose in life (5 items), purpose in sport (11 items), body awareness (8 items). |
| | 2nd assessment (qualitative) | SIRGI-33: 33 items divided into 8 themes: sense of mastery (4 items), positive relations with others (5 items), responsibility for one's health (4 items), self-awareness (4 items), emotional ability (4 items), purpose in life (4 items), purpose in sport (4 items), body awareness (4 items). Definitions confirmed as in 1st qualitative assessment. |
| Study 3: Examination of psychometric properties | CFA | SIRGI-24: confirmation of 8 dimensions in line with previous themes; selection of the three strongest items for each dimension, and definitions slightly revised to reflect the content of the remaining items; both a lower order model and a model with SIRG as high ordered factor showed acceptable fit indices. |

209 Study 2: Expert Panel Assessment

210 In Study 2, we aimed to refine the provisional scale labelled SIRGI-145 using content validation
211 procedures. Content validity refers to the extent to which a specific pool of items reflects the content
212 domain (DeVellis, 2016). In this case, Study 1 already ensure that all the items are related to the
213 construct of SIRG, however having the items reviewed by experts can help assess the appropriateness
214 of each item in terms of relevance, clarity, and specificity (Arnold et al., 2013; DeVellis, 2016). To
215 this purpose, the instrument was assessed twice by judging panels comprising academics and sport
216 psychology practitioners working in the field of psychology of sport injury, and athletes with a history
217 of previous injury. These people were determined to be the appropriate judges for the assessment for
218 diverse reasons: feedback from academics could ensure a helpful assessment from a research
219 perspective, for example the use of appropriate words according to the scientific literature, whereas
220 practitioners could contribute to understand the appropriateness of the items in describing the actual
221 experiences reported by injured athletes. On the other hand, athletes with past injury experience(s)
222 may provide useful cues for avoiding strict scientific jargon. Taken all together, advices from these
223 three groups can support the content validity of the instrument for use in both the research and the
224 applied field. The choice to include both experts in the field and potential test takers was also in line
225 with recommendations and previous studies in the field (see, e.g., Arnold et al., 2013; DeVellis, 2016;
226 Dunn et al., 1999).

227 Method**228 Sample**

229 Twenty-four judges were recruited for the first assessment of this study: eight academic
230 researchers experienced in the psychology of sport injury (female $n = 6$; male $n = 2$) with a mean age
231 of 48.13 years ($SD = 7.23$); eight sport psychology practitioners with experience on sport injury
232 (female $n = 6$; male $n = 2$) with a mean age of 36.57 years ($SD = 3.98$); and eight athletes with history
233 of previous injury (female $n = 4$; male $n = 4$) with a mean age of 22.15 years ($SD = 2.27$). The
234 inclusion criterion for the academics was to have published at least one paper on the psychology of

235 sport injury in a scientific peer reviewed journal. Practitioners were included if they had at least 2
236 years of experience working with injured athletes. Participants who were both academics and
237 practitioners were assigned to a group based on the field where they were more experienced. Athletes
238 were included if they sustained an injury keeping them away from sport for at least two weeks. Twelve
239 of the judges included in the first panel were involved in a second assessment 3 months later: four
240 academics (female $n = 2$; male $n = 2$; mean age = 51.67 years; SD = 1.76), four practitioners (female
241 $n = 3$; male $n = 1$; mean age = 36.88 years; SD = 4.39), and four athletes (female $n = 1$; male $n = 3$;
242 mean age = 25.17 years; SD = 1.26).

243 **Measures and Procedure**

244 Following ethical approval obtained at the University of the fourth author, participants were
245 contacted via email. The SIRGI-145 developed in Study 2 was administered to the 24 judges in the
246 first assessment. In this phase, the SIRGI-145 was split in two questionnaire packs of 74 (Pack 1) and
247 71 items (Pack 2) respectively. This was done in order to reduce the amount of work required by
248 every judge and make possible to complete it in a reasonable amount of time. Half of participants (4
249 academics, 4 practitioners, and 4 athletes) were asked to complete the Pack 1, while the other half
250 was asked to complete Pack 2. Items were presented for each sub-dimension, then participants were
251 asked to rate each item according to its relevance (“Does this item reflect the definition of [the sub-
252 dimension]?”), clarity (“Is this item easily understood?”), and specificity (“Is this item specific
253 enough?”) with respect to the related sub-dimension. This procedure was line with previous studies
254 on scale development (see, Arnold et al., 2013). Each item was rated on a 5-point Likert scale (from
255 “1 not at all” to “5 completely”). In addition, participants were asked to answer an open-ended
256 question with their comments on each item. At the end of the questionnaire, participants were asked
257 to answer six open-ended questions on general aspects of the questionnaire: (1) “Were the instructions
258 easy to follow? Is there anything else that you think we need to include?”; (2) “Is the questionnaire
259 presented and formatted appropriately?”; (3) “Is the response format for the relevance, clarity and
260 specificity scales appropriate for your responses?”; (4) “Is there anything you would add to the SIRGI

261 to improve it?"; (5) "Is there anything you would remove from the SIRGI to improve it?"; and (6)
262 "Do you have any further comments on the SIRGI?". Based on the participants' ratings and comments
263 the SIRGI-145 was revised and reduced in the number of items. Three months later, half of
264 participants were asked to rate and comment the revised version of the questionnaire. This second
265 assessment was considered in the ethical approval and followed the same procedure of the first, with
266 the exception that all the participants examined the scale in full. This was possible because the revised
267 version of SIRGI was shorter, and it was possible for the judges to assess it in a reasonable amount
268 of time.

