Profiles of exercise dependence symptoms in Ironman participants

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ABSTRACT

Objective: To identify distinct profiles of Ironman participants based on levels of exercise dependence, and examine whether these profiles differed in relation to eating patterns and psychological distress.

Design: Cross-sectional survey study of 345 Ironman participants in Australia.

Main outcome measures: Exercise dependence symptoms were assessed via the Exercise Dependence Scale. Eating patterns were assessed via the three-factor eating questionnaire, and psychological distress measured using the Kessler 6 scale.

Results: Latent profile analysis identified five distinct profiles based on responses to the Exercise Dependence Scale, which were labelled: Asymptomatic; Time Committed; Low psychological dependence; Symptomatic; and At-risk. The At-risk and Symptomatic profiles had less healthy eating patterns and higher psychological distress compared with the other profiles.

Conclusions: These findings suggest important individual differences in the nature and severity of exercise dependence symptoms in Ironman participants. The majority of Ironman participants appeared to have a healthy involvement with Ironman. However, approximately 30% of Ironman participants belonged to the At-risk and Symptomatic profiles, which could reflect maladaptive patterns of exercise.

Exercise dependence refers to a multidimensional and maladaptive pattern of exercise that is associated with significant distress and/or impairment (Hausenblas & Downs, 2002a). The term exercise dependence is often used interchangeably with terms such as exercise addiction and excessive exercise; for clarity we use the term exercise dependence in this paper, except when referring to the results of studies that specifically use other terms. Exercise dependence is characterised by the presence of least three of the following symptoms: (1) tolerance; (2) withdrawal; (3) intention effects; (4) lack of control; (5) excessive time spent exercising; (6) reductions in other activities because of exercise; and, (7) continuation of exercise despite recurrent physical or psychological problems (Hausenblas & Downs, 2002a, 2002b). A distinction can be drawn between primary and secondary exercise dependence (Blaydon, Linder, & Kerr, 2004; De Coverley Veale, 1987). In primary exercise dependence, individuals are motivated to exercise for intrinsic reasons (e.g., the behaviour is intrinsically rewarding or gratifying). In contrast, in secondary exercise dependence an individual is driven to exercise as a means to accomplish a separate outcome such as controlling body composition (De Coverley Veale, 1987). Secondary exercise dependence can be attributed to a range of factors including a primary eating disorder and body image preoccupation (Blaydon et al., 2004).

A substantial body of literature has examined the prevalence, antecedents, and consequences of exercise dependence symptoms in a number of different contexts. The purpose of the present study was to extend existing exercise dependence research by adopting a person-centred approach to examine individual differences in the nature of exercise dependence symptomology. We focused specifically on a sample of Ironman participants, which represents an understudied yet potentially important population in the context of exercise dependence. Furthermore, we investigated whether and how individual differences in the nature of exercise dependence symptoms are associated with maladaptive eating and psychological distress. The remainder of this introduction briefly reviews previous research examining the nature and prevalence of exercise dependence in different populations. We then propose the need for person-centred research to investigate individual differences in exercise dependence symptoms, with a specific focus on Ironman participants.

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1. Exercise dependence

A growing number of studies have examined exercise dependence symptomology in a number of different sport/physical activity contexts. Several studies indicate that exercise dependence symptoms are relatively common. For example, Slay, Hayaki, Napolitano, and Brownell (1998) found that 26% of participants in a road run in the US were classed as obligatory runners. Lejoyeux and colleagues found that 42% of clients in a French fitness centre and 30% of customers at a French sports shop were categorised as exercise dependent (Lejoyeux, Avril, Richoux, Embouazza, & Nivoli, 2008; Lejoyeux, Guillot, Chalvi, Petit, & Lequen, 2012). A study of elite Australian athletes across 25 sports, found that 34.8% were considered at-risk for exercise dependence (McNamara & McCabe, 2012). Blaydon and Lindner (2002) studied a group of recreational, sub-elite, and elite triathletes and found that 52% met the criteria for exercise dependence. In a relatively large sample of 1273 US triathletes, Youngman and Simpson (2014) found that 20% were considered high risk for exercise addiction. Other studies report lower rates of exercise dependence. Lichtenstein, Larsen, Christiansen, Støving, and Bredahl (2014) found the prevalence of exercise addiction ranged from 7% to 10% in samples of Danish football players and fitness exercisers. Allegre, Therme, and Griffiths (2007) found that only 3.4% of ultra-marathon runners met criteria for exercise dependence, while Symons Downs, Savage, and DiNallo (2013) reported that 6% of US adolescents were classified as at-risk for exercise dependence. The differences in prevalence between these studies is not surprising and could reflect a number of factors including the specific measure of exercise dependence used, the sport/physical activity context, and the personal characteristics of participants (Berczik et al., 2012).

