**Elite Youth Athletes’ Mental Health and Its Relationship with the Talent Development Environment: A Variable- and Person-Centred Approach**

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Abstract

The present research sought to examine the prevalence of elite youth athletes’ mental health and its relationship with talent development environments (TDEs). A sample of 248 Chinese elite youth athletes completed a self-report survey measuring demographic variables, TDE factors, and mental health outcomes including generalised anxiety disorder (GAD), depression, and athlete burnout. The results revealed moderate levels of burnout, with 19% of the participants meeting the diagnostic cut-off of GAD, and similar numbers for depression. The multiple regression analysis revealed alignment of expectations was the only TDE factor to significantly predict GAD and depression. Holistic quality preparation was the only significant TDE predictor of burnout. The results of cluster analysis suggested a three cluster solution: cluster 1 — “slightly below average TDE”, cluster 2 — “high TDE”, and cluster 3 — “very low TDE”. Among the three clusters, cluster 2 had the lowest levels of GAD, depression, and burnout. Cluster 3 reported a higher burnout level than cluster 1, and the two clusters showed no differences in other two mental health outcomes. These findings suggest a need to manage mental health symptoms of elite youth athletes and the roles of TDE could be considered in the management of mental health.

*Keywords*: talent development, environmental factor, psychological health, sport

**Introduction**

Research highlights the benefits of physical activity on mental health in adolescents (Eime et al., 2013). However, the media is reporting more and more cases of mental health concerns amongst high profile elite youth athletes. A recent meta-analysis indicated high prevalence rates of several mental health symptoms and disorders in elite youth and adult athletes: 18% for alcohol misuse, 19.6% for distress, 26.4% for sleep disturbance, and 34% for anxiety/depression (Gouttebarge et al., 2019). Further, 5%-19% elite youth athletes experienced mental health symptoms such as anxiety, athlete burnout, depression, and insomnia (Gerber et al., 2022; Gustafsson et al., 2007; Håkansson et al., 2022). Indeed, elite youth athletes are often required to deal with many challenges and demands both within and outside of sports settings that can negatively impact their mental health (Rice et al., 2019). Elite youth athletes are subject to a significant number of unique stressors such as school changes, puberty and transition to financial independence while they are in the period during which coping resources and skills are still under development (Schinke et al., 2022). Thus, it becomes clear that elite youth sport cohorts may be a particularly high risk group of mental health concerns (Gerber et al., 2022; Thompson & Sherman, 2014), highlighting the need to understand mental health issues of this group. Not only is this important for elite youth athletes’ mental welfare, it is also likely to have a significant impact on their talent development prospects (Hill et al., 2016).

Increasingly, research is being conducted to understand potential risk and protective factors of mental health symptoms such as athlete burnout, depression, and generalised anxiety disorder (GAD). GAD refers to a long-term condition of excessive worry about a wide range of general life events (American Psychiatric Association, 2013). Several factors such as fear of failure, life stress, and sport injury have been found to increase the risk of GAD in elite athletes, whereas factors such as adaptive coping strategies and satisfaction in sport have been shown to be protective (King et al., 2020; Li et al., 2021; McLoughlin et al., 2021; Perry et al., 2022). Similarly, a history of sport injury, insomnia, stress, being a female, and adverse life events have been shown to be risk factors of depression, factors such as sport satisfaction, support from inside and outside of sport, a starting status, and help-seeking intentions have been found to predict lower depression scores in elite athletes (Kuettel & Larsen, 2019; Kuettel et al., 2021; Perry et al., 2022; Tahtinen et al., 2021). Finally, higher levels of athlete burnout have been shown to be predicted by greater levels of stress, extrinsic motivation, perfectionism issues, and poor social interactions (Edison et al., 2021; Gustafsson et al., 2017; Lin et al., 2022).

Although previous studies have identified some potential risk and protective factors of mental health symptoms in elite youth athletes, little is known about the predicting role of the wider talent development environment (TDE; Thomas et al., 2021). TDE is defined as all of the surroundings, in which talented athletes can achieve their athletic potential (Henriksen et al., 2010; Martindale et al., 2005). Inspired by the holistic ecological approach, TDE factors are believed to play a key role in the successful development of elite youth athletes (Henriksen & Stambulova, 2023; Martindale et al., 2005). Specifically, elite youth athletes are situated within a wide range of TDE factors that could either facilitate or hinder their sporting journey and outcomes. One of the few qualitative studies in this area highlights protective TDE factors revolve around good quality relationships, such as an open and supportive coaching environment, parental and family support, and peer support (Hill et al., 2016). Risk TDE factors included unstable home life and pushy parents, pressure to perform and overly competitive environments, lack of support around key transitions, injury, adolescence, maturation, identity, and attachment difficulties (Hill et al., 2016).