269 **Data analysis**

270 Quantitative data were analysed in SPSS 28.0. Means for each item were observed and, for the
271 retention of the items, a cut-off of 4.00 (in a range from 1.00 to 5.00) was adopted both in the first
272 and the second assessment. This was in accordance with Dunn and colleagues' (Dunn et al., 1999)
273 suggestions for item reduction. Additionally, relevant disagreements between the three groups (i.e.,
274 academics, sport psychologists, and athletes) were taken into consideration, and items were discarded
275 if a significant difference with a large effect size emerged between groups and one of the groups rated
276 the item below 4.00. Following statistical recommendations (Wasserstein & Lazar, 2016; Farland et
277 al., 2016; Nuzzo, 2014), significant results were evaluated in combination with effect sizes to identify
278 meaningful results. To this purpose, ANOVA tests were performed both in the first and the second
279 assessment, and effect sizes (i.e., eta squared) were considered according to Lakens' (2013)
280 suggestions. For example, if one item was rated 4.50 by academics, 4.50 by athletes, but 3.00 by
281 practitioners, then the item was discarded. Therefore, items were retained if they achieved the cut-off
282 score for their relevance, clarity and specificity, and if there was no disagreement between groups.
283 Qualitative data were organized in a table, and they were also explored and analysed. All comments
284 provided by the judges were considered for rewording the items and revising the sub-dimensions.

285

Results

286 Quantitative analyses based on the first assessment brought the pool of items from 145 to 90
287 items, and the structure of the questionnaire from nine to eight sub-dimensions (with the removal of
288 “sport intelligence”). For the sub-dimension “mental toughness”, 25 items out of 51 from the initial
289 pool were retained. For the sub-dimension “improved relationships”, 15 items out of 18 were retained.
290 For “injury-related intelligence”, 13 items out of 18 were retained. For “self-concept”, 9 items out of
291 16 were retained. For “emotional ability” 9 items out of 11 were retained. For “reappraisal of life”, 6
292 items out of 9 were retained. For the sub-dimension “sport intelligence” 2 items out of 8 of the initial
293 pool were retained. As the objective for the final scale was to have at least 3 items for every sub-
294 dimension (Froman, 2001), the sub-dimension “sport intelligence” was removed. For “reappraisal of
295 sport”, 8 items out of 8 were retained. Finally, for the sub-dimension “body awareness” 5 items out
296 of 6 from the initial pool were retained.

297 Qualitative data based on the comments provided by the judges in the first assessment were
298 summarised and organised in a table. With regards to the single items, the major issues raised by the
299 judges were relating to: (a) the length of the phrasing (e.g., “some items are too brief”); (b) the
300 specificity of the items for some sub-dimensions; (c) the matching of the items with their sub-
301 dimension; (d) the wording of the items; (e) concerns about the use of academic jargon; (f) concerns
302 about the use of vague/unclear terms. Based on these comments, several items were reworded and
303 maintained, whereas some others were considered for deletion. At this stage, we also started to
304 remove redundant items. Regarding the general aspects of the questionnaire, the judges highlighted
305 the importance of: (a) the consistency with the use of present/past tense across the questionnaire; (b)
306 the wording of items in order to make the questionnaire usable in a prospective way (i.e., avoid “I
307 became...” or “I am more...”); (c) the definitions of each sub-dimension. A focal point was regarding
308 the definition of each sub-dimension. First, according to the experts’ suggestions, “mental toughness”
309 was considered too broad as a concept and possibly unclear for the final users; therefore, it was
310 changed to “sense of mastery” in line with the literature on psychological well-being (see, e.g., Durkin
311 & Joseph, 2009; Ryff & Keyes, 1995). Second, “self-concept” was changed to “self-awareness” to

312 better reflect the content of the items. For the same reason “injury-related intelligence” was changed
313 to “responsibility for one’s health”. The sub-dimensions “reappraisal of sport”, “reappraisal of life”,
314 and “improved relationships” were renamed respectively “purpose in sport”, “purpose in life”, and
315 “positive relations with others”, this in line with the literature on psychological well-being (Ryff &
316 Keyes, 1995). Definitions for the sub-dimensions were revised according to these changes and to the
317 experts’ suggestions.

318 Revising the definitions made the matching with some items problematic; thus, these items
319 were deleted or reworded and assigned to a different sub-dimension. For example, the item “I am
320 more determined to reach my goals” became “I am determined to reach my goals in sport” and was
321 moved from “mental toughness”/“sense of mastery” to the “reappraisal of sport”/“purpose in sport”
322 dimension. Following experts’ suggestions, the dimension “body awareness” was enriched with items
323 from a previously validated scale on body awareness (the Body Awareness Questionnaire, BAQ –
324 Shields et al., 1989). This deductive approach, consisting of extracting items from existing scales, is
325 suitable with themes or subthemes that already have a theoretical background (see Ford & Scandura,
326 2018), such as in the case of body awareness (see, e.g., Mehling et al., 2009). An examination of the
327 existing scales of body awareness was, therefore, undertaken and the BAQ (Shields et al., 1989) was
328 considered to be appropriate for sporting contexts. New items were therefore extracted from the BAQ
329 and, after were included in the “body awareness” sub-dimension to be assessed by judges’ in the
330 second expert panel. In the end, the revision based on qualitative data led to a 76-item scale, partially
331 different from the initial pool of items, and structured in the following way: sense of mastery (6
332 items), positive relations with others (12 items), responsibility for one’s health (9 items), self-
333 awareness (10 items), emotional ability (6 items), purpose in life (6 items), purpose in sport (14
334 items), and body awareness (13 items).

335 Quantitative analyses based on the second assessment brought the pool of items from 76 to 51
336 items. The structure of the questionnaire maintained 8 sub-dimensions. In particular, for the sub-
337 dimension “sense of mastery”, 4 items out of 6 were retained. For the sub-dimension “positive

338 relations with others”, 8 items out of 12 were retained. For “responsibility for one’s health”, 7 items
339 out of 9 were retained. For “self-awareness”, 4 items out of 10 were retained. For “emotional ability”,
340 4 items out of 6 were retained. For “purpose in life”, 5 items out of 6 were retained. For “purpose in
341 sport”, 11 items out of 14 were retained. Finally, for the sub-dimension “body awareness” 8 items out
342 of 13 were retained. In addition, the qualitative analyses in the second assessment allowed to select
343 the clearest items and to perfect their wording. This second qualitative assessment led to a 33-item
344 scale structured as follows: sense of mastery (4 items), positive relations with others (5 items),
345 responsibility for one’s health (4 items), self-awareness (4 items), emotional ability (4 items), purpose
346 in life (4 items), purpose in sport (4 items), and body awareness (4 items). The revisions brought to
347 the scale following the first and the second assessment are summarized in Table 1.