In addition to providing insight into the prevalence of exercise dependence symptoms, research has also provided an improved understanding of the factors underlying exercise dependence. For example, Egorov and Szabo (2013) recently integrated available research to propose an interactional model to explain the adoption, maintenance, and transformation of exercise behaviour; this provides an important framework for understanding exercise dependence symptoms. The model proposes that a complex array of personal factors (e.g., personality) interact with situational factors (e.g., accessibility, social values) to influence an individual’s type and level of exercise motivation. Egorov and Szabo (2013) propose that these motivations lead to one of two main exercise orientations: (1) a therapeutic orientation, where an individual exercises to avoid negative reinforcement and/or experience positive reinforcement; and (2) a mastery orientation, whereby an individual is motivated to develop new skills, improve/increase performance etc. The most important proposition of this model is that exercise dependence can occur when a sudden or progressively intolerable life-stressor leads to heightened psychological distress. This can occur because an individual drifts towards using excessive exercise as a way of coping with this stressor (Egorov & Szabo, 2013).

2. The need for person-centred approaches

An important gap in exercise dependence research is that very little is known about individual differences in exercise dependence symptoms. Most studies have classified individuals into predetermined groups, such as low, moderate, and high risk for exercise dependence, using cut-off scores (e.g., Blaydon et al., 2004; Cook et al., 2013; Hale, Roth, DeLong, & Briggs, 2010; Lejoyeux et al., 2008; McNamara & McCabe, 2012; Youngman & Simpson, 2014). As a result, these studies do not capture individual differences in the nature and severity of different exercise dependence symptoms (Lease & Bond, 2013). This is an important consideration because as noted above, exercise dependence is complex in that it encompasses an array of different psychological and physiological characteristics, and is influenced by a multitude of situational and personal factors (e.g., Egorov & Szabo, 2013). It is plausible that unique situational and personal characteristics manifest in distinct patterns (or profiles) of exercise dependence symptoms. These profiles may reflect differing underlying processes and have varying consequences for an individual’s health and well-being. Identifying and understanding these profiles could have important practical implications. For instance, treatment strategies may need to be tailored towards the specific subtype of exercise dependence. It is therefore important that individual differences in exercise dependence symptoms are examined using person-centred approaches, such as latent profile analysis and cluster analysis.

Only two studies have investigated individual differences in exercise dependence symptomology. Blaydon and Lindner (2002) identified four distinct clusters based on a combination of exercise dependence and eating patterns in a sample of 203 triathletes. The four clusters were labelled: (1) Primary exercise dependence; (2) Secondary exercise dependence; (3) Eating dependence; and (4) No dependence. They found differences between the clusters in relation to gender and level of competition. Maraz, Urban, Griffiths, and Demetrovic (2015) explored profiles of exercise dependence symptoms in a sample of 447 dancers. Their results indicated five distinct symptom profiles: (1) Low risk; (2) Medium risk without social conflicts; (3) Medium risk with social conflicts; (4) At-risk, no social conflicts; and (5) At-risk, with social conflicts. These profiles differed in relation to education levels, hours spent dancing per week, and borderline personality symptoms. The findings from these two studies suggest that the adoption of a person-centred approach could provide important insights into individual differences in the nature of exercise dependence.

3. Exercise dependence in Ironman participants

More person-centred research is needed to investigate the nature of exercise dependence symptomology. This should include investigating the characteristics of different symptom profiles, and their associations with outcomes such as disordered eating and well-being. There is also a need to investigate these profiles in different sporting contexts. This is consistent with a general call for more exercise dependence research to be conducted across different sport and physical activity samples (e.g., Berczik et al., 2012; Cook et al., 2013). This is an important consideration because different contexts could give rise to different patterns of exercise dependence symptoms. In the present study, we focused on Ironman participants, a group that has been largely unexamined in the context of exercise dependence, although exercise dependence research has been conducted in participants in shorter form triathlons (Blaydon & Lindner, 2002) and other endurance events such as marathon running (Allegre et al., 2007; Cook et al., 2013). The Ironman population is important for two main reasons. First, triathlon (which encompasses Ironman distance events) is among the fastest growing participation sports in many countries (British Triathlon, 2014; Triathlon Australia, 2014; USA Triathlon, 2014). In Australia, triathlon membership has increased 19–21% per year since 2011 (Triathlon Australia, 2014). In the US, there has been consistent growth in triathlon membership over the past five years, with more than 100,000 new members registering in 2013 (USA Triathlon, 2014). Second, triathlon participation requires considerable commitment in relation to the frequency and intensity of training (Vleck, Millet, & Alves, 2014). This is especially relevant to Ironman, which comprise a 3.8 km swim, 180.2 km bike, and 42.2 km run. While sprint distance events (750 m swim; 20 km bike; and 5 km run) remain most common, Ironman participation...
It is feasible that some Ironman participants engage in mal-adaptive patterns of exercise that are detrimental to health and functioning. Although several studies have examined exercise dependence symptoms in triathlon participants more broadly, there is very little research that has been conducted specifically with Ironman participants. One exception has been Youngman and Simpson (2014) who investigated Ironman participants as a subgroup of their larger sample of triathletes. Their research indicated that the prevalence of exercise dependence varied depending on the length of the triathlon event. The proportion of individuals considered at-risk for exercise dependence for sprint/Olympic distance triathlons (14.8%) appeared lower compared with those who participated in half-Ironman events (22.9%) although this difference did not reach statistical significance. The prevalence of exercise dependence was significantly higher in those who participated in full Ironman events (27.8%). Furthermore, their results indicated that the amount of time spent training each week was positively associated with the risk of exercise dependence. Although their findings are important, they do not provide an indication of whether and how the nature of exercise dependence symptoms varies between individuals.

