"I must do this!": A latent profile analysis approach to understanding the role of irrational beliefs and motivation regulation in mental and physical health.

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Accepted in Journal of Sports Sciences 9th February 2022

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Abstract

In the research concerning rational emotive behavior therapy (REBT) in sport and exercise, irrational beliefs are proposed as a risk factor for health. Concurrent to this, researchers have also indicated that autonomous and controlled motivation, as proposed in organismic integration theory could, together with irrational beliefs, could determine individual health. However, research is yet to align irrational beliefs and motivation, and explore how this alignment relates to mental health. The present two study paper identifies individual subgroups, drawn from data concerning irrational beliefs, motivation, and health (psychological distress, and physical health), in a sample of exercisers (study 1) and student athletes (study 2). We examined the latent profile structure of irrational beliefs and motivation, and how these latent profiles relate to psychological distress (studies 1 and 2), and physical health (study 2). Results indicate a two class profile whereby class 1 is characterised by high irrational beliefs, low self-determined motivation, and poor health outcomes. Class 2 is characterised by low irrational beliefs, high self-determined motivation, and better health outcomes. The findings are discussed in relation to the theoretical implications for REBT and organismic integration theory, and the practical implications for key stakeholders in the health of exercise participants and athletes.

Keywords: irrational beliefs, physical activity, self-determination, person-centered, student-athlete

"I must do this!": A latent profile analysis approach to understanding the role of irrational beliefs and motivation regulation in mental and physical health.

The application of rational emotive behavior therapy (REBT; Ellis, 1995) in the fields of sport and exercise have experienced major growth in the last decade. In REBT, it is not events (A) that directly cause emotional consequences (C), rather, it is the beliefs (B) one applies to events that underpins emotion (Ellis, 1994). Further to this ABC formulation, dysfunctional emotional consequences (e.g., anxiety) and concordant maladaptive behaviours (e.g., withdrawal) are underpinned by irrational beliefs (Browne et al., 2010). There are four core irrational beliefs (Dryden, 2014); demandingness (e.g., "I must"), awfulizing (e.g., "It is terrible"), frustration intolerance (e.g., "I cannot stand it"), and depreciation (e.g., "I am worthless"). In sport research, REBT has been applied across a range of sports, levels, and ages, revealing that REBT is effective in, for example, reducing anxiety, increasing self-efficacy, and enhancing performance in athletes (see Jordana et al., 2020, for a systematic review). In addition, irrational beliefs (rigid, extreme, and illogical), which are at the core of REBT as the central mechanism for emotionality, are associated with psychological distress (Mansell, 2021; Turner et al., 2019a; Turner et al., 2019b) and increased burnout (Turner & Moore, 2016), in athletes. In exercisers, the research concerning REBT is burgeoning, but early indicators suggest that REBT is effective in reducing muscle dysmorphia (Outar et al., 2020), and exercise dependence (Outar et al., 2018). Indeed, Ellis who developed REBT in the 1950s contributed one paper to the canon of sport and exercise psychology, which for the most part dealt with the application of REBT to exercise avoidance. Ellis (1994) postulated that exercise avoidance is driven in part by fear of failure and frustration intolerance, and lays it out thusly:

> "I dislike exercising, find it hard to get going with it, but because it is good for my health and often becomes enjoyable once I push myself, I'd better

> uncomfortably force myself to do it in order to get good results. I wish I could get better health by sitting on my ass and not exercising, but I can't! Too bad. So I'd better do some exercise.” This preferential and flexible belief, especially if strong and persistent, will tend to make you exercise. However, when you refuse to get going, you normally—or we could say abnormally—add to this a second rigid, irrational belief, such as, "Because I dislike exercise, I absolutely shouldn't have to do it. It's awful that my being in good health depends on this vile requisite. I can't stand it. I can somehow keep my good health without exercising. Screw it. I won't do it!" This demanding, musturbatory, inflexible belief blocks you from exercising.” (p. 249-250).

As can be seen in the passage above, Ellis believed that we are more likely to exercise when we adopt preferential beliefs about exercise that recognize the difficulty, and the internal and external merits, of exercise. In contrast, we are less likely to exercise when we adopt demanding beliefs about exercise and fail to appropriately recognize the merits of exercise. Inherent in Ellis’ reasoning above is the presence of motivation regulation. In the preferential statement we find hints towards intrinsic (“becomes enjoyable once I push myself”) and extrinsic (“it is good for my health”, “I'd better do some exercise”) regulation. Whereas in the demanding statement we find hints of very low intrinsic regulation (“I dislike exercise”, “this vile requisite”), and amotivation (“Screw it. I won't do it!”). The notion of motivation regulation is perhaps best captured by the organismic integration theory (OIT; Ryan & Deci, 2000), which is one of the six mini-theories of self-determination theory (SDT; Deci & Ryan, 1985; Ryan & Deci., 2019).

In OIT, motivation is categorized across a continuum of five regulation types; intrinsic motivation, integrated regulation, identified regulation, introjected regulation, and external regulation. Also, individuals can lack intentionality and motivation towards an activity, reflected in amotivation (Gustafsson et al., 2018; Ryan & Deci, 2017). Intrinsic, integrated, and identified regulations are considered more autonomous (or more self-determined), whilst introjected regulation and external regulation are considered more controlled (or less self-determined) forms of motivation (Howard et al., 2020b; Ryan & Deci, 2000). Amotivation is a lack of intention to enact a behavior (Ryan & Deci, 2000). Research evidence indicates that more autonomous motivation regulation is related to greater psychological and physical health (Ng et al., 2012), sustained physical activity engagement and health markers (e.g., Emm-Collison et al., 2020). Also, interventions that increase autonomous motivation increase psychological health and health behaviours (Ntoumanis et al., 2020), and controlled motivation regulation is related to elevated burnout, and decreased engagement (De Francisco et al., 2020). In athlete samples, greater autonomous motivation has been shown to lead to increased psychological wellbeing (e.g., Lonsdale & Hodge, 2011; Stenling et al., 2015). Greater controlled motivation has, however, been shown to predict illbeing longitudinally (Stenling et al., 2017), and is related to, mood disturbance, poorer sleep quality, anxiety, and depression (Sheehan et al., 2018), as well as increased burnout (Lonsdale & Hodge, 2011). In addition, Sheehan et al. (2018) found that amotivation (non-regulation) was related to all of the above symptoms, making it a particularly important aspect of OIT from an athlete health standpoint. In sum, greater autonomous motivation appears to be desirable for mental health across a range of populations.

Using Ellis' (1994) bridging of REBT and SDT, Turner (2016) suggested that irrational beliefs and motivation, as captured within OIT, should be considered together in the interest of athlete mental health, a suggestion previously posited in relation to predicting workaholism (van Wijhe et al., 2013). More recent research in athletes has examined the implications of irrational beliefs for motivation. Across four intervention studies, researchers have demonstrated that REBT, by reducing irrational beliefs, is effective in increasing autonomous motivation in triathletes (Davis & Turner, 2019), American football athletes (Chrysidis et al., 2020), and an archer (Wood et al., 2020). Chrysidis et al. (2020) report concomitant increases in self-efficacy, and Davis and Turner (2019) report increases in wellbeing and sleep quality. The effects of increasing autonomous motivation through reducing irrational beliefs speaks to, if not an association between irrational beliefs and motivation regulation, then a co-occurrence. This co-occurrence could have ramifications for mental health given the evidence that greater health is associated with greater autonomous (e.g., Ng et al., 2012) and less controlled (Sheehan et al., 2018) motivation, and lower irrational beliefs (e.g., Turner et al., 2019a; Vîslă et al., 2016). Specifically, Vîslă et al. (2016) evidenced that greater irrational beliefs is associated with general distress (r = .36), depression (r = .33), anxiety (r = .41), anger (r = .25), and guilt (r = .29), findings that have been echoed in athlete samples (e.g., Turner et al., 2019b).

In either sport or exercise domains, one can foresee the health risks of adopting high irrational beliefs and controlled motivation. An individual with irrational beliefs that reflect contingent self-worth (e.g., “I must succeed in the things I try, and I am worthless if I fail”) and whose motivation to engage in a sport or exercise behavior is regulated via introjected regulation (direction for action is controlled by internal pressure and contingent self-worth; Lonsdale & Hodge, 2011), is in a precarious position when it comes to their mental health. The demanding (“I must”) and depreciating (“I am worthless”) nature of the irrational beliefs, together with the self-pressure of introjected regulation, mean that the individual is likely to engage in sport or exercise because they believe they have to (rather than want to; Lonsdale & Hodge, 2011) and any setbacks are likely to be perceived as depreciating to self-worth. In addition, individuals who are extremely depreciating of themselves are unlikely to perceive themselves as being competent or self-efficacious (Chrysidis et al., 2020), and thus could be more likely to experience amotivation, a form of which is characterized by a felt lack of competence (Ryan & Deci, 2017).

The potential health risks of irrational beliefs and low self-determined motivation is in theoretical realms at present, and the studies that have demonstrated that decreased irrational beliefs lead to increased self-determined motivation (e.g., Wood et al., 2020) have been small *n* (single-case) applied studies. The question remains whether and to what extent irrational beliefs and motivation co-occur to influence health. Participating, and continuing to do so, in sport and exercise is a demanding endeavor because both activities can be punctuated by adversity (e.g., expectations, judgement, self-consciousness, fatigue). Therefore, understanding the factors that could sensitize exercisers and athletes to symptoms of poor health is an important task, because it could generate a more comprehensive understanding of effective interventions designed to prevent poor health within these demanding contexts. The combined assessment of irrational beliefs and motivation regulation using person-centered profiling methods would allow for the combined effects of irrational beliefs and motivation on health to be examined, which could be a fruitful endeavor, because together they could explain greater variances in health.