348

Discussion

349 In Study 2, the initial pool of items was reviewed and assessed by two judging panels. Both
350 experts and potential test takers were included in the judging panels in order to demonstrate the
351 content validity of the developed scale. To develop an instrument usable for both research purposes
352 and applied work in sporting contexts, the experts in the judging panels were both academics and
353 practitioners experienced in the field of psychology of sport injury. The content validity of the
354 instrument was then assessed according to Dunn and colleagues’ (1999) recommendations, with items
355 and subscales revised and the procedure of assessment repeated. This procedure was consistent with
356 previous studies on scale development in sports and other contexts (see e.g., Arnold et al., 2013;
357 Gucciardi et al., 2015).

358 Based on suggestions provided by the experts, a further review of the literature on psychological
359 well-being (e.g., Durkin & Joseph, 2009; Hefferon et al., 2009; Joseph et al., 2012; Ryff & Keyes,
360 1995; Springer, & Hauser, 2006) and body awareness (Brani et al., 2014; Hefferon et al., 2009;
361 Mehling et al., 2009; Shields et al., 1989) allowed for revision of the sub-dimensions and the initial
362 pool of items of the SIRGI. In particular, the dimension “mental toughness” was revised, because it
363 was considered too broad as a concept. The definition was aligned with that of “environmental

364 mastery” (where the high scorer “has a sense of mastery and competence in managing the
365 environment; controls complex array of external activities; makes effective use of surrounding
366 opportunities; able to choose or create contexts suitable to personal needs and values”) provided by
367 Ryff and Keyes (1995, p. 727), became “a perceived competence in managing one’s environment
368 (e.g., life events, daily frustrations)”, and was named “sense of mastery”. Similarly, the sub-
369 dimension “body awareness” was modified due to the importance of the construct in relation to post-
370 traumatic growth following physical illness (Hefferon et al., 2009). In fact, Hefferon and colleagues
371 (2009) how a new awareness of the body arises in people who have experienced physical illness.
372 Additionally, Brani and colleagues (2014) reinforced the need for more body-based and embodied
373 approaches in psychological related disciplines. Ultimately, this process led to a 33-item measure of
374 SIRG, named SIRGI-33, and comprising eight dimensions. This scale demonstrated content validity
375 as an instrument for the assessment of growth experienced by sport performers following the
376 occurrence of sport injuries; it also constitutes a measure of SIRG that needs further validation by
377 testing its factor structure and psychometric properties.

378 **Study 3: Examination of Psychometric Properties**

379 In this final study, a cross-sectional investigation allowed for the examination of the
380 psychometric properties of the developed instrument. Specifically, we assessed: (a) the factor
381 structure of the developed questionnaire; (b) its internal consistency reliability; and (c) its
382 relationships with other relevant variables. This procedure was in line with the most recent standards
383 for test development (see AERA et al., 2014; Tenenbaum et al., 2012; Zumbo & Chan, 2014). In
384 particular, Confirmatory Factor Analysis is seen as a rigorous and parsimonious method to evaluate
385 a theoretical model (Marsh, 2007; Marsh et al., 2020) and allows for further statistical procedures.
386 Additionally, examining the relationships with other variables allows to prove the concurrent
387 properties of an instrument. To provide this kind of evidence, it is necessary that the instrument is
388 positively correlated with a similar construct and should demonstrate very weak or no correlations
389 with a construct which is considered to be different (Tenenbaum et al., 2012). As SIRG and post-

390 traumatic growth roots in the same theoretical background (see, e.g., Salim & Wadey, 2021), we
391 expected that the components of the SIRGI would correlate positively with sub-dimensions and
392 composite score for the PTGI. On the other hand, as post-traumatic growth is proposed to have no
393 relationship with social desirability (Tedeschi & Calhoun, 1996), we hypothesised the SIRGI to also
394 have weak or no correlations with the Lie Scale.

395 **Method**

396 **Sample**

397 The sample comprised 452 athletes (76,3% men) with a mean age of 23.19 years ($SD = 7.33$)
398 and involved in different individual (e.g., athletics, boxing, cycling, diving, gymnastics, mixed
399 martial arts, running, swimming, tennis, weightlifting) and team-based sports (e.g., American
400 football, baseball, basketball, cricket, football, hockey, rugby, softball, volleyball). Most of
401 participants were competing at county, university, or recreational level ($n = 309$), while a minor part
402 at regional ($n = 71$), national ($n = 55$), or international ($n = 17$) level. Inclusion criteria required the
403 athletes to have sustained a sport injury within the last three years, and this injury must have kept
404 them out of training and competition for at least 2 weeks. MacKenzie and colleagues (2011)
405 recommend the sample to be representative of the population, which is the objective of the
406 measurement; so, athletes chosen for this study were athletes with a history of previous injury through
407 sport, and not, for example, athletes injured through other life situations. With regards to the sample
408 size, MacKenzie and colleagues (2011) suggested a minimum of 100–500 participants, and a
409 minimum ratio between the number of respondents and the number of items of at least 3:1. Based on
410 these recommendations, this sample was more than adequate for the assessment of a 33-item scale.

411 **Measures**

412 **Sport injury-related growth.** The Sport Injury-Related Growth Inventory-33 (SIRGI-33)
413 developed in Study 2 was utilised to assess perceptions of psychological changes following sport
414 injury. The scale comprised 33 items divided into the 8 sub-dimensions mentioned above: sense of
415 mastery, positive relations with others, responsibility for one's health, self-awareness, emotional

416 ability, purpose in life, purpose in sport, and body awareness. For administering the questionnaire to
417 the athletes, items were randomised and were introduced by the stem “Please, indicate on each item
418 how much you perceive yourself to have changed as a result of the sport injury”. As noted by Linley
419 and Joseph (2004), self-report measures that do not allow for negative responses should be avoided,
420 so an appropriate answer scale was adopted for the instrument. The response format was on a 7-point
421 Likert scale ranging from –3 (much less so now) to +3 (much more so now).