4. The present study

The aim of the present paper was to investigate the nature of exercise dependence symptomatology in a sample of Ironman participants. Consistent with a small number of empirical studies (Blaydon & Lindner, 2002; Maraz et al., 2015), and drawing on Egorov and Szabo’s (2013) interactional model of exercise dependence, we anticipated that there would be considerable individual differences in exercise dependence characteristics. We aimed to explore these differences using a latent profile analysis (LPA) approach to identify distinct profiles of exercise dependence based on the Exercise Dependence Questionnaire-Revised (EDS-R; Hausenblas & Downs, 2002b). Second, we explored the co-occurrence of exercise dependence symptoms with eating patterns, to provide insights into the presence of primary and secondary exercise dependence in this population. Third, we examined whether exercise-related behaviours and psychological distress differed between the profiles. Consistent with some existing research (Cook et al., 2013), we hypothesised that longer time spent competing in Ironman events, longer training times, better performance (reflected in faster completion times), and higher psychological distress would be linked with more severe exercise dependence symptomology.

5. Methods

5.1. Participants

Participants in this study were recruited through a survey link distributed via one of Ironman Australia’s quarterly newsletters. This electronic newsletter is emailed to all individuals who are registered with Ironman Australia, the vast majority of whom are current or recent Ironman participants. The newsletter specifically invited current and former Ironman participants to be involved in this study. By clicking on the survey link, individuals were informed of the purpose of the survey and invited to participate. The study received ethics approval from the host institution’s Human Research Ethics Committee.

Data were collected from 392 participants, although 47 had incomplete data. When these individuals were excluded, the final sample included 345 adults aged 22–71 years (71.3% male). As shown in Table 1, most participants had a tertiary qualification (66.1%), worked full-time (72.8%), and had a BMI in the lean range (72.2%). In relation to history of Ironman participation, there was a mix in terms of years competing, and most recent finishing time. Most participants had completed an Ironman event in the previous 12 months (57.4%) or had registered for their first event (18.6%). A small proportion of participants had completed their most recent Ironman event within the past 13–24 months (15.9%), while 8.1% had completed their most recent Ironman event more than 2 years ago. Using the scoring criteria for the EDS-R proposed by Hausenblas and Downs (2002b), 9.0% of the current sample were considered at-risk for exercise dependence, 78.8% were nondependent-symptomatic, and 12.2% nondependent-asymptomatic.

5.2. Measures

Participants were invited to complete an online survey administered through the survey platform Qualtrics. The survey collected information on demographics, exercise dependence, health behaviours, and history of Ironman participation. The relevant parts of the survey included in this study are described below.

Exercise dependence

Participants completed the 21-item Exercise Dependence Scale (Hausenblas & Downs, 2002b), which comprised items across the following seven subscales: tolerance (e.g., “I continually increase my exercise frequency to achieve the desired effects/benefits”);
withdrawal (“I exercise to avoid feeling irritable”); intention effect (e.g., “I exercise longer than I intend”); lack of control (e.g., “I am unable to reduce how long I exercise”); time (e.g., “I spend most of my free time exercising”); reductions in other activities (e.g., “I would rather exercise than spend time with family/friends); continuance (e.g., “I exercise when injured”). Each item ranged from 1 (never) to 6 (always); thus higher scores indicated increased severity of exercise dependence. Hausenblas and Downs (2002b) provided guidelines for interpreting scores across the seven subscales. Individuals with average scores of 5 or 6 for three or more subscales can be considered “at-risk” for exercise dependence. Individuals with average scores of 3 or 4 for three or more subscales are considered “nondependent symptomatic”; these individuals display some exercise dependence symptoms, but are not considered at-risk. Individuals with average scores of 1 or 2 are classed as “nondependent asymptomatic”; these individuals are considered to not experience exercise dependence symptoms. Cronbach’s α ranged from .81 to .92 for six of the subscales; the reduction in other activities subscale had a lower Cronbach’s α of .63 which is consistent with previous research (Paradis, Cooke, Martin, & Hall, 2013).

Eating cognitions
Participants completed the Three-Factor Eating Questionnaire — Revised (18) (Karlsson, Persson, Sjöström, & Sullivan, 2000; Stunkard & Messick, 1985). This 18-item scale assesses three domains of eating cognitions: restrained eating, emotional eating, and uncontrolled eating. The cognitive restraint subscale (Cronbach α = .71) consists of six items assessing the extent to which individuals control their food intake to influence body weight and shape (e.g., “I do not eat some foods because they make me fat”). The emotional eating subscale (Cronbach α = .89) included three items that examined whether individuals eat in response to negative emotions (e.g., “When I feel anxious, I find myself eating”). The uncontrolled eating subscale (Cronbach α = .87) included nine items and assessed the extent to which individuals overeat and feel out of control (e.g., “Sometimes when I start eating, I just can’t seem to stop”). Lower scores are indicative of more maladaptive eating cognitions. All items were assessed on a four-point scale, and were coded so that higher scores reflected higher cognitive restraint, higher emotional eating, and higher uncontrolled eating.