The present paper comprises two studies that employ latent profile analysis (LPA; see Ekblom-Bak et al., 2020; Shannon et al., 2021, for examples within sport and exercise), a person-centered approach well-suited to the examination of multidimensional motivation. Motivation has typically been examined using variable-centered designs, limiting understanding of this multivariate construct (Martinent & Decret, 2015). Recently, Cece and colleagues (2018) evidenced that types of motivation can operate in conjunction with one another. Considering this, and that such an approach has not been taken within REBT research, alongside the apparent association between irrational beliefs and motivation regulation (e.g., Davis & Turner, 2019), the person centered approach can provide complex combinations of several REBT and motivation dimensions. LPA allows researchers to identify individual subgroups drawn from data concerning irrational beliefs, motivation, and health markers. This is important because people’s behaviours are motivated by multiple different reasons simultaneously (Emm-Collison et al., 2020) and motives can interact to predict outcomes such as health. Thus, we take a categorical latent variable, or a person-centred (rather than variable- centred), approach (Spurk et al., 2020) in this paper, and test whether irrational beliefs and motivation form differentiable latent profiles. We assume that, based on the empirical bridging of REBT and OIT (Ellis, 1994; Turner, 2016), individuals will display profiles that are adaptive (i.e., low irrational beliefs, high autonomous motivation, low amotivation) or maladaptive (i.e., high irrational beliefs; high controlled motivation, high amotivation) for health. The core aim of the present paper is to examine the latent profile structure of irrational beliefs and motivation, and how these latent profiles associate with psychological distress (mental ill-health) in exercisers (study 1), and psychological distress and physical health in student-athletes (study 2). We anticipate that more adaptive belief and motivation profiles will be associated with better health outcomes.

Study 1

The practice of regular exercise behaviours is associated with many psychological and physical benefits (Mandolesi et al., 2018). Exercise behaviours can bolster self-esteem, vitality, and satisfaction with life (Fox et al., 2006). Following typical discourse in research, it would be expected that all those who exercise will boast greater mental health. That said, the reasons people have for engaging in exercise can influence their persistence and well-being (Briki, 2016; Ryan & Deci, 2000). As such, it is fruitful to understand the role that irrational beliefs and motivation regulation play in symptoms of psychological distress in exercisers. We ask the question, to what extent do irrational beliefs and motivation regulation co-occur to associate with psychological distress symptomology?

Methods

Participants

Following institutional ethical approval at respective universities, convenience and snowball sampling took place, contacting individuals who regularly exercise via emails, word of mouth, and social media. Convenience sampling was achieved by liaising with fitness groups (e.g., running groups). Snowball sampling was achieved by encouraging individuals on completion to send details of the study to other potential individuals that may be interested. A total of 650 (M_{age} = 30.65 ± 10.62; 250 males) regular exercisers ($M_{\text{days/week}}$ = 4.74 ± 2.58) took part in the study. Chi-square tests on sex and age evidenced that the distribution of participants was heterogenous (χ^2 (4) = 19.23, $p < .001$; age was coded 18-30, 31-40, 41-50, 51-60, 61-70). The majority of participants were within the 18-30 years of age category (20.77% of the sample were 18-30 year old males, and 43.08% of the sample were 18-30 year old females). Individuals were eligible for the study if they took part in at least 30 minutes of moderate to vigorous leisure time activity in a typical 7-day period. In the present study we were interested in individuals' beliefs about their exercise behaviours, rather than the type of exercise behaviour, and whether individuals meet national exercise guidelines (GOV.UK, 2019). Participants in this sample were not part of competitive, organised sport, unlike participants in study 2. Once ethically approved, a Qualtrics survey was sent to the individuals. All surveys were completed on the participants' electronic device.

Design

An atemporal cross-sectional design was employed to investigate the latent profile structure of irrational beliefs and motivation regulation, and how these latent profiles associate with psychological distress. LPA identifies distinct, non-overlapping latent classes of individuals based on individual responses (Tein et al., 2013). An LPA returns multiple solutions that describe the data, providing six different models (i.e., 6 profile structures). The models are provided alongside a multitude of fit indices (Akogul & Erisoglu, 2017), evidencing which of the models provide best fit. Because of this ability to a) provide more than a single model, and b) provide model fit indices, LPA, was chosen as the most contextually appropriate technique for the present research.

Measures

***Irrational Beliefs*.** The Irrational Performance Beliefs Inventory II (iPBI-II; Turner & Allen, 2018) is a 20-item questionnaire that measures irrational beliefs performance settings, including exercise (e.g., Outar et al., 2018). Responses are made on a 5-point Likert scale from 1 (*strongly disagree*) to 5 (*strongly agree*). The iPBI-II measures the four core irrational beliefs; demandingness, awfulizing, frustration intolerance, and self-depreciation. A higher score reflects greater irrational beliefs. Cronbach's α and McDonalds Omega (ω) for the present study demonstrated good to excellent internal consistency for demandingness (α = .82, ω = .81), awfulizing (α = .91, ω = .91), frustration intolerance (α = .86, ω = .86) and depreciation (α = .92, ω = .93). In addition, a robust confirmatory factor analysis (via the Lavaan package of R software (v. 4.0.2)) provided good fit for the theorized (four-factor) model (χ^2 (645) = 681.02, p < .001, CFI = .94, TLI = .92, SRMR = .04, RMSEA = .08).

***Motivation*.** The Behavioural Regulation in Exercise Questionnaire (BREQ-3) is a 24-item questionnaire assessing six types of behavioural regulations (amotivation, external, introjected, identified, integrated and intrinsic motivation). Responses were on a Likert scale from 1 (*completely disagree*) to 7 (*completely agree*) as per Rodrigues and colleagues' (2020) recommendations. We selected this measure because of its exercise focus. This measure has evidenced good factor structure and Cronbach's alpha coefficients (Rodrigues et al., 2020). The BREQ-3 is a valid instrument for motivation research (Rodrigues et al., 2020). Given that measurement of higher order models (i.e., autonomous, controlled and amotivation) are not well supported, each regulation is measured independently as part of latent profile modelling, providing model fit estimations (Howard et al., 2020b). The measure showed at least good internal consistency across five of the six motivation regulations ($\alpha \geq .85$, $\omega \geq .85$). Introjected motivation regulation was close to acceptable ($\alpha = .68$, $\omega = .69$). A robust confirmatory factor analysis provided adequate fit for the theorized six-factor structure (χ2 (644) = 728.883, $p < .001$, CFI = .92, TLI = .89, SRMR = .08, RMSEA = .09).

Psychological Distress. The depression anxiety and stress scale (DASS-21) is a 21-item questionnaire that measures three subcategories of psychological distress (Lovibond & Lovibond, 1995). The subcategories include depression (e.g., loss of self-esteem and depressed mood), anxiety (e.g., fear and anticipation of negative events) and stress (e.g., persistent state of over arousal). Containing 7-items for each subscale, responses are made on a 4-point Likert scale. To calculate comparable scores with the full DASS questionnaire, each 7-item scale was multiplied by two. Higher scores indicating greater symptoms (stress, 0-7, anxiety, 0-3, depression, 0-4 = minimal or no symptoms; stress, 8-9, anxiety, 4-5, depression, 5-6 = mild symptoms; stress 10-12, anxiety, 6-7, depression, 7-10 = moderate symptoms; stress 13-16, anxiety, 8-9, depression, 11-13 = severe symptoms; and stress 17+, anxiety, 10+, depression, 14+ = extremely severe symptoms). Participants were asked to rate how many of the items applied to them in the past week, from 0 (*did not apply to me at all*) to 3 (*applied to me very much, or most of the time*). Data was not collected from participants with medically diagnosed health conditions (e.g., depression, anxiety). The inclusion of such participants may have influenced the nature of individuals' motivational profiles (Smith, 2013).

In relation to scale cut-points, 59.38% (n = 386) reported minimal symptoms of stress, 18.77% (n = 122) reported mild symptoms, 10.31% (n = 67) reported moderate symptoms, 9.69% (n = 63) reported severe symptoms, and 1.85% (n = 12) reported extremely severe symptoms. Regarding anxiety, 17.08% (n = 111) reported minimal symptoms, 46.46% (n =

302) reported mild symptoms, 16.77% (n = 109) reported moderate symptoms, 13.69% reported severe symptoms (n = 81), and 7.2% (n = 47) reported extremely severe symptoms. Lastly, 27.08% (n = 176) reported minimal symptoms of depression, 42.31% (n = 275) reported mild symptoms, 13.85% (n = 90) reported moderate symptoms, 11.08% reported severe symptoms, whilst 5.7% reported extremely severe symptoms. DASS-21 has been validated in a number of populations (e.g. Crawford et al., 2009). Depression, anxiety and stress are critical psychological signs that relate to individuals' well-being, being a closely related concept to quality of life (Zikmund, 2003). In addition, robust confirmatory factor analyses provided good fit for the theorized unidimensional structure of anxiety ($\chi2$ (649) = 3373.72, $p < .001$, CFI = .99, TLI = .98, SRMR = .02, RMSEA = .07), depression ($\chi2$ (649) = 3420.85, $p < .001$, CFI = .99, TLI = .99, SRMR = .01, RMSEA = .05) and stress ($\chi2$ (649) = 2753.27, $p < .001$, CFI = .98, TLI = .97, SRMR = .03, RMSEA = .08). Cronbach's α and McDonalds Omega (ω) for the present study demonstrated excellent internal consistency (Depression α = .91, ω = .91; Anxiety α = .86, ω = .86; Stress α = .89, ω = .89).