422 **Post-traumatic growth.** The PTGI (Tedeschi & Calhoun, 1996) was adopted to assess post-
423 traumatic growth for comparison with the SIRGI-33. The PTGI is a 21-item scale divided in 5 sub-
424 dimensions: relating to others, new possibilities, personal strength, spiritual change, and appreciation
425 of life. The items were introduced by the stem “please indicate for each statement below the degree
426 to which this change occurred in your life as a result of the sport injury”, and the response format was
427 on a 6-point Likert scale ranging from 0 (I did not experience this change as a result of my sport
428 injury) to 5 (I experienced this change to a very great degree as a result of my sport injury). Cronbach
429 alpha values reported in the original study ranged from .67 to .85.

430 **Social desirability.** Social desirability was assessed through the Lie scale (Eysenck et al.,
431 1985), which is a 21-item instrument with response format YES/NO. Examples of questions are “Are
432 all your habits good and desirable ones?” or “Do you always practice what you preach?”. The answers
433 are aggregated to obtain a single score ranging from 0 to 21, where 0 expresses no lies and 21 means
434 that the participant lied on every question.

435 **Procedure**

436 Ethical approval for Study 3 was also obtained from the University of the fourth author. The
437 majority of participants ($n = 322$) were approached in person during their university classes, and the
438 questionnaire was administered on paper to them. Another portion ($n = 130$) completed an online
439 survey. The participants who completed the online survey were recruited in different ways: (a) email
440 contact with the sport club of appurtenance; (b) link to the survey posted on social networks.

441 **Data analysis**

442 To prepare data for the analysis, a listwise deletion approach was adopted for the Lie Scale;
443 whereas a pairwise deletion was adopted for the SIRGI-33 and the PTGI items, and missing values
444 in these scales were substituted with means. Further data screening (i.e., descriptive statistics of the
445 sample and data distribution) was performed using IBM SPSS 28.0. Data was then transferred onto
446 IBM AMOS Graphic 28.0 in order to examine the factor structure of the scale through Confirmatory
447 Factor Analyses (CFAs) and to observe correlations with other variables (i.e., the PTGI sub-
448 dimensions and Lie scale) through Structural Equation Modelling (SEM) techniques. CFAs provide
449 different indexes of fit for the hypothesised model, such as model fit, comparative or incremental fit,
450 parsimony, and error of approximation (Byrne, 2016). First, a ratio between Chi-square and degrees
451 of freedom lower than 5 or lower than 3 indicates, respectively, acceptable or good model fit (Kline,
452 1998; Byrne, 2016). Comparative or incremental fit indexes must be equal to 0.90 or higher to be
453 considered acceptable (Bentler & Bonnett, 1980; Byrne, 2016), and values close to 0.95 or higher
454 indicate superior fit (Byrne, 2016; Hu & Bentler, 1999). Among the possible comparative or
455 incremental fit indexes that can be evaluated, Comparative Fit Index (CFI) and Incremental Fit Index
456 (IFI) were preferred to the Normed Fit Index (NFI), as they take into account for the sample size
457 (CFI) and for the complexity of the model, i.e. degrees of freedom (IFI). For parsimony, The CFI
458 should be accompanied by a Parsimony Comparative Fit Index (PCFI) above .50 (Byrne, 2016).
459 Finally, Root Mean Square Error of Approximation (RMSEA) values above .10 indicate the model
460 should be rejected, between 0.08 and .10 are considered mediocre, between 0.05 and 0.08 are
461 acceptable, and below .05 are considered excellent (Byrne, 2016). Narrow 90% Confidence Intervals
462 (CIs) around the RMSEA are also indicative of a good fit of the model (Byrne, 2016). Additional
463 observations of the Aikake Information Criteria (AIC) can inform about improvements in the model
464 or future cross-validations, with lower AICs indicating a better fit.

465 Thereafter, data were re-analysed on SPSS to provide information with regards to the reliability.
466 Internal consistency reliability was evaluated through calculation of Cronbach's alphas and
467 MacDonal's omegas, with values ranging from 0.50 and 0.69 considered acceptable, from 0.70 to

468 .89 considered good, and above .90 considered excellent (Taber, 2018; Watkins, 2017). Pearson's
469 correlations between the SIRGI-33 and its sub-dimensions, the PTGI and its sub-dimensions, and the
470 Lie Scale were also evaluated. Strength of Pearson's correlations was described according to Evans'
471 (1996) guidelines: .00-.19 "very weak", .20-.39 "weak", .40-.59 "moderate", .60-.79 "strong", and
472 .80-1.00 "very strong".