Psychological distress
The Kessler 6 (K6) scale (Kessler et al., 2002) was used to assess levels of psychological distress. This scale consists of six items that assess general psychological distress encompassing depression and anxiety (e.g., “During the last 30 days how often did you feel hopeless?”). Each item was assessed on a five-point scale from ‘none of the time’ to ‘all of the time’. The levels of internal consistency were appropriate for this scale (Cronbach α = .81). Higher scores on the K6 are indicative of higher psychological distress.

Ironman training and performance
Several questions in the survey asked participants about their history of participating in Ironman events. In particular, participants were asked how many years they had spent training/competing in endurance events such as Ironman and triathlon (<2 years, 3–5 years, 6–10 years, 11–15 years, and >15 years). If they had previously completed an Ironman, they were asked to indicate how long it took to complete the most recent event: responses were coded as not applicable (i.e., not yet completed an Ironman), <10 h, 10–12 h; 12–14 h; >14 h. Participants were also asked to indicate when they had completed their most recent Ironman Event (coded as not yet completed an event, within the past 12 months, within 13–24 months, more than 2 years ago). Furthermore, participants indicated the number of sessions and average amount of time they spent each week training for Ironman.

Covariates
Participants indicated their gender, age, country of birth (coded as Australia or other country), marital status (coded as single or partnered), and education level (coded as ≤ year 12, certificate/diploma/trade, bachelor degree, or postgraduate degree). Participants also self-reported their height and weight, which were used to calculate body mass index.

5.3. Statistical analysis
Latent profile analysis (LPA) is a flexible analytic technique that identifies homogenous subgroups (or profiles) of individuals on the basis of a given set of variables (Berlin, Williams, & Parra, 2014). In the present context, it has the potential to identify distinct naturally occurring patterns of exercise dependence symptomology that would not be evident using variable based approaches. In this paper, LPA was conducted on the seven EDS-R subscales to identify distinct profiles of individuals based on exercise dependence. This approach involved running a series of LPA models specifying different numbers of profiles. For example, a model with 1 profile was first specified, followed by a model with 2 profiles, and so on until the optimal number of profiles was identified. Several considerations were taken into account when determining the optimal number of profiles. Information criteria — Akaike information criteria (AIC), Bayesian information criteria (BIC), and sample size adjusted BIC — were used to compare models (Nylund, Asparouhov, & Muthén, 2007). Lower relative values of these information criteria are indicative of a better model fit. Bootstrap likelihood ratio tests (BLRT) were also used to compare sequential models (e.g., a model with 2 profiles relative to a model with 1 profile); a non-significant BLRT indicates that a given model does not provide a significant improvement over the previous model (Nylund et al., 2007). Although these statistical criteria are important, the size, distinctiveness, meaning, and interpretability of profiles also need to be taken into account during model selection (Bauer & Curran, 2003; Berlin et al., 2014; Jung & Wickrama, 2008; Ram & Grimm, 2009). This is because profiles need to be large enough (e.g., >5% or > n = 25) to examine meaningfully (Berlin et al., 2014; Nylund et al., 2007). The characteristics of profiles also need to be inspected to examine whether they are meaningful (e.g., consistent with theory) and clearly distinct from one another. These considerations, in combination with statistical criteria, are important for selecting a parsimonious and meaningful solution (Ram & Grimm, 2009).

After the LPA analyses were performed, ANOVAs and chi-square tests of independence were conducted to examine differences between profiles in relation to demographic characteristics, involvement in Ironman (e.g., performance, years competing, training sessions and amounts), and levels of psychological distress and eating patterns. Post-hoc pairwise comparisons were performed to examine differences between profiles, with statistical significance determined using a conservative p value of .01 to reduce the likelihood of a Type I error. At present, there are no published validated data that would allow us to determine whether the differences between profiles on the eating subscales are clinically significant. The K6 does have validated cut-offs for determining level of psychological distress (Kessler et al., 2010), but there are limited data regarding how to determine clinical significance between groups. Therefore, in order to aid interpretation, we calculated effect sizes (Cohen’s d) for the significant pairwise comparisons. This allowed us to infer whether these differences were small (d = .20), moderate (d = .50), or large (d = .80).
6. Results

6.1. Profiles of exercise dependence

The results of the LPA models are shown in Table 2. The model with five latent profiles was deemed optimal given that it provided a better fit compared with models with four or less profiles. Although the model with six profiles indicated a statistically improved model fit, the additional profile identified was too small (n = 11) to examine meaningfully (e.g., Berlin et al., 2014; Nylund et al., 2007). Furthermore, the pattern of exercise dependence for this profile was not clear and more research with larger sample sizes may be needed to determine whether this profile is distinct from the others. Therefore, for the purposes of this study, we retained the five profile model. The scores on the seven EDS-R subscales for each of the five profiles are shown in Fig. 1. The cut-offs suggested by Hausenblas and Downs (2002b) for each of the seven subscales (i.e., at risk, symptomatic, and asymptomatic) as noted above were used to guide the interpretation of the profiles.