Analytic Strategy

Descriptive statistics including means (Ms), standard deviations (SDs), and intercorrelations were calculated for all main study variables. The distribution of irrational beliefs and motivation data across psychological distress cut-points can be seen in Table 1. Second, Latent Profile Analyses (LPA) identified patterns across irrational beliefs, motivation regulation, and mental health. The R package (v. 4.0.2) tidyLPA was used to identify latent profiles (Rosenberg et al., 2019). A standardised z-score of ±0.50 indicated high and low estimations, while scores in between (i.e., +0.50 to −0.50) indicated moderate estimations (Martinent et al., 2013). Latent profiles can be identified with different constraints placed on the variance (varying or equal) and covariance (varying, zero, equal) of the profiles, returning multiple solutions (model 1, 2, 3 and 6; see supplementary material) that describe the data with varying numbers of profiles. Six different models in regard to the profiles' variance and covariance properties can be obtained. Similar to Cece et al. (2018), a combination of statistical indicators was used to decide on the best-fitting model: (i) information-theoretic method, and (ii) entropy-based criterion. The first method included the Akaike Information Criteria (AIC), the Bayesian Information Criteria (BIC), and the Sample Adjusted Bayesian Information Criteria (SABIC), with lower values indicating greater model fit. Second, entropy values range from 0 to 1, with higher values indicating a better differentiation between profiles. The Bootstrap Likelihood Ratio Test (BLRT) was used to determine whether the *k*-1 class model should be rejected in favour of a *k* class model. The bootstrap method has powerful means for statistical inference and is widely employed in various scientific problems (Davison & Hinkley, 1997; Good, 2005). In addition, Approximate Weight of Evidence (AWE), Classification Likelihood Criterion (CLC), and Kullback Information Criterion (KIC) values (Akogul & Erisoglu, 2017) were taken into account in identifying the number of profiles best suited[1]. It is also important to understand the meaning of the profiles that emerge in order to interpret the results (Martinent & Decret, 2015; Martinent & Nicolas, 2017). As such, in order to identify the best model fit, both statistics and theoretical underpinnings were considered (Martinent & Decret, 2015). Following extant research in sport and exercise, analyses were conducted on up to six potential latent profiles (Fryer et al., 2016; Gustafsson et al., 2017). An intercorrelation matrix (see Table 2) identified that intercorrelations between predictor variables were below the .80 cut-off (Berry & Feldman, 1985). Third, multivariate analyses of covariance (MANCOVA) identified whether there was a significant difference in reported depression, anxiety and stress between the latent profiles identified. Because there are reported differences in irrational beliefs

[1] The R package (v. 4.0.2) tidy LPA automatically calculates the number of profiles best suited using a culmination of AIC, BIC, SABIC, AWE, CLC, KIC and entropy values.

between males and females (Turner et al., 2019a), sex was used as a covariate within analyses. Further, it is reasonable to suggest that persistent exercise is likely to influence irrational exercise beliefs (Ellis, 1987), and as such was also used as a covariate (i.e., times exercised per week).

Because the ability to detect the number of classes via the aforementioned methods (AIC, BIC, BLRT, AWE, CLC, KIC, SABIC) can be influenced by number of variables and sample size (Tein et al., 2013), a formal power analysis is necessary. Given the paradigms and design adopted (LPA), one study was located that closely aligns with the current research (both for Study 1 and 2) in how irrational beliefs associate with mental health (Turner et al., 2019a). Priori G*Power (v 3.1.6) multiple linear regression calculations (α error probability = 0.05, $1 - \beta$ error probability = 0.95) based on comparable research (Turner et al., 2019a, $R^2 \geq .02$) were conducted, evidencing the need for a minimum of 532 participants. Because our sample size estimates are based on a single article, this calculation should be considered an approximation. Analysis revealed no missing data (missing data was unlikely because participants were prompted to complete questions they may have missed, during their participation, automatically in Qualtrics). Data-points with *z* scores greater than 3.29 (Hahs-Vaughn, 2017), were Winsorized. This is a process in which extreme values are replaced to reduce the influence of outliers on the data. Overall, .001% of data were Winsorized ($n = 62$ from 42,250 cases = .001%; Kwak & Kim, 2017).

[insert table 1]

[insert table 2]

Results

Latent Profile Analysis

Based on theoretical underpinnings as well as AIC (10084.40), AWE (11173.35), BIC (10502.37), CLC (10044.39), KIC (10258.40) (Akogul & Erisoglu, 2017), SABIC

(10276.95), entropy values (.93) and BLRT *p*-values (< .01), a solution with two latent profiles of varying variance and covariance was favoured (Model 6: see supplementary file 1). Entropy values were reliable within the two-class solution. Further, there was a non-significant difference in exercise behaviours between the two latent profiles ($p > .05$).

Class 1 comprised of 142 participants (21.85% of the sample; 56 males, 86 females), Class 2 comprised of 508 participants (78.15% of the sample, 194 males, 314 females). Those in Class 1 reported higher irrational beliefs (moderate (≤ .5)), amotivation, and controlled motivation (i.e., external; high (≥ .5)) relative to Class 2 (see Figure 1). In addition, those in Class 1 reported lower autonomous motivation (i.e., intrinsic, integrated and identified; low (≤ -.5)) than those in Class 2. Differences in introjected motivation were minimal (see Figure 1).

The patterns evidence two classes, those who hold high irrational beliefs, high amotivation, and high controlled motivation regulation, and low autonomous motivation regulation, (Class 1), and those who hold low irrational beliefs, low amotivation and low controlled motivation regulation, alongside high autonomous motivation regulation (Class 2). As such, Class 1 is characterised by high irrational beliefs and low self determination, whilst Class 2 is characterised by low irrational beliefs and high self-determination. Thus, we provide evidence that rigid and illogical (e.g., “I must”, “I am worthless”) beliefs are likely to be concomitant with controlled regulation and amotivation.

Multivariate analyses

In understanding whether there is a difference in psychological distress between the two classes, MANCOVA examined possible differences in depression, anxiety, and stress symptoms (see Figure 1). Irrespective of sex and times exercising per week, there was a significant main effect of Class on depression, anxiety and stress (Wilks’ $\Lambda = .49$, $F(3, 646) = 227.84$, $p < .001$, $\eta^2_p = 0.51$). Follow up comparisons identified that depression, anxiety, and stress were significantly higher in Class 1 (higher irrational beliefs, predominantly non-self-determined) than in Class 2 (lower irrational beliefs, predominantly self-determined; $p < .001$).

Discussion

Results from Study 1 identified that a two-class solution best fit the latent profile structure of irrational beliefs and motivation regulation. Those who reported high irrational beliefs, high amotivation, high controlled motivation regulation, and low autonomous motivation regulation, were likely to report greater psychological distress (Class 1). Conversely, individuals who reported low irrational beliefs, low amotivation, and low controlled motivation regulation alongside high autonomous motivation regulation, were likely to report lower psychological distress (Class 2). Specifically, those in Class 1 (high irrational beliefs, low self-determination) reported significantly greater depression, anxiety, and stress than those in Class 2 (low irrational beliefs, high self-determination). Based on these results, it is evident that a profile characterized by higher irrational beliefs and less self-determined exercise motivation regulation is related to greater psychological distress.

In study 2, we use Schmidt's (2009) guidelines to replicate and extend study 1. Schmidt (2009) posited that in order to demonstrate the same result as study 1 with a different sample (i.e., student-athletes), a modified procedure is required. As such, we adapt the motivation scale used in study 1 to fit the context, as well as the mental health form to enhance reliability of the findings. In study 2 we examine the latent profile structure of student-athletes' irrational beliefs and motivation regulation, and assess the association these profiles have with psychological distress, and physical health.

Study 2

The health risks facing student-athletes have been highlighted in psychology literature for decades (i.e., Brand et al., 2013; Pinkerton et al., 1989). Student-athletes are at particular risk of mental health disorders due to their typical age (young adulthood; Kessler et al., 2007), injury, time demands, regimented schedules impinging the expansion of social networks, and interpersonal conflict with teammates or coaches (Bissett & Tamminen, 2020). Amidst the litany of psychological stressors faced by athletes, they must somehow demonstrate attainment in both athletic and academic pursuits, which can be at odds with each other as each domain competes for time and energy. Despite physical gains from regular physical activity, the prevalence of depression and anxiety are similar between college athletes as compared to their non-athlete peers (Kroshus, 2016), with around 20% of adults experiencing a mental illness in a given year, compared to 17% and 21% in student-athlete populations (e.g., Weigand et al., 2013; Yang et al., 2007). Aligned with the mental health of athletes, is of course physical health. Indeed, 'health' per se has been defined by the World Health Organization (1946) as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity." Thus, investigating the mental and physical health of student-athletes is important to provide a holistic picture of student-athlete health (e.g., Etzel et al., 2006), so that interventions can be accurately formulated.

Method

Participants

We used convenience and snowball sampling across 25 universities in the United Kingdom. In total n = 781 student-athletes were recruited (382 women, 381 men, 18 unreported; M_{age} = 20.64, SD = 3.12 to take part in the study, with a clear dominance of participation by student-athletes located in the Midlands (n = 334) and North of England (n = 209). Chi-square tests on sex and age evidenced that the distribution of participants was heterogenous (χ^2 (2) = 18.16, p < .001; age was coded 18-20, 21-24, 25+). Age was categorized based on typical student ages in higher education. The majority of participants were within the 18-20 years of age category (26.63% of the sample were 18-20 year old males, and 33.67% of the sample were 18-20 year old females). 31.37% of participants were within the 21-24 age category (18.05% were males, 13.32% were females). Participants were invited to voluntarily take part in the study by academic staff at ten UK universities (convenience) and encouraged to invite fellow student-athletes to take part (snowball). Questionnaires were completed either online using Qualtrics (online survey provider), or physically in person using paper surveys. Research has shown that online versions of questionnaires have the same psychometric properties as paper versions (Riva et al., 2003), but also allow data to be collected nationally and multi-nationally.

All participants were undergraduate students, representing their attended university in one main sport (total of 69 sports representing team, n = 655, and individual, n = 124, sports). Sports ranged from Alpine skiing to Yoga, with prominent representation (n > 20) for American football (n = 35), Athletics (n = 24), Basketball (n = 27), Field Hockey (n = 62), Futsal (n = 51), Lacrosse (n = 37), Netball (n = 100), Rugby (n = 71), Soccer (n = 173), and Volleyball (n = 33). According to Swann et al. (2014), student-athletes in the current sample ranged in athletic level (e.g., Swann et al., 2014) across semi-elite (n = 371), competitive elite (n = 192), successful elite-world class (n = 59) (n = 159 did not report their athletic level). University ethical approval was gained from the lead author's institution prior to participant recruitment and all participants completed informed consent prior to taking part.