473

Results

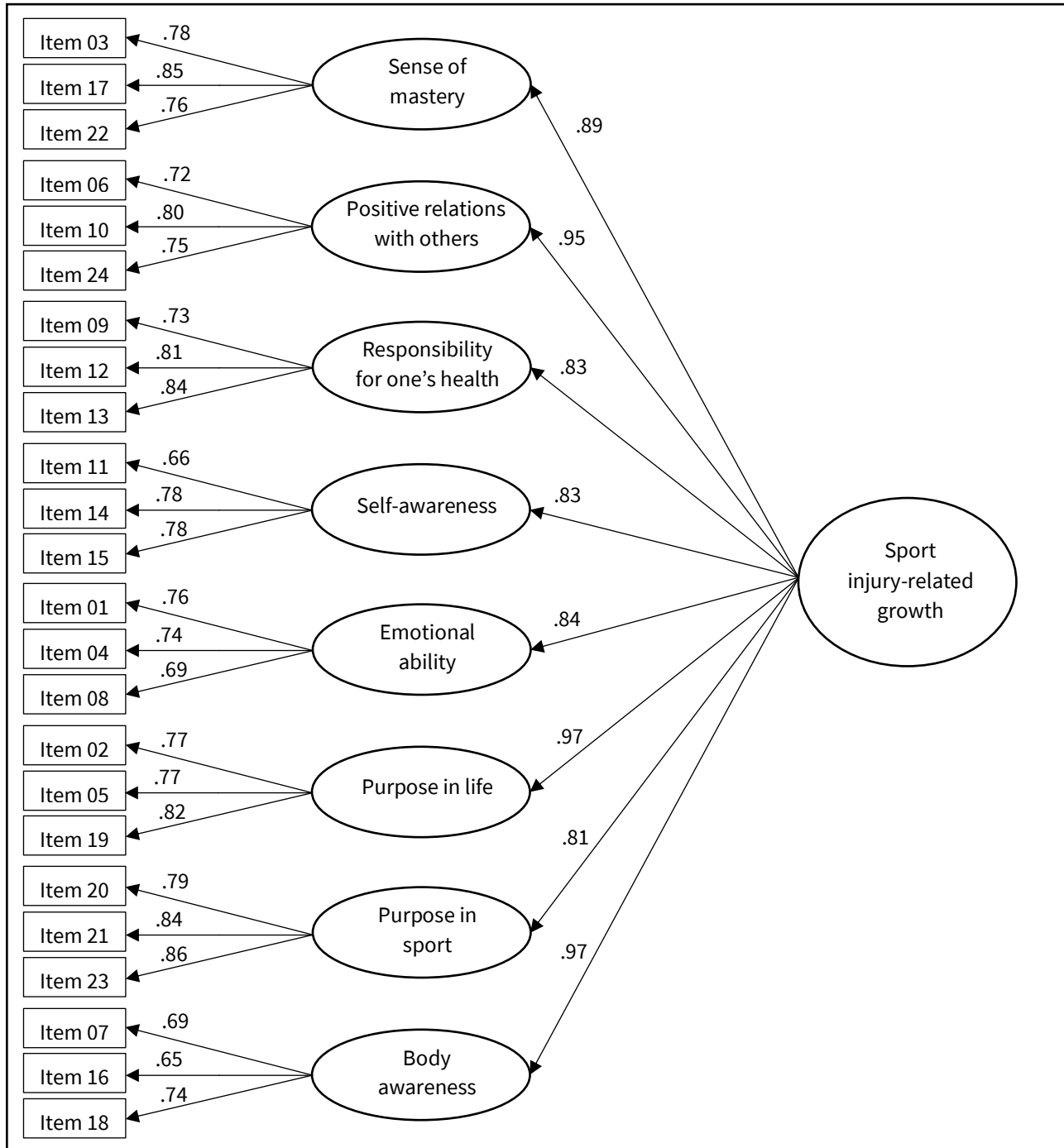
474 Factor Structure

475 Examination of histograms, and values of skewness and kurtosis showed that further parametric
476 tests were allowed. An initial CFA was performed to assess the structure of the SIRGI-33 and possibly
477 select the items with higher factor loadings. A lower order model with eight dimensions was tested
478 (SIRGI-33 lower order), but did not show completely acceptable fit indices [Model fit: $\chi^2 =$
479 1574.0(467), $\chi^2/df = 3,37$; CFI = 0.89, IFI = 0.89; RMSEA = .072 (90% CI = .069–.076); AIC =
480 1827.96], and the covariance matrix was not positive definite, with the dimension and "purpose in
481 life" showing multicollinearity problems with most of the other dimensions, and the dimension
482 "emotional ability" showing multicollinearity problems with "sense of mastery". Thus, items were
483 reduced one at a time based on their lowest standardised regression weight. A second criterion was
484 to maintain at least three items for each dimension. This procedure led to a second lower order model
485 (SIRGI-24 lower order) of SIRG with three items for each dimension. This second version
486 demonstrated acceptable or good fit indices [Model fit: $\chi^2 = 637.7(224)$, $\chi^2/df = 2,85$; CFI = 0.94, IFI
487 = 0.94; PCFI = 0.76; RMSEA = .064 (90% CI = .058–.070); AIC = 837.73] and did not show any
488 multicollinearity issues. Finally, a model with SIRG as higher-order factor (SIRGI-24 higher order –
489 see Figure 1) was tested and showed very similar fit indices [Model fit: $\chi^2 = 681.9(241)$, $\chi^2/df = 2,83$;
490 CFI = 0.94, IFI = 0.94; PCFI = 0.82; RMSEA = .064 (90% CI = .058–.069); AIC = 821.23], allowing
491 for the use of a composite score of SIRG and for the use of its sub-dimensions as interdependent
492 variables. A comparison between these three models is showed in Table 2.

493 **Table 2**494 *Comparison between the three proposed models for the SIRGI.*

| Model | χ^2 | df | (χ^2/df) | CFI | IFI | PCFI | RMSEA | AIC | notes |
|--------------------------------------|----------|-----------|----------------------|------------|------------|-------------|----------------------|------------|-----------------------------------------------------------|
| SIRGI-33 8-factor lower order | 1574.0 | 467 | (3.4) | 0.89 | 0.89 | 0.78 | .072 CI=.069-.076 | 1827.96 | Multicollinearity issues among some sub- dimensions |
| SIRGI-24 8-factor lower order | 637.7 | 224 | (2.8) | 0.94 | 0.94 | 0.76 | .064 CI=.058-.070 | 837.73 | |
| SIRGI-24 8-factor higher order | 681.9 | 241 | (2.8) | 0.94 | 0.94 | 0.82 | .064 CI=.058-.069 | 847.93 | |

495

496 **Figure 1**497 *Higher order model of the SIRGI-24.*

498 *Notes.* Standardised estimates are reported in the figure. Residual errors are not reported in order to
 499 simplify the figure. Model fit: $\chi^2 = 681.9(241)$, $\chi^2/df = 2.83$; CFI = 0.94, IFI = 0.94; PCFI = 0.82;
 500 RMSEA = .064 (90% CI = .058–.069); AIC = 847.93.