Profile 1 (n = 93; 21.2%) had the lowest scores on all of the seven subscales. This profile had scores on the tolerance and time subscales that were in the asymptomatic range; however, their scores on the other subscales were asymptomatic. Based on these characteristics, we labelled this profile Asymptomatic.

Profile 2 (n = 48; 11.0%) had scores approaching at-risk levels on tolerance and time, and scores slightly above the minimum threshold for reduction in other activities. Consistent with Cook et al., (2013) high scores on physical dependence domains are expected in many sports and may not be maladaptive. Focusing on the other subscales, we found that levels of withdrawal, intention effects, and lack of control were relatively low. In combination, this suggests a group of individuals who spent a lot of time exercising, but have a lot of control over their behaviour and have low psychological dependence. As a result, we labelled this profile Time Committed.

Profile 3 (n = 82; 18.7%) had scores that were symptomatic across all subscales, with none of the scores across the seven subscales approaching at-risk levels. The characteristics of this profile suggested some physical dependence, and relatively low psychological dependence. As a result, we labelled this profile Low psychological dependence.

Profile 4 (n = 93; 21.2%) had scores in the symptomatic range across all of the subscales, and had some similarities to the Time Committed and Low psychological dependence profiles. However, there were some important defining characteristics. First, this profile had scores on the tolerance and time subscales that were higher than the Low Psychological dependence profile and approached at-risk levels. Second, the present profile had levels of tolerance and time that were comparable with the Time Committed profile, but differed in that levels of withdrawal, intention effects, and lack of control were considerably higher. This may indicate a form of symptomatic exercise dependence that is characterised by a lack of control and high physiological dependence. As a result, we labelled this profile Symptomatic.

The fifth profile was the smallest of the five profiles (n = 29; 8.4%). Despite its small size, it did provide sufficient statistical power to be examined meaningfully (e.g., Berlin et al., 2014). Furthermore, the characteristics of this profile were clearly distinct from the other four profiles (Fig. 1). This profile was characterised by scores on all subscales that were considerably higher than the other four profiles. In addition, scores on three subscales – tolerance, time, and withdrawal – were at-risk or near at-risk. As a result we labelled this profile At-risk.

6.2. Differences in Ironman behaviours, psychological distress, and eating patterns

Table 3 presents the characteristics of the five profiles. There were few differences in demographic characteristics between the profiles. The Asymptomatic profile had a significantly higher mean age compared with the Symptomatic profile (p < .001). Interestingly, the proportion of males and females did not differ between the profiles (χ² = 6.02, p = .197). The lack of differences could be attributable to the relatively low number of female participants. There were also no differences between the profiles in relation to recent Ironman performance, the timing of their most recent Ironman event, and years spent competing in Ironman.

The five profiles, however, were found to differ in relation to cognitive restraint, F(4, 340) = 4.263, p = .002, uncontrolled eating, F(4, 340) = 7.268, p < .001, and emotional eating F(4, 340) = 7.741, p < .001 (see Table 3). Post hoc tests indicated that the Symptomatic profile had lower cognitive restraint compared with the Asymptomatic profile (p = .005); this represented a moderate effect (d = .48). Compared with the Asymptomatic profile, the At-risk (p < .001; d = 1.07) and Symptomatic profiles (p = .003; d = .55) had higher levels of uncontrolled eating; these effect sizes were strong and moderate respectively. Similarly, emotional eating was higher in the At-risk (p < .001; d = 1.01) and Symptomatic profiles (p = .009; d = .51) compared with the Asymptomatic profile. Finally, the Time Committed profile had lower emotional eating scores compared with the At-risk profile (p < .001; d = .90).

Psychological distress was also found to vary between the profiles, F(4, 340) = 11.030, p < .001 (Table 3). The At-risk profile had higher levels of psychological distress compared with the Time Committed profile (p = .004; d = .78), Low Psychological dependence (p = .001; d = .72), and Asymptomatic profiles (p < .001; d = 1.00). The Symptomatic profile had higher levels of distress compared with the Asymptomatic profile (p < .001; d = .69).

Relatively few differences were observed between the profiles in relation to Ironman performance and training. Post-hoc tests indicated that number of training hours did not differ between any of the five profiles. In relation to training sessions, the Asymptomatic profile had fewer training sessions per week compared with the Symptomatic profile (p = .001; d = .73), Time Committed (p = .014; d = .68), and At-risk profiles (p = .020; d = .76).

7. Discussion

The present study adopted a person-centred approach to investigate the nature and severity of exercise dependence symptoms in Ironman participants. Our results indicated five profiles, which varied in relation to the type and severity of exercise dependence symptoms as assessed via the EDS-R. These profiles were labelled: (1) Asymptomatic (2) Low physiological dependence; (3) Time Committed; (4) Symptomatic; and, (5) At-risk. Only

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Table 2

Model fit information and classification accuracy for the LPA models.