Design

As in Study 1, we adopted an atemporal cross-sectional design to investigate the latent profile structure of irrational beliefs and motivation regulation, and how these latent profiles associate with psychological distress and physical health in student athletes. Because LPA identifies distinct, non-overlapping latent classes of individuals (Tein et al., 2013), LPA was considered the most appropriate technique, being contextually appropriate to the present research.

Measures

Irrational Beliefs. As in study 1, we used the iPBI-II (Turner & Allen, 2018) to measure irrational beliefs. In the current sample, Cronbach's α and McDonalds Omega (ω) for the present study demonstrated acceptable to good internal consistency for demandingness (α = .73, ω = .73), awfulizing (α = .74, ω = .74), frustration intolerance (α = .78, ω = .78) and depreciation (α = .84, ω = .84). A robust confirmatory factor analysis provided adequate fit for the theorized model (χ2 (776) = 832.42, p < .001, CFI = .88, TLI = .84, SRMR = .05, RMSEA = .08).

Motivation Regulation. Consistent with OIT, the Sport Motivation Scale-II (SMS-II; Pelletier et al., 2013) assesses amotivation, external regulation, introjected regulation, identified regulation, integrated regulation, and intrinsic motivation. This mirrored study 1 in which we used an exercise-specific measure of motivation regulation, so in the current study we used a sport-specific assessment. Each of the 18-items is rated on a 7-point Likert-scale ranging from 1 (*not true at all)* to 7 (*very true*). For the current sample, Cronbach's α and McDonalds Omega (ω) for the present study demonstrated acceptable internal consistency for amotivation (α = .78, ω = .78), external regulation (α = .63, ω = .63), identified regulation (α = .79, ω = .79) integrated regulation (α = .81, ω = .80), and intrinsic motivation (α = .81, ω = .80). Cronbach's α and McDonalds Omega (ω) for introjected regulation was poor (α = .47, ω = .46). A robust confirmatory factor analysis provided less than adequate fit for the theorized six-factor structure (χ2 (775) = 1294.61, p < .001, CFI = .83, TLI = .79, SRMR = .12, RMSEA = .11).

Psychological Distress. The Patient Health Questionnaire (PHQ-9; Kroenke et al., 2001) is a standard measurement tool for depression, used nationally in NHS Increasing Access to Psychological Therapies (IAPT) services, and has been recommended for use in athlete populations (e.g., Trojian, 2016). The nine-items of the PHQ-9 assess frequency in symptoms of depression over the last two weeks, and is scored on a Likert-scale from 0 (*not at all*) to 3 (*nearly every day*). Participants can score between 0-27, with higher scores indicating greater depression symptoms (0-4 = minimal or no symptoms, 5-9 = mild symptoms, 10-14 = moderate symptoms, 15-19 = moderately severe symptoms, and 20-27 = severe symptoms). In the current sample, 35.6% (n = 278) reported minimal symptoms, 29.1% (n = 227) reported mild symptoms, 20.4% (n = 159) reported moderate symptoms, 11.1% (n = 87) reported moderate-severe symptoms, and 3.6% (n = 27) reported severe symptoms. In addition, robust confirmatory factor analyses provided adequate fit for the unidimensional structure of depression (χ2 (780) = 2863.09, p < .001, CFI = .93, TLI = .90, SRMR = .04, RMSEA = .10). Cronbach's α and McDonalds Omega (ω) for depression demonstrated good internal consistency (α = .88, ω = .88).

The General Anxiety Disorder Questionnaire (GAD-7; Spitzer et al., 2006) is a standard measurement tool for anxiety used in NHS IAPT services. The seven-items of the GAD-7 assess frequency of anxiety symptoms over the last two weeks on a Likert-scale from 0 (*not at all*) to 3 (*nearly every day*). Participants can score between 0-21, with higher scores indicating greater anxiety symptoms (0-4 = minimal or no symptoms, 5-9 = mild symptoms, 10-14 = moderate symptoms, and above 15 = severe symptoms). 43.5% (n = 340) reported minimal symptoms, 29.4% (n = 222) reported mild symptoms, 17.4% (n = 136) reported moderate symptoms, and 9.6% (n = 75) reported severe symptoms. In addition, robust confirmatory factor analyses provided adequate fit for the theorized unidimensional structure of anxiety (χ2 (780) = 3226.71, p < .001, CFI = .95, TLI = .92, SRMR = .05, RMSEA = .12). Cronbach's α and McDonalds Omega (ω) for anxiety demonstrated good internal consistency (α = .91, ω = .91).

Physical Health. The 14-item physical health questionnaire (PHQ; Schat et al., 2005) assesses four dimensions of somatic health: quality of sleep (4-items), digestion problems (4-

items), headaches (3-items), and respiratory problems (3-items). The PHQ pertains to the frequency with which participants experience somatic health problems. Separate subscales can be used, as well as an overall index of somatic health (Schat & Kelloway, 2003). A robust confirmatory factor analyses supports the use of an overall somatic health index, providing excellent fit for the bifactor structure of physical health ($\chi2$ (776) = 4111.57, p < .001, CFI = .99, TLI = .98, SRMR = .02, RMSEA = .04). Higher scores indicate greater somatic health problems. Cronbach's α and McDonalds Omega (ω) for overall physical health demonstrated good internal consistency (α = .83, ω = .83).

Analytic Strategy

The distribution of irrational beliefs and motivation data across psychological distress cut-points can be seen in Table 1. The current study followed the same procedures as study 1, including the calculation of descriptive statistics for all main study variables, LPA to identify patterns across irrational beliefs and motivation regulation, and (MANCOVA) to identify differences in reported depression and anxiety between the latent profiles identified. Data were screened for outliers (standardized z values > 3.29; Hahs-Vaughn, 2017), and outliers were Winsorized (n = 79 from 67,166 cases = .12%; Kwak & Kim, 2017).

Results

Latent Profile Analysis

Based on theoretical underpinnings as well as AIC (15166.70), AWE (16993.56), BIC (15753.38), CLC (14906.20), KIC (15300.70) (Akogul & Erisoglu, 2017), SABIC (15337.46), entropy values (.75) and BLRT p-values (< .01), a solution with two latent profiles of varying variance and covariance was favoured (Model 6: see supplementary file 2). Entropy values were reliable within the two-class solution.

Class 1 comprised of 396 participants (50.70% of the sample; 200 males, 187 females, 9 preferred not to say), Class 2 comprised of 385 participants (49.30% of the sample, 181 males, 195 females, 9 preferred not to say). Those in Class 1 reported higher irrational beliefs (moderate (≤ .5)), amotivation, external regulation (high ≥ .5), introjected regulation (moderate ≤ .5), identified regulation (moderate ≤ .5) and integrated regulation (moderate ≤ .5) relative to Class 2. In addition, those in Class 1 reported lower intrinsic motivation (moderate (≤ .5) than Class 2 (see Figure 1). The patterns evidence that those who hold high irrational beliefs, high amotivation, and high controlled motivation to participate in sport (Class 1), and those who hold low irrational beliefs, low amotivation and low controlled motivation (Class 2; see Figure 1). As such, Class 1 is characterised by high irrational beliefs and low self-determination, whilst Class 2 is characterised by low irrational beliefs and high self-determination. In other words, similar to study 1, rigid and illogical (e.g., "I must", "I am worthless") beliefs are likely to be concomitant with controlled motivation regulation and amotivation.

[insert Figure 1]

Multivariate analyses

In understanding whether there is a difference in psychological and physical health between the two classes, MANCOVA examined possible differences in depression, anxiety, and perceived ill-health between the two latent profiles (see Figure 2). Irrespective of sex, there was a significant main effect of Class on perceived depression, anxiety and ill-health (Wilks' Λ = .98, $F(3, 765) = 5.17$, $p = .002$, $\eta^2_p = 0.02$). Follow up comparisons identified that anxiety ($p = .039$), depression ($p = .047$) and perceived ill-health ($p \leq .001$) were significantly higher in Class 1 (higher irrational beliefs, higher amotivation and controlled motivation regulation) than in Class 2 (lower irrational beliefs, lower amotivation and controlled motivation regulation).

[insert Figure 2]

Discussion

Results from Study 2 identified that a two-class solution best fit the latent profile structure of irrational beliefs and motivation. Those who reported high irrational beliefs, high amotivation, and high controlled motivation regulation, were likely to report greater anxiety and depression (Class 1). But in addition, those in class 1 were also more likely to report more physical health problems. In contrast, participants who reported low irrational beliefs, low amotivation, and low controlled motivation regulation, were likely to report lower anxiety and depression, as well as less physical health problems (Class 2). Based on these results, it is evident that a profile characterized by high irrational beliefs and low self-determined sport motivation regulation is related to greater psychological distress and poorer physical health. Study 2 builds on past work on the mental health of student-athletes (e.g., McGuire et al., 2017), and research highlighting the possible role of motivation regulation in the mental health of student-athletes (Shannon et al., 2019).

General Discussion

The present paper offers a first empirical foray into the conceptual convergence of REBT and OIT, an endeavor that has until now existed as a theoretical postulation (e.g., Turner, 2016; Van Wijhe et al., 2013) and has been indicated in some intervention research (e.g., Davis & Turner, 2019). The current paper extends the literature concerning REBT in sport and exercise by explicating poorer and greater health profiles determined by irrational beliefs and motivation. To achieve this, in the current study we adopted an LPA approach to data analysis, recommended for its less subjective and more robust approach for person-centered analyses (Morin & Wang, 2016). In addition, REBT research thus far has somewhat neglected exercise and student-athlete populations, and little is known about the risks of holding irrational beliefs and less self-determined motives for exercise and sport respectively. There is perhaps reason to suggest that when there is convergence between high irrational beliefs and maladaptive low self-determined motives, there are risks to psychological (study 1 and 2) and physical health (study 2) for the populations we sampled.