501

502 Concurrent Properties

503 Once the structure of the questionnaire was defined, the SIRGI-24 lower model was included
504 in a larger SEM together with the model for the PTGI and the Lie Scale. Correlations between latent
505 variables were observed to evaluate the concurrent properties of the instrument. The Lie Scale was
506 considered as manifest variable, as it provides a single score. First, strong or very strong correlations
507 (ranging from .69 to .96) were observed among the SIRGI sub-dimensions. When comparing the
508 SIRGI-24 with the other two instruments, weak to strong correlations (ranging from .29 to .68)
509 emerged between its sub-dimensions and the subdimensions of the PTGI. Similarly, no correlations
510 or weak correlations (ranging from .136 to .218) emerged between the sub-dimensions of the SIRGI-
511 24 and the Lie Scale. Full results are reported in Table 3.

512 Reliability

513 Reliability analyses demonstrated excellent alpha and omega values for the composite score of
514 the SIRGI-24 ($\alpha = .96$; $\omega = .96$) and good values ranging from .73 to .87 for all its sub-dimensions
515 (in detail, sense of mastery $\alpha = .83$, $\omega = .84$; positive relations with others $\alpha = .80$, $\omega = .80$;
516 responsibility for one's health $\alpha = .83$, $\omega = .83$; self-awareness $\alpha = .78$, $\omega = .79$; emotional ability $\alpha =$
517 $.77$, $\omega = .78$; purpose in life $\alpha = .83$, $\omega = .83$; purpose in sport $\alpha = .87$, $\omega = .87$; and body awareness
518 $\alpha = .73$, $\omega = .74$). Similarly, the PTGI in the present study demonstrated excellent values for the total
519 score ($\alpha = .97$; $\omega = .97$) and good to excellent values for its sub-dimensions (relating to others $\alpha =$
520 $.94$, $\omega = .94$; new possibilities $\alpha = .91$, $\omega = .92$; personal strength $\alpha = .88$, $\omega = .88$; spiritual change α
521 $= .81$, ω not computable due to only two items in the sub-dimension; appreciation of life $\alpha = .87$, $\omega =$
522 $.87$).

523

524

525

526

527

528 **Table 3**529 *Correlations between the SIRGI-24, the PTGI, and the Lie scale.*

| | SM | PR | RH | SA | EA | PL | PS | BA | 1 | 2 | 3 | 4 | 5 | Lie scale |
|--------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|-----------|
| <u>SIRGI-24</u> | | | | | | | | | | | | | | |
| Sense of mastery (SM) | (0.83) | | | | | | | | | | | | | |
| Positive relations with others (PR) | .824*** | (.80) | | | | | | | | | | | | |
| Responsibility for one's health (RH) | .705*** | .831*** | (.83) | | | | | | | | | | | |
| Self-awareness (SA) | .691*** | .834*** | .866*** | (.78) | | | | | | | | | | |
| Emotional ability (EA) | .956*** | .754*** | .723*** | .691*** | (.77) | | | | | | | | | |
| Purpose in life (PL) | .911*** | .903*** | .779*** | .767*** | .851*** | (.83) | | | | | | | | |
| Purpose in sport (PS) | .777*** | .798*** | .713*** | .699*** | .699*** | .884*** | (.87) | | | | | | | |
| Body awareness (BA) | .852*** | .945*** | .824*** | .818*** | .787*** | .927*** | .775*** | (.73) | | | | | | |
| <u>PTGI</u> | | | | | | | | | | | | | | |
| Relating to others (1) | .563*** | .618*** | .403*** | .381*** | .509*** | .630*** | .529*** | .629*** | (.94) | | | | | |
| New possibilities (2) | .571*** | .568*** | .425*** | .401*** | .545*** | .651*** | .502*** | .61*** | .890*** | (.91) | | | | |
| Personal strength (3) | .608*** | .589*** | .492*** | .480*** | .607*** | .677*** | .623*** | .654*** | .919*** | .910*** | (.88) | | | |
| Spiritual change (4) | .512*** | .493*** | .291*** | .312*** | .496*** | .580*** | .431*** | .577*** | .824*** | .803*** | .796*** | (.81) | | |
| Appreciation of life (5) | .576*** | .560*** | .457*** | .422*** | .531*** | .653*** | .573*** | .603*** | .918*** | .941*** | .981*** | .814*** | (.87) | |
| <u>Lie Scale</u> | .218*** | .136** | .078 | .058 | .202*** | .174*** | .143** | .202*** | .244*** | .209*** | .227*** | .286*** | .225*** | - |

530 *Notes.* Cronbach's alpha values for each sub-dimension are reported between parentheses. *Correlation is significant at the 0.05 level (2-tailed).

531 **Correlation is significant at the 0.01 level (2-tailed). ***Correlation is significant at the 0.001 level (2-tailed).

532

533

Discussion

534 Findings from Study 3 provide support for the reliability and validity of the SIRGI-24 for the
535 measurement of SIRG among athletes (see Appendix for items and definitions of the dimensions). In
536 particular, the examination of the factor structure of the scale and its relationships with other variables
537 provide further evidence to the construct validity of the instrument. Analysis of the factor structure
538 confirms an 8-dimension model should be adopted for the SIRGI-24. As both the lower order and the
539 higher order models satisfied criteria of fit, it is legitimate both the use of a composite score of SIRG,
540 and the use of the scores of the eight sub-dimensions as interdependent variables. In line with
541 theoretical perspectives (see, e.g., Salim & Wadey, 2021) positive correlations were found between
542 the SIRGI-24 and the PTGI. As expected, very weak or absent correlations emerged between the
543 SIRGI-24 and the Lie Scale, and this also was in line with previous studies which found the PTGI to
544 be uncorrelated with the construct of social desirability (Tedeschi & Calhoun, 1996). Altogether,
545 these results provide support for the concurrent properties of the developed instrument.