<table>
<thead>
<tr>
<th>Number of profiles</th>
<th>AIC</th>
<th>BIC</th>
<th>Sample-size adjusted BIC</th>
<th>BLRT p value</th>
<th>Entropy</th>
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<tbody>
<tr>
<td>1</td>
<td>12,909.47</td>
<td>12,963.28</td>
<td>12,918.87</td>
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<td>.84</td>
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<td>2</td>
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<td>12,456.18</td>
<td>12,386.39</td>
<td>.001</td>
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<td>12,199.36</td>
<td>12,314.67</td>
<td>12,219.50</td>
<td>.001</td>
<td>.82</td>
</tr>
<tr>
<td>4</td>
<td>12,135.61</td>
<td>12,281.66</td>
<td>12,161.12</td>
<td>.001</td>
<td>.78</td>
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<td>12,093.52</td>
<td>12,270.33</td>
<td>12,124.40</td>
<td>.001</td>
<td>.78</td>
</tr>
<tr>
<td>6                 *</td>
<td>12,055.24</td>
<td>12,262.79</td>
<td>12,091.49</td>
<td>.001</td>
<td>.83</td>
</tr>
</tbody>
</table>

AIC: Akaike Information Criteria; BIC: Bayesian Information Criteria; BLRT, bootstrap likelihood ratio test.
* Small profile identified (n = 11).
two previous studies (Blaydon & Lindner, 2002; Maraz et al., 2015) have investigated distinct profiles (or clusters) or exercise dependence symptoms. Person-centred approaches enable the identification of distinct patterns of exercise dependence symptomology that are not captured by approaches that categorise individuals into pre-defined groups using cut-offs. As discussed below, person-centred approaches are important for understanding the complexity of exercise dependence, particularly in a context such as Ironman, where long amounts of time spent exercising are common and not necessarily harmful or problematic (Vleck et al., 2014).

A key characteristic of all of the profiles, with the exception of the Asymptomatic profile, was the moderate-to-high levels of physical tolerance and long amounts of time spent exercising. This suggests that most participants in this sample displayed at least moderate levels of physiological dependence. This is not surprising given that Ironman participation requires a considerable amount of training and commitment (Vleck et al., 2014), which could lead to physical tolerance. Long amounts of time spent on training and physiological tolerance may not necessarily be problematic (Cook et al., 2013), but rather simply reflect the physical challenges and demands of involvement in a sport such as Ironman. These physiological symptoms on their own may not indicate a maladaptive pattern of exercise; this is consistent with Cook et al. (2013) who argued that psychological factors could be more important in contributing to exercise dependence symptoms in endurance exercise populations.

Some important differences in psychological dependence symptoms were observed between the profiles. The At-risk profile in particular had elevated scores across all of the seven EDS-R subscales, suggesting physiological and psychological symptoms of exercise dependence. In addition, these individuals displayed evidence of maladaptive eating patterns, as indicated by higher levels of uncontrolled and emotional eating relative to some of the other profiles, notably the Asymptomatic profile. The effect sizes

![Fig. 1. Average scores for each of the five profiles across the seven EDS-R scales. Average scores of 2 or less are asymptomatic; average scores >2 but <5 are symptomatic; average scores of 5 and above are at-risk.](image)

### Table 3

Differences in Ironman-related behaviours, eating patterns, and psychological distress between the five profiles.