A few quantitative studies, utilizing the Talent Development Environment Questionnaire (TDEQ; Li et al., 2015; Martindale et al., 2010) have examined the predictive role of TDEs on mental health of elite youth athletes. For example, Ivarsson et al. (2015) employed a person-centred analytic approach (e.g., cluster analysis) to investigate the predictive ability of the TDE on elite youth football players’ well-being and stress. This study found that coach-athlete relationships which demonstrated good communication about athlete’s lives inside and outside of sport were important in this regard. As were coherent, individualised development plans and processes, with well established relationships between clubs, coaches, parents and school. Building on this work, Li et al. (2017) showed that three TDEQ factors (i.e., long-term development focus, holistic quality preparation, and communication) negatively predicted athlete burnout through needs satisfaction in elite athletes. However, only holistic quality preparation was found to negatively predict athlete burnout in a more recent study (Thomas et al., 2021). This research to date highlights the complexity, and perhaps context specific nature of the impact of the TDE on different mental health outcomes. However, there is consistency in the finding that the environment may have a significant role to play on the protection and even facilitation of positive mental health outcomes in young athletes. As such, more research is needed to examine the predictive role of TDEs in youth athletes’ mental health.

To address the outlined literature gaps, our study sought to (a) examine the prevalence of mental health issues among elite youth athletes in China and (b) investigate the relationship between TDEs and mental health through both variable- and person-centred approaches. Of note, to date, most research has employed a variable-centred analytic approach such as regression analysis to examine risk and protective factors of mental health in elite athletes (Kuettel et al., 2021). As a supplement to the variable-centred approach, the person-centred approach can help identify subgroups of a sample who share similar characteristics on a set of variables such as TDE factors (Howard & Hoffman, 2018), which can provide additional insight. Furthermore, we limited outcomes to three mental health symptoms (i.e., GAD, depression, and athlete burnout) given their high prevalence rates and close associations with sport performance in elite youth athletes (Gouttebarge et al., 2019; Gustafsson et al., 2007; Sanhueza et al., 2016). Elite youth athletes often experience general and high performance risk factors (e.g., abuse and maltreatment, identity formation, overtraining, perfectionism, and pressure to win) that are likely to result in GAD, depression, and athlete burnout (Gerber et al., 2022; Rice et al., 2019; Schinke et al., 2022). According to previous research (Ivarsson et al., 2015; Li et al., 2017; Thomas et al., 2021), it was hypothesised that TDE factors would be significantly related to the three mental health symptoms. It was also hypothesised that the identified TDE subgroups would differ in levels of mental health symptoms.

**Method**

**Design**

A cross-sectional observational study design was used in our research. We obtained ethics approval from the Human Research Ethics Committee of South China Normal University (approval number: SCNU-SPT-2021-018).

**Context**

Similar to many other countries, China has a long tradition to identify and develop talented athletes through a scientific approach (e.g., use of a talent identification test battery, and provision of sports science support). Meanwhile, there is a 4-layer pyramidal system for talent identification and development, ranging from the fundamental level to the national level. At the fundamental level, athletes who could be as young as 6 years old are selected and trained in a specialised sport. Some of these athletes may be selected onto the next level (i.e., elementary level) to receive semi-professional training in sports schools or other schools hosting talent development programmes. Only 5% of the athletes can progress into the next two levels (i.e., intermediate level and national level). Intermediate level athletes are usually trained in provincial teams, sports institutes, or professional clubs. The national level athletes are generally trained in national training centres (Hong et al., 2005). Obviously, this pyramidal system is highly competitive in nature, which requires elite youth athletes to focus on their performance outcomes in order to progress into a higher level or to maintain elite performance. This would result in performance anxiety and fear of failure. Of concern, few provincial and national training centres in China provide mental health management training to elite youth athletes (Schinke et al., 2022).

**Participants and Procedure**

To be eligible for the present research, participants must be: (a) an active elite youth athlete from China at the time the survey was conducted; (b) an elected member in provincial talent programmes or representative squads; and (c) aged 13 years or above to ensure they were able to understand survey questions.