546 If compared with other measures of growth following adversity, the SIRGI-24 demonstrates a
547 stronger internal consistency reliability than the PTGI. In fact, Cronbach's alpha values for the
548 SIRGI-24 and its sub-dimensions ranged from .73 to .96, whereas they ranged between .67 and .90
549 for the PTGI and its sub-dimensions in the original study (Tedeschi & Calhoun, 1996). The
550 Cronbach's alpha value for the total score of the SIRGI-24 is also in line with that of the SRGS, which
551 was .94 for the total score in the original study (Park, et al., 1996). Regarding the dimensionality, the
552 SRGS demonstrated a single dimension of growth, which is in contrast with what emerged in the
553 literature on growth following sport injury. Differently, the PTGI revealed five factors, and this was
554 partially in line with the multiple themes emerged for the growth following sport injury. However,
555 these five factors (relating to others, new possibilities, personal strength, spiritual change, and
556 appreciation of life) were not sport-specific and did not cover all the facets of SIRG. For example, a
557 dimension regarding bodily sensations, such as the "body awareness" of the SIRGI-24, was not
558 covered by the PTGI. On the other hand, some aspects present in the PTGI, such as the "spiritual

559 change”, did not emerge in the sport injury-related literature. In contrast, the SIRGI-24 presents eight
560 context-specific dimensions which encompasses all the principal aspects of growth following sport
561 injury, and it seems a more suitable instrument for the assessment of SIRG.

562 **General Discussion and Conclusions**

563 The present multi-study paper aimed to develop and validate a measure to assess SIRG. The
564 instrument was named Sport Injury-Related Growth Inventory-24 (SIRGI-24 – see Appendix) and
565 consists of eight sub-scales of three items each: sense of mastery, positive relations with others,
566 responsibility for one’s health, self-awareness, emotional ability, body awareness, purpose in life,
567 purpose in sport, and body awareness. These eight sub-dimensions aims to cover all the facets of
568 psychological growth experienced by athletes following the return from sport injury and emerged in
569 the scientific literature on this topic. In line with the most recent guidelines for scale development
570 (AERA et al., 2014; Tenenbaum et al., 2012; Zumbo & Chan, 2014), the construct validity of this
571 instrument was demonstrated through: (a) assessment of its content validity; (b) examination of the
572 factor structure; and (c) analysis of concurrent properties.

573 Assessment of content validity in this multi-study paper followed a rigorous procedure in line
574 with recommendations and previous studies in the field (e.g., Dunn et al., 1999; Arnold et al., 2013).
575 Items were extracted from pertinent and specific literature in the systematic review, therefore, they
576 were quantitatively and qualitatively assessed by judging panels. As suggested by Dunn and
577 colleagues (1999), in the selection of judges for the expert panel assessment, the expertise of
578 participants was preferred over the number of participants. Indeed, this one of the strengths of the
579 current paper, as all the judges involved in the assessment had a specific expertise in sport injury
580 contexts. On the one hand, academics and sport psychologists provided the majority of comments
581 and suggestions, useful with particular the regards to the theoretical links of the items with the various
582 sub-dimensions and the scale applicability in the field. On the other hand, athletes helped to identify
583 and avoid the use of academic jargon in the items wording, and they also brought their injury
584 experience in relation to some items.

585 Regarding the factor structure of the instrument, the main facets of SIRG emerged in Study 1
586 are covered by the SIRGI-24. However, a few aspects have been lost in the development procedure;
587 in fact, themes initially labelled as “sport intelligence”, “nutrition”, “self-encouragement”, and “time
588 management” were removed because they were scarcely reported in the reviewed literature or due to
589 the judges’ assessments (see Table 1). With the wisdom of hindsight, getting rid of some of these
590 themes might have been considered more carefully. Eating disorders, for instance, could vary
591 according to gender (Krebs et al., 2019; Neely et al., 2021), and considering this aspect a-priori might
592 have allowed the authors to explore if the items relating to “nutrition” were more frequent among
593 women. Future studies could evaluate if enriching the questionnaire with items covering this or other
594 sub-dimensions. If compared with other studies that proposed possible dimensions of SIRG (i.e.,
595 Rubio et al., 2021; Wadey et al., 2013) the SIRGI-24 still exhibits its strengths. In particular, Wadey
596 and colleagues’ (2013) investigation among sport coaches identified four aspects of growth following
597 sport injury (i.e., personal, psychological, social, and physical), and these aspects are all covered by
598 the SIRGI-24 sub-dimensions. For example, increased “body awareness” and “responsibility for
599 one’s health” may well represent physical growth, “positive relations with others” may cover the
600 aspects of social growth, and the other SIRGI-24 sub-dimensions may cover the aspects of personal
601 and psychological growth. Similarly, Rubio and colleagues (2021) proposed five themes: personal
602 growth, improved social life, health benefits, sport benefits, and social support and recognition.
603 Personal growth may be represented by several sub-dimensions of the SIRGI-24 (i.e., “sense of
604 mastery”, “self-awareness”, and “emotional ability”), improved social life may be referred to
605 “positive relations with others”, health and sport benefits overlap with “responsibility for one’s
606 health” and “purpose in sport” respectively. Social support and recognition, instead, is described by
607 Rubio and colleagues (2021) as the fact of receiving support, attention and care during the
608 rehabilitation process; these aspects, in particular, were removed at step 2 of Study 1 (i.e., alignment
609 with the definition of SIRG) because they were considered more as opportunities that the athlete had
610 during the rehabilitation rather than real aspects of growth.

611 Correlations between the SIRGI-24 and other relevant variables were in line with theoretical
612 expectations, thus demonstrating concurrent properties. In particular, the instrument demonstrated
613 significant positive correlations with the PTGI. Despite both the SRGS (Park et al., 1996) and the
614 PTGI (Tedeschi & Calhoun, 1996) had been previously utilised in sport injury contexts, we preferred
615 to compare the SIRGI-24 with the PTGI, because of its multidimensionality and its adoption in the
616 most recent studies on this topic (i.e., Brewer et al., 2017; Salim & Wadey, 2021). As well as post-
617 traumatic growth (Tedeschi & Calhoun, 1996), also SIRG demonstrated to be uncorrelated or weakly
618 correlated with social desirability, suggesting that growth following sport injury occurs independently
619 from the desire to be appreciated by others.