<table>
<thead>
<tr>
<th></th>
<th>Asymptomatic (n = 93; 21.2%)</th>
<th>Time committed (n = 48; 11.0%)</th>
<th>Low psychological dependence (n = 82; 18.7%)</th>
<th>Symptomatic (n = 93; 21.2%)</th>
<th>At-risk (n = 29; 8.4%)</th>
<th>p value *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean (SD)</td>
<td>45.2 (9.5)*</td>
<td>42.8 (10.8)</td>
<td>41.6 (9.5)</td>
<td>40.8 (8.9)*</td>
<td>41.8 (10.9)</td>
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<td>Sex</td>
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<td></td>
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<td></td>
<td></td>
<td>.197</td>
</tr>
<tr>
<td>Male</td>
<td>74 (79.6)</td>
<td>32 (66.7)</td>
<td>57 (69.5)</td>
<td>66 (71.0)</td>
<td>17 (58.6)</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>19 (20.4)</td>
<td>16 (33.3)</td>
<td>25 (30.5)</td>
<td>27 (29.0)</td>
<td>12 (41.4)</td>
<td></td>
</tr>
<tr>
<td>Most recent Ironman event</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.821</td>
</tr>
<tr>
<td>Not yet completed an event</td>
<td>13 (14.0)</td>
<td>7 (14.6)</td>
<td>15 (18.3)</td>
<td>21 (22.6)</td>
<td>8 (27.6)</td>
<td></td>
</tr>
<tr>
<td>Within the past 12 months</td>
<td>58 (61.3)</td>
<td>26 (54.2)</td>
<td>50 (61.0)</td>
<td>49 (52.7)</td>
<td>16 (55.2)</td>
<td></td>
</tr>
<tr>
<td>13–24 months ago</td>
<td>14 (15.1)</td>
<td>11 (22.9)</td>
<td>11 (13.4)</td>
<td>15 (16.1)</td>
<td>4 (13.8)</td>
<td></td>
</tr>
<tr>
<td>More than 2 years ago</td>
<td>9 (9.7)</td>
<td>4 (8.3)</td>
<td>6 (7.3)</td>
<td>8 (8.6)</td>
<td>1 (3.4)</td>
<td></td>
</tr>
<tr>
<td>Recent Ironman performance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>294</td>
</tr>
<tr>
<td>Not yet completed an event</td>
<td>13 (14.0)</td>
<td>7 (14.6)</td>
<td>15 (18.3)</td>
<td>21 (22.6)</td>
<td>8 (27.6)</td>
<td></td>
</tr>
<tr>
<td>≤11 h</td>
<td>17 (18.3)</td>
<td>16 (33.3)</td>
<td>17 (20.7)</td>
<td>26 (28.0)</td>
<td>8 (27.6)</td>
<td></td>
</tr>
<tr>
<td>11–14 h</td>
<td>48 (51.6)</td>
<td>18 (37.5)</td>
<td>36 (43.9)</td>
<td>35 (37.6)</td>
<td>7 (24.1)</td>
<td></td>
</tr>
<tr>
<td>≥14 h</td>
<td>15 (16.1)</td>
<td>7 (14.6)</td>
<td>14 (17.1)</td>
<td>11 (11.8)</td>
<td>6 (20.7)</td>
<td>.564</td>
</tr>
<tr>
<td>Years competing in Ironman</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤5 years</td>
<td>32 (34.4)</td>
<td>13 (27.1)</td>
<td>36 (43.9)</td>
<td>37 (39.8)</td>
<td>13 (44.8)</td>
<td></td>
</tr>
<tr>
<td>6–10 years</td>
<td>25 (26.9)</td>
<td>15 (31.3)</td>
<td>23 (28.0)</td>
<td>21 (22.6)</td>
<td>8 (27.6)</td>
<td></td>
</tr>
<tr>
<td>≥11 years</td>
<td>36 (38.7)</td>
<td>20 (41.7)</td>
<td>23 (28.0)</td>
<td>35 (37.6)</td>
<td>8 (27.6)</td>
<td></td>
</tr>
<tr>
<td>Training hours/week mean (SD)</td>
<td>15.60 (4.40)</td>
<td>18.24 (4.70)</td>
<td>17.13 (5.30)</td>
<td>17.60 (4.57)</td>
<td>18.50 (5.23)</td>
<td>.025</td>
</tr>
<tr>
<td>Training sessions/week mean (SD)</td>
<td>8.99 (2.39)*</td>
<td>10.71 (2.80)*</td>
<td>9.78 (2.74)</td>
<td>10.71 (2.38)*</td>
<td>11.05 (3.76)*</td>
<td>.001</td>
</tr>
<tr>
<td>Eating patterns, mean (SD)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uncontrolled eating</td>
<td>16.00 (4.99)*</td>
<td>18.02 (5.51)</td>
<td>18.72 (4.60)*</td>
<td>18.99 (5.24)*</td>
<td>21.24 (7.47)*</td>
<td>.001</td>
</tr>
<tr>
<td>Emotional eating</td>
<td>4.60 (2.03)</td>
<td>4.71 (2.04)*</td>
<td>5.48 (2.16)*</td>
<td>5.73 (2.41)*</td>
<td>6.97 (3.23)*</td>
<td>.001</td>
</tr>
<tr>
<td>Psychological distress, mean (SD)</td>
<td>7.66 (1.98)*</td>
<td>8.40 (2.81)*</td>
<td>8.87 (2.58)*</td>
<td>9.86 (3.51)*</td>
<td>11.17 (4.67)*</td>
<td>.001</td>
</tr>
</tbody>
</table>

*p values derived from chi-square test of independence (categorical variables) or analysis of variance (continuous variables).

Profiles with the same superscript varied significantly from one another (at p < .05) based on the post-hoc comparisons.
suggested that the differences from the Asymptomatic profile were large. High scores on these subscales indicate that individuals in this profile have difficulties controlling the amount of food they consume (uncontrolled eating) and have a tendency to eat in response to negative emotions (emotional eating). Previous research suggests that the co-occurrence of exercise dependence symptoms and eating disorders is indicative of secondary, rather than primary, exercise dependence (Berczik et al., 2012; Blaydon et al., 2004; De Coverley Veale, 1987). Therefore, it is plausible that some individuals in the At-risk profile have exercise dependence symptoms that are secondary to an eating disorder. However, it is also possible that factors such as low behavioural control and low self-efficacy underlie the co-occurrence of exercise dependence symptoms and higher uncontrolled and emotional eating observed in this profile. We also found that the At-risk profile had considerably higher (as indicated by the effect sizes) levels of psychological distress compared with the other profiles. High psychological distress is often reported in individuals with exercise dependence (e.g., Grandi, Clementi, Guidi, Benassi, & Tossani, 2011), and there are many potential explanations for these findings. It is plausible that psychological distress is a contributing factor to exercise dependence. For example, Egorov and Szabo (2013) proposed that a significant life stressor that causes psychological distress can trigger exercise dependence. This is because an individual may engage in excessive exercise as a way to cope with the stressor. Furthermore, psychological distress could be an outcome of exercise dependence (Hausenblas & Downs, 2002a). This is because adverse consequences of exercise dependence such as injury, relationship problems, and lower satisfaction could lead to higher psychological distress. Although more research is required, the At-risk profile could represent a group of Ironman participants who have an unhealthy obsession with exercise.