Based on social networks, we approached head coaches who were affiliated with elite training centres across China, including Beijing municipality, Chongqing municipality, Fujian Province, Guangdong Province, Hebei Province, Heilongjiang Province, Sichuan Province, and Shanxi Province. The coaches were invited to forward a url link to eligible athletes to participate in this anonymous survey. The link directed athletes to an online survey package. Athletes and their parents/guardians completed consent and assent forms before proceeding to complete the survey form. Of 251 athletes entered the survey platform between 1 July 2021 and 31 August 2021, one did not complete the survey and two were aged 12 years. Thus, we removed these three cases and used the data of the remaining 248 athletes for analysis.

**Measures**

Athletes’ mental health symptoms, including GAD, depression, and athlete burnout were our study outcomes. Predicting factors were TDEs and participant demographics (i.e., age, gender, and training hours per week).

**TDE.** We used the validated Chinese TDEQ-5 to measure TDEs (Li, Martindale, et al., 2018; Li et al., 2015). The scale includes 25 items and five TDE factors: long-term development focus (five items; e.g., “My coach allows me to learn through making my own mistakes”); alignment of expectations (five items; e.g., “My coaches make time to talk to my parents about me and what I am trying to achieve”); communication (four items; “My coach and I talk about what current and/or past world-class performers did to be successful”); holistic quality preparation (seven items; e.g., “My coach takes the time to talk to other coaches who work with me”); and support network (four items; e.g., “I can pop in to see my coach or other support staff whenever I need to”). Participants scored the scale items on a 6-point scale (1 = strongly disagree, 6 = strongly agree). The five factors showed adequate internal reliability in the present sample (α = 0.76 to 0.87).

**GAD.** We employed the validated Chinese GAD-7 to measure anxiety symptoms (Spitzer et al., 2006). The scale has seven items (e.g., “Over the last two weeks, how often have you been bothered by feeling nervous, anxious, or on edge?”). Participants provided responses to scale items on a 4-point scale (0 = not at all, 3 = nearly every day). According to Spitzer et al. (2006), a total score of 10 or above was used as a diagnostic cut-off for GAD. The scale had excellent internal reliability with our sample (α = 0.92).

**Depression.** We used the validated Chinese Patient Health Questionnaire-2 to assess depression symptoms (Kroenke et al., 2003). This scale has two items (e.g., “Little interest or pleasure in doing things”) and a leading question asks “Over the last two weeks, how often have you been bothered by the following problem?” Participants provided responses on a 4-point scale (0 = not at all, 3 = nearly every day). A total score of 3 or above was used as a diagnostic cut-off for a major depressive disorder. The scale had good internal reliability with the present sample (α = 0.88).

**Athlete burnout.** We used the validated Chinese Athlete Burnout Questionnaire to assess athlete burnout (Chen & Zhou, 2007). In line with previous research, we only used the physical and emotional exhaustion subscale as it measures the core dimension of burnout (Li, Kee, et al., 2018). The use of this subscale can also ease the administration burden of our survey. The subscale has five items (e.g., “I feel physically exhausted from the sport”). Participants answered the scale items on a 5-point scale (1 = almost never, 5 = almost always). A diagnostic cut-off for the burnout syndrome is not available for this subscale. The subscale demonstrated excellent internal reliability in our sample (α = 0.93).

**Data Analysis**

We used descriptive statistics including means, standard deviations, frequencies, and percentages to describe characteristics of study variables. We estimated prevalence of GAD and depression as the number of participants with symptoms divided by the total sample size. We computed zero-order correlations to determine the relationships between predicting variables and the three mental health outcomes (i.e., GAD, depression, and athlete burnout). We used those predicting factors that showed a significant association with mental health outcomes in subsequent regression analyses. To estimate the minimal sample size needed for multiple regression analyses, G\*Power 3 was used (Faul et al., 2009). By assuming a medium and practically meaningful effect size (*f2* = 0.15, α = 0.05, power = 0.95, maximal number of predictors = 8), we would need a minimum sample size of 160. Thus, our sample size was adequate.

We conducted cluster analyses (i.e., a person-centred analytic approach) to identify subgroups of athletes on the basis of TDE scores. Specifically, we used the recommended two-step process to conduct the analyses (Hair et al., 2010). In the first step, we used a hierarchical cluster analysis to determine the potential number of clusters with the assistance of the agglomeration schedules and dendrogram. In the second step, we employed a non-hierarchical cluster analysis (i.e., k-means) by specifying the most appropriate cluster solution identified from the first step. We calculated Z-scores of TDE to better interpret what constitutes low or high TDE values from the most appropriate cluster solution. According to Gustafsson et al. (2018), we classified *Z*-scores of −0.5 to 0.5 *SD*, ± 0.5 to 1 *SD*, and ± 1 *SD* as slightly below/above average, high/low, and very high/low, respectively.