In the current paper, we operationalized irrational beliefs and motivation as separable constructs that, whilst sharing some conceptual similarities (e.g., introjected regulation shares some characteristics of irrational beliefs; e.g., Turner, 2016), are distinct from one another. LPA produced profiles in which greater irrational beliefs, greater amotivation, and greater controlled motives, were associated with poorer psychological and physical health indicators. In other words, participants who held irrational beliefs, whose engagement in the respective activity (exercise or sport) was driven by more external types of motivation regulation, or who were not motivated to engage, were more likely to report greater symptoms of psychological distress (study 1 and 2), and poorer physical health (study 2). The current findings are in line with past research (Gustafsson et al., 2018) which demonstrates that athletes characterized by profiles with controlled regulations and amotivation report higher levels of burnout. Equally, the findings agree with the implicated bridging of irrational beliefs and self-determined motivation, and the consequences of maladaptive profiles (e.g., reduced self-efficacy, Chrysidis et al., 2020; depleted sleep quality and wellbeing, Davis & Turner, 2019).

It is possible to imagine why, for example, irrational beliefs and amotivation together might present risk to health. As my rigid and extreme beliefs concerning my performance grow ("I can't stand not reaching my goals"), and at the same time my motivation for sport engagement wanes ("I don't really think my place is in sport"), a sense of hopelessness manifests, reflected in a declination of health. The individual on the one hand berates themselves ("I am a complete loser"), and on the other hand questions their reasons for engaging in sport or exercise. One can imagine the dual impact of these factors on the day-to-day lives of exercisers and student-athletes, whereby exercise or sport is both a context in which they rigidly believe that they must achieve, and simultaneously their motives for engagement are evaporating. How will I meet my rigid need to succeed if I am questioning my reasons for doing sport? I do not want to partake in this activity, but if I do not, it will show that I am a worthless loser.

Conceptually, irrational beliefs are in themselves goal relevant, in that they are formed and activated in goal relevant situations in which the individual appraises goal incongruence (e.g., Chadha et al., 2019). Captured within the GABC aspects of the REBT framework, this connection between goal relevance (G), goal incongruence (A), and irrational beliefs (B) underpins emotional and behavioural consequences (C). Without a motivation towards a goal, irrational beliefs are not salient, because one cannot face goal incongruence (A) in the absence of a relevant goal (G). So, motivation per se is an important consideration for understanding REBT theory and practice. However, the present study, building on previous theorizing (Turner, 2016) and research (e.g., Davis & Turner, 2020), incorporates multidimentional motivation theory, namely OIT, whereby motivation is not simply considered to be the strength with which one holds or pursues a goal, rather, motivation is stratified across distinct reasons as to why activities are pursued (Howard et al., 2020a). In utilizing OIT it is possible to begin to understand how irrational beliefs and self-determined motivation operate together as indicators of health. The results of the present study indicate that individuals who report greater irrational beliefs and low self-determined motives report worse mental and physical health. As such, it might be that irrational beliefs are more problematic when motivation for a particular endevour is regulated in a less autonomous manner, or even when there is a lack of intention to engage (amotivation). Therefore, the strength of one's motivation might be important for the activation of irrational beliefs, but the extent to which these irrational beliefs are problematic for wellbeing outcomes might rest in part on the underlying reasons as to why the goal is being pursued and the extent to which one perceives a sense of autonomy over one's actions.

Whilst the LPA results do not indicate a specific irrational belief to be particularly important, the correlational statistics reveal that depreciation is more strongly related to contraindicators of psychological and physical health. Together with previous findings (e.g., Mansell, 2021; Turner et al., 2019a) a picture is being constructed that reveals depreciation beliefs to be particularly pernicious for wellbeing. Self-depreciation beliefs reflect a person giving themselves a global negative evaluation (Dryden, 2019) whereby the individual evaluates a specific trait, behaviour, or action, according to a standard of desirability or worth and then apply the evaluation to their entire being (MacInnes, 2004). In other words, depreciation beliefs are very extreme and final (e.g., "I am a complete failure") and with such negative self-evaluation it is understandable how damaging this belief could be for mental health. Individuals who believe that they are a complete failure are more likely to also report greater self-doubt (Balkis & Duru, 2018) and lower self-esteem (Chamberlain & Haaga, 2001), both of which are important for wellbeing outcomes (e.g., Braslow, 2012; Henriksen et al., 2017). In sum, self-depreciation is a worthy construct for further study within the context of mental and physical health because it appears to be particularly deleterious.

There were some results that were less clear cut. In study 1, class 1 was characterised by lower autonomous regulation compared to class 2, but in study 2, autonomous regulation showed no clear differences between classes 1 and 2. That is, whilst controlled motivation regulation and amotivation seemed to distinguish between profile classes, autonomous motivation regulation did not distinguish between the classes. This may suggest that it is not so much that higher autonomous regulation is important for distinguishing classes, but more important is the level of controlled regulation. Of course, we cannot rule out cohort effects here, especially because in study 1 where exercisers were recruited, autonomous regulation did distinguish between the two classes. What is clear across both studies is that irrational beliefs, amotivation, and external regulation, were able to distinguish between the classes.

Practical Recommendations

The findings of the present paper provide some clear implications for the wellbeing support of exercisers and student athletes. First, practitioners working with individuals who present with high irrational beliefs and less self-determined motives, should consider the health implications of this profile. Whilst acute performance may or may not be deleteriously affected by this profile, it is likely that psychological and physical health will suffer, and by extension, performance in the longer-term will suffer. It is important when working with athletes to consider the whole human being, and not just the 'athlete' (Turner, 2016). Second, just because an individual might report high irrational beliefs, it does not automatically mean that poor health outcomes will arise. Although it is clear in the extant literature that high irrational beliefs are related to poorer wellbeing outcomes (e.g., Turner et al., 2019a), there are a range of potential mediating factors that can explain these effects, such as maladaptive schemas (Turner et al., 2019b), automatic thoughts (Buschmann et al., 2018), and rumination (Artiran et al., 2020), for example. One such mediating, or contributing, factor, might be multidimensional motivation, as presented in the current paper. Future research should examine whether and to what extent motivation mediates the relationship between irrational beliefs and health outcomes, to help explain under what specific conditions irrational beliefs are especially harmful to health. In addition, future research may wish to examine whether and to what extent those with diagnoses of mental health conditions are likely to fall within a maladaptive profile.

Third, practitioners have at least two very achievable potential intervention strategies, one based in REBT, and one based in SDT. That is, practitioners could apply REBT to help individuals to reduce their irrational beliefs (e.g., Turner, 2016), or practitioners could work to help individuals explore more self-determined motives for engagement (Ntoumanis et al., 2020). This can be achieved by helping the individual to develop a greater sense of basic psychological needs (competence, autonomy, relatedness) fulfilment. For example, key stakeholders in the wellbeing of exercisers or athletes could seek to develop and propagate an autonomy supportive environment (Balaguer et al., 2018; Ntoumanis et al., 2018). Furthermore, there is evidence that through REBT, individuals report increases in self-determined motivation (e.g., Davis & Turner, 2019), and increases in basic psychological need fulfillment (Jones et al., 2021). Thus, practitioners might consider how REBT can be implemented to facilitate increases in autonomous motivation regulation.

In sum, the findings of the current study could provide a basis from which practitioners, and other key stakeholders of exerciser and athlete wellbeing, can support the mental and physical health of the individuals they work with. We encourage key stakeholders to create autonomy supportive environments, and to avoid encouraging the reinforcement of irrational ideologies (e.g., rigid, extreme, illogical beliefs). This might include key stakeholders involving individuals in decision making, and limiting the use of dogmatic, rigid, and extreme lexicon in their interactions with individuals (e.g., Evans et al., 2018). If an individual is suffering from a mental or physical illness, then referral to a medical clinician is required, but there is much we can do as stakeholders in wellbeing to stave off the onset of health issues through how we communicate with and support exercisers and athletes.

Limitations

Like all questionnaire-based research, the veracity of the data is predicated on the assumption that participants respond honestly, an assumption that is difficult to prove or disprove. Relatedly, stigma associated with health may lead to an underreporting of mental disorders in exercisers (Carless & Douglas, 2008), athlete populations (Roberts et al., 2016), and undergraduates (Royal College of Psychiatrists, 2011). To assuage response bias, future research could utilize objective behavioral data such as prevalence in self-harm, substance abuse, and attempted suicide. Longer-term, universities, sporting organizations, gyms, and fitness centers should work hard to reduce mental health stigma (Coyle et al., 2017). Relatedly, study 2 in the current paper used self-reported physical health indicators, but researchers should collect objective indicators of physical health, such as visits to physicians, and actual health assessments (e.g., cardiovascular, sleep analysis). In addition, in study 2 the differences between the two classes on psychological distress appear small (although statistically significant). Whilst mean differences may appear slight, the distribution of irrational beliefs and motivation data across the cut-points for psychological distress (Table 1) reveal more substancial differences in irrational beliefs and motivation at the extreme ends of distress. However, in the future researchers need to examine more closely the profiles of those who report severe psychological distress.

Psychometrically, we did find some issue with the motivation measures we used. Specifically, we found questionable model fit for both the BREQ-3 and the SMS-II. Contributing to this, Cronbach's alpha coefficients for introjected motivation across both studies, and external regulation in study 2, were less than ideal. Whilst it might be prudent to reanalyze data without the questionable items for said constructs (i.e., introjected regulation, external regulation), reducing the number of items per subscale to less than the existing four in the BREQ-3, and three in the SMS-II, introduces questionable convergent solutions (Robinson et al., 2018). Namely, it is recommended to include at least four items per subscale (i.e., Robinson et al., 2018). As such, it is unsurprising that motivation measurement issues were present across studies, nonetheless, results pertaining to introjected motivation should be interpreted with caution.

On the whole, the findings of the current paper are somewhat enlightening and offer some grounds for future exploration, but a cross-sectional approach has some downsides such as the static representation of potentially dynamic constructs. Indeed, the mental and physical health markers selected in the current study capture participant symptoms experienced in the last two weeks, so changes in scores are likely over time. To understand the potential causal links between irrational beliefs, motivation, and health, temporal (longitudinal) research should be undertaken, perhaps using cross-lagged auto-regression or latent profile transitional analyses (Cece et al., 2018). Large-scale intervention research would also be helpful to determine the extent to which changes in beliefs and motives influence health change. On the basis of the current study, it seems that one strategy for promoting health is to engage individuals in programs that discourage irrational beliefs and encourage self-determined motivation.