The Symptomatic profile had elevated scores across most of the EDS-R subscales, although these were not as pronounced as the At-risk profile. This suggested a group of participants with moderate levels of physiological and psychological dependence symptoms. This profile also had higher levels of cognitive restraint, uncontrolled eating, and emotional eating compared with the Asymptomatic scale; these effect sizes were moderate. The scores on these eating subscales suggest these individuals have less control over their eating behaviour and are influenced more by external cues compared with the Asymptomatic profile. Similar to the At-risk profile, it is plausible that these scores reflect the presence of an underlying eating disorder and thus this profile could reflect a form of secondary exercise dependence. This profile also had elevated levels of psychological distress compared with the Asymptomatic profile; as noted above, psychological distress could be a contributor to or an outcome of exercise dependence symptoms.

These findings suggest that the At-risk and Symptomatic profiles could be problematic and represent Ironman participants who may have a less healthy involvement in exercise. This is particularly concerning given that these two profiles in combination account for nearly one-third of the present sample. In contrast, the other three profiles had patterns of exercise dependence symptoms that appeared to be more adaptive. In particular, the Asymptomatic profile was characterised by relatively low levels of both physiological and psychological dependence symptoms. The Time Committed and Low physiological dependence profiles had elevated scores on physiological dependence subscales (most notably time and tolerance), but low scores on the other subscales. Eating patterns and psychological distress in these two profiles were also comparable with the Asymptomatic profile. This suggests that although these individuals spent a lot of time exercising, it may not reflect an underlying eating disorder, and rather may reflect an adaptive and healthy involvement in the sport of Ironman.

7.1. Strengths and limitations

A key strength of the present study is that we focused on a sample of athletes of varying ability who participate in Ironman. Many studies examining exercise dependence have focused on university students, with comparatively fewer studies examining specific athlete groups. The present findings are important given that participation in triathlon — and Ironman more specifically — is increasing rapidly in many countries. Understanding the nature of exercise dependence in these contexts could inform strategies to promote healthy engagement with these events. A further strength of this study is the use of the EDS-R which has been demonstrated to have sound psychometric properties across a number of different samples and encompasses multiple domains of exercise dependence (Hale et al., 2010; Hausenblas & Downs, 2002b; Paradis et al., 2013). The LPA approach is also an important strength that is able to extend on previous research through the identification of multiple profiles based on exercise dependence symptoms.

There are some limitations that require consideration. First, although we cannot accurately estimate the response rate for this study, it is likely to be low. It is also possible that individuals experiencing more exercise dependence symptoms were less likely to volunteer for this study. These response biases mean that the sample is unlikely to be representative of Ironman participants in Australia and may underestimate the occurrence of exercise dependence symptomology. This could mean that the nature and number of the identified profiles could differ in a more representative sample.

Second, the present study was cross-sectional, and although it provides an informative snapshot of exercise dependence profiles, longitudinal research is needed to clarify the antecedents and consequences of these profiles. Furthermore, longitudinal research that tracks profiles over time would be important in clarifying whether certain profiles (e.g., uncontrolled symptomatic) develop into exercise dependence over time.

Third, although the sample size was sufficient for the purposes of conducting LPA (e.g., Berlin et al., 2014; Nylund et al., 2007; Tein, Cox, & Cham, 2013), there may not have been sufficient power to identify smaller (yet still important) profiles of exercise dependence symptomology. For example, as suggested by the statistical criteria, there may have been a sixth profile; research with a larger sample size would be needed to investigate the presence and nature of these and other profiles in Ironman participants. The sample size also meant that some of the identified profiles were small, which limits statistical power when comparing profiles. Therefore, although the present results are novel and important, some caution is required when interpreting the nature of, and differences between, the identified profiles. A final consideration is that because the number and proportion of females in this sample was low (28.7%), we were unable to investigate gender differences in the exercise dependence profiles. Some previous research has found differences between males and females in relation to levels of exercise dependence (e.g., Cook et al., 2013). Investigating whether profiles of exercise dependence symptomology vary by gender could be an important avenue for future research.

8. Conclusion

This study examined profiles of exercise dependence in a sample of Australian Ironman participants. The results indicate that the nature and magnitude of exercise dependence can vary considerably within a sample of Ironman participants, and can be reflected by distinct profiles. Furthermore, our results indicate that the exercise dependence profiles have varying associations with eating and psychological distress. This suggests that individual differences...
in the nature and severity of exercise dependence symptoms could have important implications for the health and well-being of Ironman participants. The nature of the five profiles indicates that most individuals had a healthy engagement with Ironman participation. Thus these individuals may derive positive health and well-being outcomes from their training and participation in these events. Despite this, it is possible that some of the other profiles could have considerable implications for health and well-being. This suggests there is a need to continue to raise awareness among Ironman participants regarding the importance of preventing exercise dependence, and promoting healthy involvement with the sport. This could include strategies to aid participants in maintaining control over their behaviour, recognize the signs and symptoms and exercise dependence, and balance training with other aspects of their life. We recommend that future research in Ironman and other sporting contexts utilise a person-centred approach to better understand exercise dependence symptomology.

References