Finally, we used a one-way analysis of variance (ANOVA) to examine whether the three mental health outcomes were different across the identified cluster solutions. We used Tukey’s honest significance difference (HSD) test to further compare between-cluster differences if the main test was significant. We set a statistical significance level at *p* < 0.05 (two-tailed). We conducted all the analyses using IBM SPSS Statistics 25 (IBM, Armonk, NY, USA).

**Results**

**Participant Characteristics and Descriptive Statistics**

A sample of 248 Chinese elite athletes was included in the present study (see Table 1). They had a mean age of 18.34 years (*SD* = 3.11) and the majority of them were male (67.3%). The participants were from 16 different sports (e.g., athletics, martial arts, table tennis, and water polo). They on average trained for 35.14 hours per week (*SD* = 15.26). They reported moderate to high TDE levels (*M* = 4.27 to 4.81, *SD* = 0.77 to 0.94) and a moderate burnout level as measured by the physical and emotional exhaustion subscale (*M* = 2.56, *SD* = 0.95). Nineteen percentage (95%CI [14.3, 24.4]) of the participants met the diagnostic cut-off of GAD. Further, about the same proportion of the participants (19.4%; 95%CI [14.6, 24.8]) met the diagnostic cut-off of depression.

**Associations Between TDE and Mental Health: Regression Analyses**

Table 2 shows the findings of zero-order associations between study variables. In general, three demographic variables (i.e., age, gender, and training hours per week) were not significantly associated with mental health outcomes including GAD, depression, and athlete burnout. The only exception was that age was significantly associated with athlete burnout (*r* = 0.24, *p* < 0.001), and thus age was the only demographic variable controlled in the subsequent regression analyses. All the five TDE factors were significantly related to the three mental health outcomes (β = -0.13 to -0.32, *p*s < 0.01).

Table 3 presents the results of multiple regression analysis. We found alignment of expectations was the only TDE factor to significantly predict GAD (β = -0.24, *p* = 0.04) and depression (β = -0.26, *p* = 0.02). Further, holistic quality preparation was the only significant TDE predictor of athlete burnout (β = -0.26, *p* = 0.03). These predicting effects were close to moderate (Cohen, 1992). All predictors explained a total variance of 8.7% to 15.9% in the three mental health outcomes. These magnitudes represented a medium effect (Cohen, 1992).

**Associations Between TDE and Mental Health: Cluster Analyses**

After inspection of the agglomeration schedules and dendrogram, we decided to select a three-cluster solution. The decision was also supported by the finding of a one-way multiple analysis of variance (MANOVA): *Pillai’s Trace* = 0.92, *F* (10, 484) = 40.89, *p* < 0.001, *ηp*2 = 0.46. This result suggests that the three clusters differed significantly in TDE subscale scores. We repeated the two-step approach with a randomly selected split-half sample (*n* = 120). The result confirmed the stability of the three-cluster solution (Hair et al., 2010).

Table 4 summarises the descriptive statistics of the three-cluster solution. According to Z scores of TDE, the three clusters were coined as cluster 1 — “slightly below average TDE” (*n* = 123), cluster 2 — “high TDE” (*n* = 85), and cluster 3 — “very low TDE” (*n* = 40). The results of ANOVA indicated that the three mental health outcomes were significantly different across the three clusters (*p*s < 0.001, *ηp*2 = 0.07 to 0.09), and thus Tukey’s HSD test was followed. As expected, cluster 2 had the lowest levels of GAD, depression, and athlete burnout among the three clusters (*p*s < 0.01). Although cluster 1 and cluster 3 showed no significant difference in GAD and depression, cluster 3 had a higher level of athlete burnout than cluster 1 (*p* = 0.01).