Conclusions

This paper provides evidence for two profiles that distinguish between poorer and greater self-reported health in exercisers and student-athletes. Specifically, profiles characterized by higher irrational beliefs, lower autonomous motivation regulation, higher controlled motivation regulation, and higher amotivation, were associated with worse health. In contrast, profiles characterized by lower irrational beliefs, higher autonomous motivation regulation, lower controlled motivation regulation, and lower amotivation, were associated with better health. In brief, profiles categorized by more adaptive beliefs and motives were indicative of better health, compared to profiles categorized by less adaptive beliefs and motives. Findings provide some useful implications for key stakeholders in exerciser and athlete health, as well as stimuli for further conceptual work within REBT and SDT.

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Table 1

Means and standard deviations of main study variables within mental health cut off points for study 1 and study 2

Study 1 – Exercise Participants					
Depression					
	Minimal	Mild	Moderate	Severe	Extremely Severe
Demandingness	13.67 +/- 2.92	14.07 +/- 3.31	14.64 +/- 3.05	15.37 +/- 2.66	15.74 +/- 3.26
Awfulizing	14.84 +/- 3.83	15.13 +/- 3.63	15.48 +/- 3.39	16.67 +/- 2.65	16.65 +/- 2.98
Frustration Intolerance	13.24 +/- 2.91	13.59 +/- 3.58	13.71 +/- 3.29	15.28 +/- 3.00	15.33 +/- 3.00
Depreciation	7.77 +/- 3.81	9.49 +/- 3.99	10.47 +/- 3.79	11.07 +/- 4.60	11.24 +/- 4.18
Intrinsic	5.25 +/- 1.32	5.18 +/- 1.24	5.34 +/- 1.19	4.93 +/- 1.36	4.73 +/- 1.35
Integrated	4.95 +/- 1.39	4.70 +/- 1.47	5.00 +/- 1.24	4.50 +/- 1.53	4.36 +/- 1.50
Identified	5.54 +/- 1.11	5.42 +/- 1.17	5.46 +/- 1.06	5.32 +/- 1.07	4.96 +/- 1.35
Introjected	5.36 +/- 1.00	5.27 +/- 1.11	5.33 +/- 1.12	5.15 +/- 1.05	4.80 +/- 1.29
External	2.65 +/- 1.68	2.68 +/- 1.71	2.76 +/- 1.83	2.81 +/- 1.68	2.79 +/- 1.94
Amotivation	2.56 +/- 1.68	2.64 +/- 1.82	2.51 +/- 1.93	2.54 +/- 1.74	2.75 +/- 1.92
Anxiety					
	Minimal	Mild	Moderate	Severe	Extremely Severe
Demandingness	13.72 +/- 3.17	13.97 +/- 3.11	14.50 +/- 3.40	15.31 +/- 2.67	15.30 +/- 3.02
Awfulizing	14.45 +/- 4.02	15.13 +/- 3.65	15.71 +/- 3.36	16.25 +/- 2.63	16.56 +/- 3.07
Frustration Intolerance	12.98 +/- 3.39	13.57 +/- 3.28	13.99 +/- 3.37	14.94 +/- 3.22	14.77 +/- 2.98
Depreciation	8.11 +/- 4.21	8.83 +/- 3.80	10.71 +/- 3.94	11.06 +/- 4.30	10.72 +/- 4.60
Intrinsic	5.20 +/- 1.30	5.32 +/- 1.19	4.95 +/- 1.41	5.08 +/- 1.26	4.74 +/- 1.37
Integrated	4.83 +/- 1.44	4.92 +/- 1.39	4.64 +/- 1.49	4.56 +/- 1.41	4.31 +/- 1.59
Identified	5.59 +/- 1.13	5.59 +/- 1.04	5.09 +/- 1.26	5.20 +/- 1.06	5.11 +/- 1.37
Introjected	5.42 +/- 1.06	5.34 +/- 1.01	5.23 +/- 1.25	4.97 +/- 1.07	5.01 +/- 1.24
External	2.72 +/- 1.79	2.59 +/- 1.66	3.06 +/- 1.83	2.36 +/- 1.52	3.18 +/- 1.84
Amotivation	2.61 +/- 1.86	2.51 +/- 1.76	2.86 +/- 1.90	2.35 +/- 1.62	2.92 +/- 1.80
Stress					
	Minimal	Mild	Moderate	Severe	Extremely Severe
Demandingness	13.84 +/- 3.18	14.52 +/- 2.94	15.36 +/- 3.07	15.19 +/- 3.15	15.27 +/- 2.14
Awfulizing	14.89 +/- 3.75	15.64 +/- 3.42	16.35 +/- 2.97	16.32 +/- 2.93	16.87 +/- 2.30
Frustration Intolerance	13.30 +/- 3.32	14.10 +/- 3.35	15.03 +/- 3.12	14.69 +/- 3.18	15.33 +/- 2.36
Depreciation	8.70 +/- 3.95	10.07 +/- 3.97	11.01 +/- 4.56	10.77 +/- 4.28	11.00 +/- 4.42
Intrinsic	5.28 +/- 1.24	5.03 +/- 1.27	5.10 +/- 1.29	4.95 +/- 1.43	4.47 +/- 1.43
Integrated	4.97 +/- 1.35	4.25 +/- 1.53	4.80 +/- 1.49	4.70 +/- 1.55	3.83 +/- .90
Identified	5.62 +/- 1.06	4.90 +/- 1.23	5.50 +/- 1.02	5.39 +/- 1.16	4.03 +/- 1.08
Introjected	5.37 +/- 1.03	5.10 +/- 1.20	5.23 +/- .96	5.06 +/- 1.25	4.75 +/- 1.40
External	2.68 +/- 1.69	2.78 +/- 1.84	2.61 +/- 1.70	2.65 +/- 1.64	3.67 +/- 2.13
Amotivation	2.59 +/- 1.79	2.75 +/- 1.87	2.38 +/- 1.62	2.39 +/- 1.69	3.67 +/- 2.24
Study 2 – Student-Athletes					
Depression					
	Minimal	Mild	Moderate	Moderate-Severe	Severe
Demandingness	16.22 +/- 3.61	16.60 +/- 3.48	17.42 +/- 3.32	17.58 +/- 3.64	17.84 +/- 3.29
Awfulizing	18.04 +/- 3.61	18.26 +/- 3.66	19.09 +/- 3.23	19.77 +/- 3.07	19.56 +/- 3.64
Frustration Intolerance	15.80 +/- 3.57	15.84 +/- 3.60	16.90 +/- 3.50	16.98 +/- 3.36	17.19 +/- 4.18
Depreciation	11.43 +/- 4.00	12.17 +/- 4.30	13.55 +/- 4.62	14.23 +/- 4.47	15.75 +/- 5.01
Intrinsic	16.28 +/- 3.82	16.41 +/- 3.66	17.09 +/- 4.51	17.21 +/- 4.54	16.78 +/- 6.60
Integrated	14.64 +/- 4.35	14.23 +/- 5.00	15.37 +/- 4.98	16.52 +/- 5.27	15.96 +/- 6.76
Identified	14.99 +/- 4.22	15.05 +/- 4.25	15.36 +/- 4.33	15.37 +/- 4.22	15.22 +/- 5.53
Introjected	11.69 +/- 3.82	11.76 +/- 3.81	12.86 +/- 4.53	14.10 +/- 4.58	14.11 +/- 4.74
External	8.38 +/- 4.45	7.89 +/- 4.26	7.84 +/- 3.89	8.74 +/- 4.56	9.15 +/- 4.44
Amotivation	8.46 +/- 5.45	8.12 +/- 4.99	7.52 +/- 4.39	8.31 +/- 4.81	8.05 +/- 3.04
Anxiety					
	Minimal	Mild	Moderate	Severe	
Demandingness	16.19 +/- 3.62	16.91 +/- 3.52	17.26 +/- 3.25	18.13 +/- 3.45	
Awfulizing	18.07 +/- 3.65	18.52 +/- 3.45	18.87 +/- 3.31	20.13 +/- 3.14	
Frustration Intolerance	15.59 +/- 3.61	16.17 +/- 3.37	16.76 +/- 3.63	17.86 +/- 3.66	
Depreciation	11.54 +/- 4.24	12.49 +/- 4.25	13.73 +/- 4.38	15.25 +/- 4.43	
Intrinsic	16.32 +/- 3.78	16.53 +/- 3.89	17.11 +/- 4.61	16.77 +/- 5.08	
Integrated	14.06 +/- 4.80	15.17 +/- 4.73	16.10 +/- 4.99	15.63 +/- 5.20	

Identified	14.85 +/- 4.26	15.34 +/- 4.10	15.25 +/- 4.30	15.36 +/- 4.84
Introjected	11.40 +/- 3.83	12.57 +/- 4.15	13.48 +/- 4.19	13.20 +/- 4.50
External	8.09 +/- 4.45	8.36 +/- 4.17	7.85 +/- 3.80	9.09 +/- 4.77
Amotivation	8.25 +/- 5.35	8.26 +/- 4.90	7.51 +/- 4.01	8.76 +/- 4.89