620 Future studies could provide further evidence regarding the predictive properties of the SIRGI-
621 24, for example by investigating the validity of this instrument in predicting a successful return to
622 sport or career transition (see, e.g., Chen & Bansal, 2022; Ivarsson et al., 2018). In fact, in the
623 aftermath of injury, athletes' emotions may change also in the course of the day (see, e.g., Santi &
624 Pietrantonio, 2013) and a measure of SIRG can help determine when these fluctuations have ceased,
625 and the athlete has reached a psychological stability. Along with these aspects, future investigations
626 could also adapt the SIRGI-24 for use within other countries and languages, as the linguistic and
627 cultural adaptation of measurement instruments allows sport psychology researchers and practitioners
628 to compare data across different countries (see ISSP Position Stand – Ryba et al., 2013).

629 **Strengths and Limitations**

630 The adopted multi-method design can represent a best practice for those questionnaires that
631 aims to be underpinned by a sounded theoretical background (Boateng et al., 2018; Zhou, 2019), such
632 as in the case of psychological scales. The authors identified the most appropriate qualitative and
633 quantitative methods to develop an instrument rooted in the theory. In particular, systematic literature
634 review (Weed, 2005), code thematic analysis for the identification of themes (Braun et al., 2016),
635 repeated expert panel assessment (Arnold et al., 2013), and CFA for evaluating the theoretical
636 organisation of themes (Marsh et al., 2020), were adopted in the three presented studies. On the other

637 hand, it has to be acknowledged, that the 8-factor structure emerged in the present study may
638 encounter multicollinearity issues in future scale translation studies and further refinements might be
639 required to perfect the scale. Other validation procedures exist that might help in this process and/or
640 in reducing the dimensions of the present scale (see, e.g., Marsh et al., 2009; 2020); however, it should
641 be noted that, for other seminal scales developed in psychology or related disciplines, it has been
642 preferred to maintain a dimensionality that was consistent with the original theory, rather than
643 adopting purely statistical approaches to scale refinement (see, e.g., Minnesota Multiphasic
644 Personality Inventory-2 – MMPI-2; Chmielewski et al., 2017; Williams & Lally, 2017). Links with
645 existing theoretical concepts, in fact, can help practitioners in the field to best structure their
646 psychological interventions. For example, the literature on “environmental mastery” (e.g., Nicolas et
647 al., 2022) could inform interventions aiming at enhancing injured athletes’ “sense of mastery”.

648 **Conclusions**

649 In conclusion, this multi-study paper provides researchers and practitioners with a valid and
650 reliable instrument for the assessment of SIRG among a population of athletes of various age and
651 competitive levels. The SIRGI-24 allows for the assessment of context-specific sub-dimensions, such
652 as “responsibility for one’s health” or “purpose in sport”, that were not included in previous measures
653 of growth following adversity (i.e., the PTGI or the SRGS). The present scale also allows for the
654 quantitative exploration of individual differences in this context (e.g., gender differences), thus
655 allowing researchers for a deeper exploration of the psychological growth experienced following
656 sport injury and giving sport psychologists the possibility to enhance their intervention with injured
657 athletes.

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664 The authors report no conflict of interest.

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668 **Ethics statement**

669 The study is in agreement with the declaration of Helsinki. Ethic approval was obtained by the
670 Ethics Sub-Committee of St. Mary's University, Twickenham, nr. 00001644, and all participants in
671 the study provided informed consent.

672 **Data availability statement**

673 The data that support the findings of this study and other supplementary materials are available
674 from the corresponding author, GS, upon reasonable request.

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936 **Appendix**937 **Items of the SIRGI-24 and definitions of the sub-dimensions.**

Sport Injury-Related Growth Inventory-24 (SIRGI-24)

Sport injury-related growth refers to those perceived changes that propel the injured athletes to a higher level of functioning than that which existed prior to the injury

“Sense of mastery” is a perceived competence in managing one’s environment (e.g., life events, daily frustrations).

- 3. I can overcome challenging non-sporting life events.
- 17. I can manage the responsibilities of my daily life.
- 22. I can cope with the hassles of everyday life.

“Positive relations with others” where the person has good relationships with others and understands the importance of human relationships.

- 6. I have a good relationship with other people in sport.
- 10. I have good relationships with other people outside of sport (e.g., friends and family).
- 24. I value trust in a relationship.

“Responsibility for one’s health” is an appreciation of being healthy and having an understanding of healthy behaviours.

- 9. I appreciate the importance of being healthy.
- 12. I understand how healthy behaviours can contribute to my sporting performance.
- 13. I have a good understanding of healthy behaviours.

“Self-awareness” is being aware of one’s personal strengths, limitations, and qualities.

- 11. I am aware of my limitations in sport.
- 14. I am aware of my strengths in sport.
- 15. I am aware of my qualities.

“Emotional ability” is an ability to understand and regulate one’s emotions.

- 1. I am able to manage my emotions outside of sport.
- 4. I have the ability to manage my emotions in sport.
- 8. I understand my own emotions.

“Purpose in life” is a sense of purpose and an appreciation on one’s life.

- 2. I know what is important to me in life.
- 5. I enjoy working towards my plans to make them a reality.
- 19. I enjoy making plans for the future.

“Purpose in sport” is a sense of purpose and an appreciation on sport in one’s life.

- 20. I am determined to reach my goals in sport.
- 21. I know what I want to get from sport.
- 23. I have a clear idea of what I want to achieve in sport.

“Body awareness” is having the capacity to perceive and understand one’s bodily sensations, processes, and actions.

- 7. I know how much sleep I will need at night in order to wake up refreshed.
 - 16. I always know when I have exerted myself to the point where I will be sore the next day.
 - 18. I am aware of internal changes in my body (e.g., body temperature, heart beating).
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