**Discussion**

As an extension to previous research (Ivarsson et al., 2015; Li et al., 2017; Thomas et al., 2021), our study examined the predicting roles of the five TDE factors on GAD, depression, and athlete burnout of Chinese elite youth athletes through both variable- and person-centred approaches. The descriptive findings indicated a 19% prevalence rate of GAD in our sample, which is greater than that reported in Chinese youth (15.8%) (Zhu et al., 2021). This means that elite youth athletes are more likely to develop GAD symptoms than general populations. Further, our GAD figure is within the range of prevalence rates reported in previous studies with elite youth and adult athletes from western countries (7% to 27.7%) (Du Preez et al., 2017; Gulliver et al., 2015; King et al., 2020; Kuettel et al., 2021; McLoughlin et al., 2021). Around 19.4% of our sample showed symptoms of depression. A recent review indicated that the prevalence of depression in elite youth and adult athletes can ranged from 0% to 57% across the world (Kuettel & Larsen, 2019).

The observed differences in prevalence rates of GAD/depression could be attributed to the data collection period of the present study (1 July 2021 and 31 August 2021) which happened to be in the midst of the COVID-19 pandemic. The observed differences could also be attributed to varied participant demographics, outcome measures, and cultural differences across studies. In comparison to individualistic values that are largely unique in Western cultures (e.g., independence, self-reliance, and personal success), a collective perspective is valued China. Within this eastern ideology, Chinese elite youth athletes are filled with gold medal expectations and pressure to bring glory to their family and country for the common good. Chinese elite youth athletes are part of the whole-national system in which individual interests such as independence and personal wellbeing are overridden by collective interests (Schinke et al., 2022). Thus, culture could be a factor influencing elite youth athletes’ mental health. Regardless of the observed differences, the relatively high prevalence rates of GAD/depression symptoms suggest the need of regular screening for these mental health symptoms for Chinese elite youth athletes. Unfortunately, mental health screening and training services for Chinese elite youth athletes are limited (Schinke et al., 2022).

Protective factors of GAD and depression such as sport satisfaction, social support, and help-seeking intentions have been identified in elite athletes (Kuettel & Larsen, 2019; Kuettel et al., 2021; Perry et al., 2022; Tahtinen et al., 2021). Our results of regression analysis add to the existing literature, showing that alignment of expectations was the only TDE factor that negatively predicted both GAD and depression. It is worthy to note that all of the five TDE factors had a significant negative association with these two mental health symptoms (see Table 2). These TDEQ-5 factors include (a) Long-term development - The extent to which developmental programmes are specifically designed to facilitate athletes’ long-term success (e.g., fundamental training, ongoing opportunities, and de-emphasis of winning); (b) Holistic quality preparation - The extent to which intervention programmes are prepared both inside and outside of sports settings (e.g., caring coach, mental preparation, and balanced life); (c) Support network - The extent to which a coherent, approachable, and wide-ranging support network is available for the athlete in all areas (e.g., professionals, parents, and coaches); (d) Communication - The extent to which the coach communicates effectively with the athlete in both formal and informal settings (e.g., development path, rationale for training, and feedback); and finally (e) Alignment of expectations - The extent to which goals for sport development are coherently set and aligned (e.g., goal setting, goal review, and individualised goals) (Li et al., 2015).

Taken together, our findings suggest alignment of expectations is a more important protective factor than the other four TDE factors. Unpacking the factor alignment of expectations may be particularly important in understanding what it is about the environment that may be most impactful in protecting GAD and depression. Alignment of expectations concerns ongoing individualised goal setting and adjustment, which involve different stakeholders such as parents and coaches (Li et al., 2015; Martindale et al., 2010). This highlights the importance of input from parents and communication between parents and coaches, the need for individualised goal setting and review, and the importance of athlete involvement in the process, as protective factors for mental health concerns examined in this study.

Interestingly, the work by Hill et al. (2016), who examined specialised clinicians’ perceptions of mental health protective and risk factors in elite youth sport found two key protective features of the environment. First, the role of parents and family was found to be fundamental to protecting well-being throughout the development journey. Second, the role of an open and supportive coaching environment where coaches proactively build relationships and trusted, open communication channels. These two factors that emerged from this qualitative research, have strong connection to the alignment of expectations factor as outlined above. Such individualised communication, and coherently set, time adjusted goals characterise alignment of expectations (Li et al., 2015; Martindale et al., 2010) would be expected to increase ability, confidence and career satisfaction, as well as decrease performance stress and adverse response to failure. These positive changes could subsequently reduce the chances of mental health concerns such as GAD and depression symptoms (Beaumont et al., 2015; Hammond et al., 2013; Rice et al., 2019).