Table 2

Scale Reliabilities, Descriptive Statistics and Inter-correlations

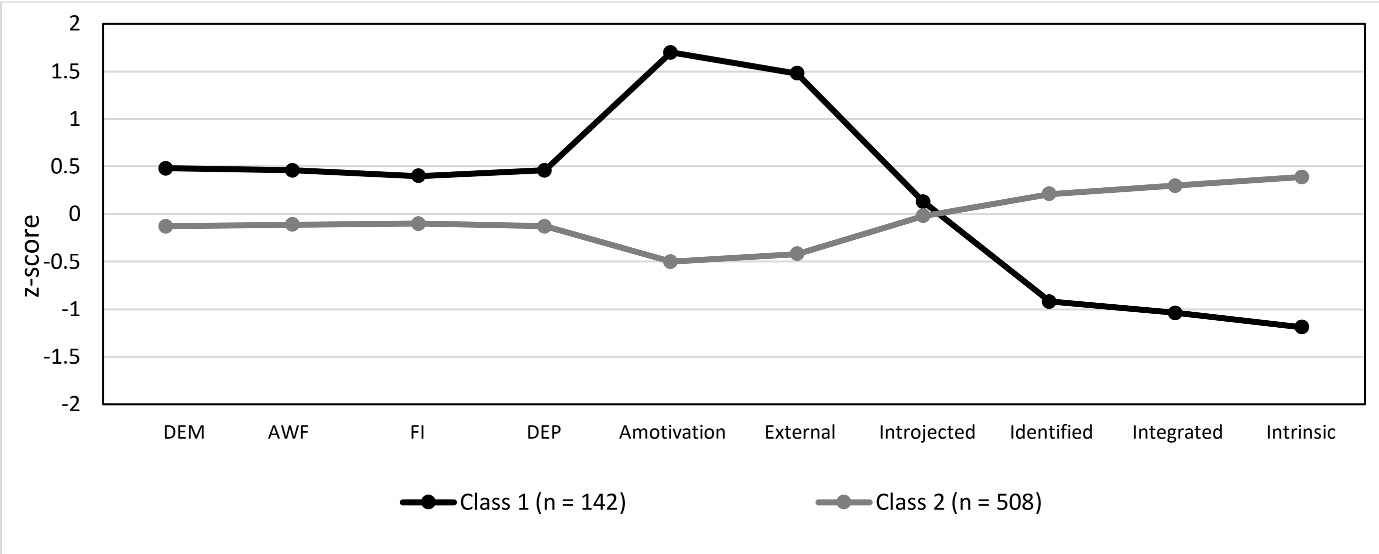
						Exercise								
	Mean +/- SD	1	2	3	4	5	6	7	8	9	10	11	12	
1. Demandingness	14.28 +/- 3.15	-												
2. Awfulizing	13.80 +/- 3.34	.71**	-											
3. Frustration Intolerance	15.36 +/- 3.57	.62**	.61**	-										
4. Depreciation	9.44 +/- 4.15	.31**	.44**	.26**	-									
5. Intrinsic	5.32 +/- 1.21	-.10*	-.08	-.16**	.01	-								
6. Integrated	4.86 +/- 1.45	-.10*	-.10**	-.17**	-.04	.56**	-							
7. Identified	5.54 +/- 1.12	-.17**	-.16**	-.26**	-.03	.51**	.61**	-						
8. Introjected	5.23 +/- 1.14	-.08	-.06	-.10**	.02	.14**	.34**	.41**	-					
9. External	2.37 +/- 1.51	.08	.07	.09*	.08*	-.22**	-.03	-.08*	.36**	-				
10. Amotivation	2.22 +/- 1.42	.07	.07	.08	.06	-.34**	-.28**	-.21**	.21**	.71**	-			
11. Depression	7.09 +/- 3.23	.18**	.20**	.17**	.25**	-.16**	-.16**	-.13**	.19**	.24**	.33**	-		
12. Anxiety	6.90 +/- 3.32	.17**	.18**	.16**	.22**	-.12**	-.16**	-.10**	.13**	.24**	.31**	.79**	-	
13. Stress	7.72 +/- 3.14	.18**	.18**	.16**	.22**	-.15**	-.15**	-.10**	.22**	.24**	.28**	.79**	.75**	-
						Student-athlete								
	Mean +/- SD	1	2	3	4	5	6	7	8	9	10	11	12	
1. Demandingness	16.77 +/- 3.54	-												
2. Awfulizing	16.20 +/- 3.61	.73**	-											
3. Frustration Intolerance	18.56 +/- 3.53	.53**	.56**	-										
4. Depreciation	12.56 +/- 4.45	.45**	.53**	.34**	-									
5. Intrinsic	16.59 +/- 4.14	.06	.03	.16**	-.07	-								
6. Integrated	14.92 +/- 4.92	.17**	.15**	.29**	.06	.53**	-							
7. Identified	15.12 +/- 4.30	.12**	.10**	.23**	-.01	.67**	.54**	-						
8. Introjected	12.31 +/- 4.17	.21**	.16**	.19**	.19**	.31**	.44**	.36**	-					
9. External	8.19 +/- 4.30	.23**	.20**	.15**	.17**	.08*	.24**	.20**	.29**	-				
10. Amotivation	8.14 +/- 4.96	.16**	.13**	.11**	.10**	-.02	.13**	.13**	.08*	.73**	-			
11. Depression	7.82 +/- 5.81	.15**	.15**	.16**	.27**	08*	.12**	.03	.21**	.03	-.03	-		
12. Anxiety	6.51 +/- 5.28	.18**	.20**	.18**	.27**	.06	.15**	.05	.22**	.05	.00	.65**	-	
13. Physical Health	9.30 +/- 3.15	.17**	.16**	.06	.23**	-.10*	-.05	-.06	.11**	.11**	.05	.40**	.46**	-

Note: $p \leq .05$*, $p \leq .01$**

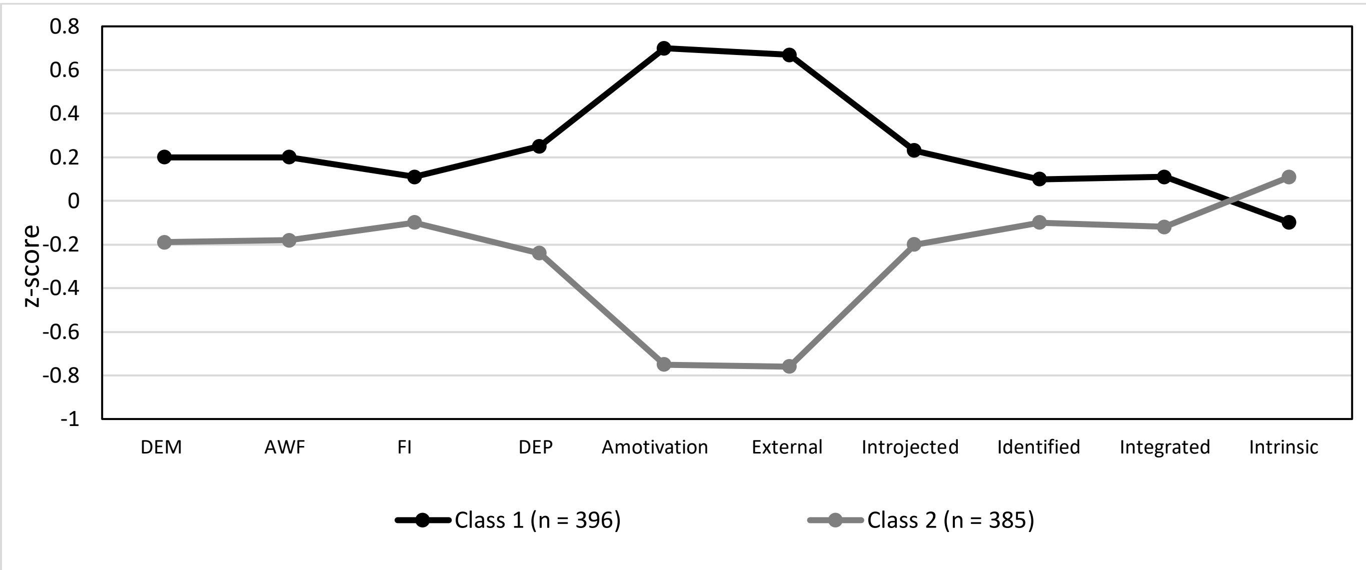
Figure 1

Estimates of the variables for the two latent profile analysis (LPA) classes in exercise participants and student-athletes, measuring irrational beliefs, and motivation regulation

Exercise



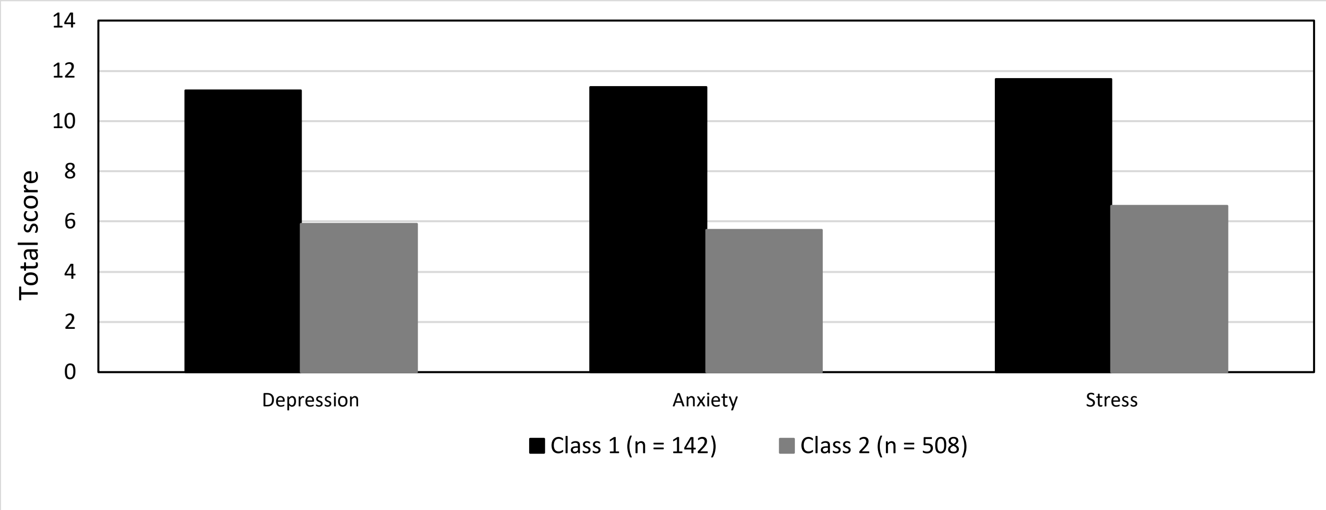
Student-athlete



DEM = Demandingness; AWF = Awfulizing; FI = Frustration intolerance; DEP = Depreciation
Class 1: High irrational beliefs, low self-determination
Class 2 Low irrational beliefs, high self-determination

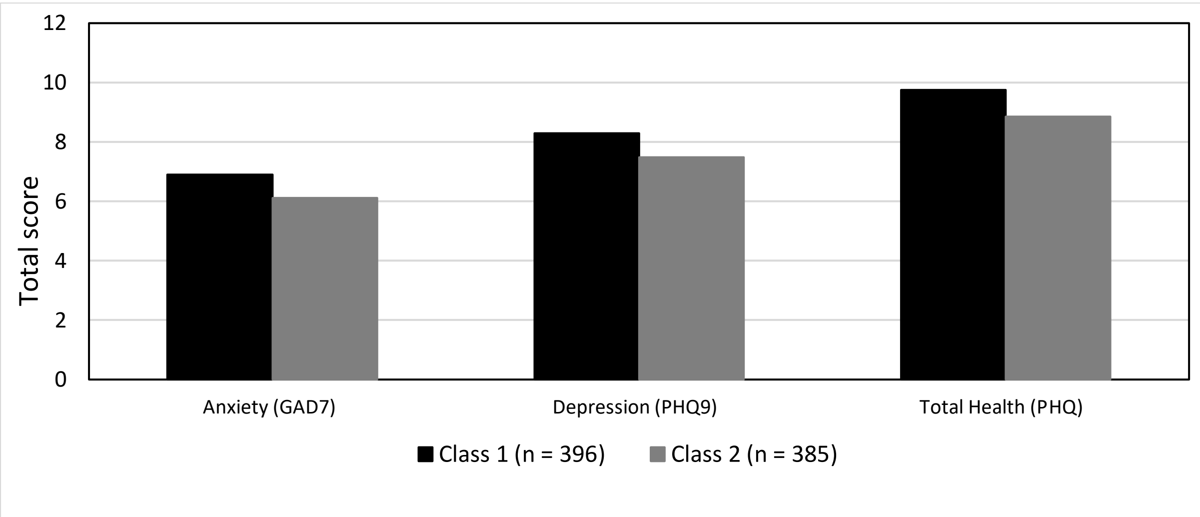
Figure 2

Latent profiles as predictors of health symptoms in exercise participants as measured using the DASS-21



Class 1: High irrational beliefs, low self-determination
Class 2 Low irrational beliefs, high self-determination

Latent profiles as predictors of mental and physical health in student-athletes



Class 1: High irrational beliefs, low self-determination
Class 2 Low irrational beliefs, high self-determination

Supplementary file 1

Fit statistics for latent profile analysis exercise data

		AIC	BIC	AWE	CLC	KIC	SABIC	Entropy	BLRT *p*-value
Model 1	1 Class	22278.20	22371.44	22561.68	22240.20	22301.20	22307.93	1	
Model 1	2 Classes	20389.26	20533.78	20831.35	20329.21	20423.26	20435.34	.99	< .01
Model 1	3 Classes	19826.65	20022.45	20426.47	19744.42	19871.65	19889.08	.94	< .01
Model 1	4 Classes	19488.82	19735.89	20246.25	19384.54	19544.82	19567.59	.88	< .01
Model 1	5 Classes	19243.40	19541.75	20158.34	19117.17	19310.40	19338.52	.90	< .01
Model 1	6 Classes	19075.06	19424.70	20147.63	18926.77	19153.06	19186.54	.85	< .01
Model 2	1 Class	18498.85	18588.42	18777.06	18461.92	18522.92	18525.99	1	
Model 2	2 Classes	16676.33	16859.95	17246.62	16596.28	16720.33	16729.78	.97	< .01
Model 2	3 Classes	15977.21	16254.88	16840.79	15854.97	16042.21	16058.03	.87	< .01
Model 2	4 Classes	15575.61	15947.32	16732.27	15411.37	15661.61	15683.80	.88	< .01
Model 2	5 Classes	15422.78	15888.55	16872.53	15216.57	15529.78	15558.35	.89	< .01
Model 2	6 Classes							-	-
Model 3	1 Class	15365.75	15656.85	16270.95	15237.75	15433.75	15450.48	1	
Model 3	2 Classes	14808.37	15148.74	15867.12	14658.36	14887.37	14907.44	.99	< .01
Model 3	3 Classes	14758.38	15148.01	15970.84	14586.18	14848.38	14871.78	.95	< .01
Model 3	4 Classes	14599.89	15038.79	15965.88	14405.69	14700.89	14727.64	.90	< .01
Model 3	5 Classes	14566.30	15054.46	16085.93	14349.98	14678.30	14708.38	.87	< .01
Model 3	6 Classes	14540.55	15077.97	16213.68	14302.26	14663.55	14696.97	.86	< .01
Model 6	1 Class	10782.55	10939.31	11269.05	10714.55	10820.55	10828.18	1	
Model 6	**2 Classes**	**10084.40**	**10502.37**	**11173.35**	**10044.39**	**10258.40**	**10276.95**	**.93**	**< .01**
Model 6	3 Classes	9987.16	10466.37	11378.92	9874.82	9997.16	10026.64	.82	< .01
Model 6	4 Classes	9897.41	10437.84	11691.58	9713.10	9843.41	9983.81	.86	< .01
Model 6	5 Classes	9754.53	10416.19	12151.07	9698.30	9836.53	9957.86	.94	< .01
Model 6	6 Classes							-	-

Note: Boldface indicates the selected model.
Abbreviations: AIC, Akaike Information Criterion; BIC, Bayesian Information Criterion; AWE, Approximate Weight of Evidence; CLC, Classification Likelihood Criterion; KIC, Kullback Information Criterion; SABIC, Sample Adjusted Bayesian Information Criterion; BLRT, Bootstrap Likelihood Ratio Test. Model 1 = equal variances and covariances fixed to 0; Model 2 = varying variances and covariances fixed to 0; Model 3 = equal variances and covariances; Model 4 and 5 cannot be estimated with the tidyLPA package; Model 6 = varying variances and covariances. For Model 2, the 6-profile version could not be estimated. For model 6, the 6-profile version could not be estimated.

Supplementary file 2

Fit statistics for latent profile analysis student-athlete data

		AIC	BIC	AWE	CLC	KIC	SABIC	Entropy	BLRT *p*-value
Model 1	1 Class	10276.95	18123.67	18311.24	17996.10	18057.10	18060.17	1	
Model 1	2 Classes	17292.34	17431.17	17723.60	17231.74	17326.34	17332.75	.87	< .01
Model 1	3 Classes	16946.69	17134.79	17531.41	16864.16	16991.69	17001.44	.82	< .01
Model 1	4 Classes	16740.78	16978.14	17478.94	16636.35	16796.78	16809.87	.82	< .01
Model 1	5 Classes	16475.37	16762.00	17367.03	16348.97	16542.37	16558.80	.80	< .01
Model 1	6 Classes	16347.44	16683.32	17392.59	16199.05	16425.44	16445.20	.83	< .01
Model 2	1 Class	18034.10	18123.67	18311.24	17996.10	18057.10	18060.17	1	
Model 2	2 Classes	17117.77	17301.39	17688.48	17037.29	17161.77	17171.21	.78	< .01
Model 2	3 Classes	16692.88	16970.55	17556.66	16570.44	16757.88	16773.70	.80	< .01
Model 2	4 Classes	16431.23	16802.94	17588.10	16266.79	16517.23	16539.42	.82	< .01
Model 2	5 Classes	16210.43	16676.19	17660.35	16004.03	16317.43	16345.99	.82	< .01
Model 2	6 Classes	16033.13	16592.95	17776.12	15784.78	16161.13	16196.07	.84	< .01
Model 3	1 Class	15504.15	15795.25	16409.35	15376.15	15572.15	15588.88	1	
Model 3	2 Classes	15496.51	15836.88	16555.91	15345.84	15575.51	15595.58	.93	< .01
Model 3	3 Classes	15381.20	15770.83	16594.19	15208.47	15471.20	15494.61	.88	< .01
Model 3	4 Classes	15356.28	15795.17	16722.84	15161.51	15457.28	15484.02	.71	< .01
Model 3	5 Classes	15341.63	15829.78	16861.55	15125.01	15453.63	15483.71	.75	< .01
Model 3	6 Classes	15314.25	15851.67	16987.65	15075.68	15437.25	15470.67	.79	< .01
Model 6	1 Class	15504.15	15795.25	16049.359	15376.15	15572.15	15588.88	1	
Model 6	**2 Classes**	**15166.70**	**15753.38**	**16993.56**	**14906.20**	**15300.70**	**15337.46**	**.75**	**< .01**
Model 6	3 Classes	15072.30	15894.56	17750.36	14739.77	15202.30	15259.09	.75	< .01
Model 6	4 Classes	14913.97	16091.82	18583.17	14389.47	15179.97	15256.80	.79	< .01
Model 6	5 Classes	14872.01	16345.44	19462.25	14215.64	15204.01	15300.87	.78	< .01
Model 6	6 Classes	14919.56	16688.57	20430.95	14131.19	15317.56	15434.45	.80	< .01

Note: Boldface indicates the selected model.

Abbreviations: AIC, Akaike Information Criterion; BIC, Bayesian Information Criterion; AWE, Approximate Weight of Evidence; CLC, Classification Likelihood Criterion; KIC, Kullback Information Criterion; BLRT, Bootstrap Likelihood Ratio Test; SABIC, Sample Adjusted Bayesian Information Criterion; BLRT, Bootstrap Likelihood Ratio Test. Model 1 = equal variances and covariances fixed to 0; Model 2 = varying variances and covariances fixed to 0; Model 3 = equal variances and covariances; Model 4 and 5 cannot be estimated with the tidyLPA package; Model 6 = varying variances and covariances.