Although alignment of expectations was a significant predictor of GAD/depression, we did not find this factor to predict athlete burnout as measured by the physical and emotional exhaustion subscale, which is in line with other research that has investigated the role of TDE and athlete burnout (Li et al., 2017; Thomas et al., 2021). Instead, we found holistic quality preparation was the only TDE factor to negatively predict athlete burnout through regression analyses, similar to Thomas et al.’s (2021) finding in Caribbean youth track and field athletes. In line with previous research, this supports the idea that different TDE factors would affect different mental health symptoms in different ways (Li et al., 2017). Indeed, the features and factors within the environment are likely to interact and impact each other in quite a complex way, as has been shown in TDE intervention (Hall et al., 2019). In our case, compared with the other four TDE factors, holistic quality preparation played a more important role in the prevention of athlete burnout. This could be because holistic quality preparation concerns providing clear guidance and transition planning, balancing sport training and life, and understanding of athletes’ wellbeing (Li et al., 2015; Martindale et al., 2010). There is also indirect evidence showing that appropriate training loads and supportive coaching environments were linked to lower levels of athlete burnout (Bergeron et al., 2015; Booth et al., 2018). Thus, it is reasonable to find holistic quality preparation to predict athlete burnout.

While the study by Thomas et al. (2021) and ours did not find other TDE factors to predict athlete burnout, Li et al. (2017) found that long-term development focus, holistic quality preparation, and communication were negative predictors of athlete burnout through needs satisfaction in elite youth athletes. Similarly, the same three TDE factors were also found to predict mental toughness via needs satisfaction (Li et al., 2019). That is, instead of a direct effect, some of the TDE factors (e.g., long-term development focus, and communication) may have an indirect effect on elite youth athletes’ mental health. Other sport-environmental risk factors such as low support from teammates, deselection, and uncertainty about retirement were found to affect mental health (Kuettel & Larsen, 2019). Overall, these findings highlight the importance of high-quality environments on mental health of elite athletes, and the need to consider the TDE as a complex, highly interactive domain (Henriksen et al., 2010).

One significant contribution of this study was the use of cluster analysis to understand the predictability of TDE factors on mental health. Our cluster analysis revealed three distinct clusters with each shared similar characteristics based on TDEQ-5 scores: “slightly below average TDE”, “high TDE”, and “very low TDE”. Among these three clusters, athletes from the “high TDE” cluster experienced the lowest levels of GAD, depression, and athlete burnout. This finding supplements our findings of regression analysis. This finding is also somewhat consistent with the study by Ivarsson et al. (2015). Their study revealed “high TDE”, “moderate TDE”, and “poor TDE” clusters based on TDEQ scores, whereby the “poor TDE” cluster had higher levels of stress and lower levels psychological well-being than the other two. Their study finding together with ours suggest the need to consider the person-centred approach and the interplay of different TDE factors on mental health of elite athletes. By examining cluster sizes of “slightly below average TDE” (*n* = 123, 49.6%) and the “very low TDE” cluster (*n* = 40, 16.1%), it is understandable that many elite youth athletes were not trained in high-quality TDEs. Thus, coaches, parents, and other stakeholders are required to provide these athletes with effective TDEs such as allowing athletes to make mistakes, setting individualised development goals and reviewing them regularly, offering sport science coach support, and providing holistic and balanced training programmes (Li et al., 2019; Martindale et al., 2010; Thomas et al., 2021). Meanwhile, it is also important to maintain and even further improve TDEs for those who are trained in high-quality TDEs. Currently there are no well-established cut-off scores for low-, moderate-, and high-quality TDEs, values presented in Table 4 could therefore be used as a reference, at least for determining whether TDEs are conducive for relieving symptoms of GAD, depression, and athlete burnout.

**Limitations and Future Research Directions**

Although this study provides further insights into the associations between TDEs and mental health, it has a few major limitations. One limitation is that we employed a cross-sectional design to examine the protective roles of the five TDE factors on mental health symptoms. As this design is limited to draw casual conclusions, a prospective longitudinal design or a trial design can be used to further examine the predictability of TDE factors on mental health. Future research can also include other potential risk/protective factors of mental health in addition to the TDE factors to understand which factor plays a more significant role. The second limitation is related to our study sample. Despite recruiting elite youth athletes is a challenging task, a convenience sample largely dominated by male players of individual sports was used in our present analysis. A more representative and diverse sample should be recruited, if possible, to replicate the present findings in future. As to the sample size, it is adequate for conducting multiple regression analyses. However, to conduct logistic regression analyses (i.e., use the diagnosis of GAD/depression as a dependent variable), a larger sample size will be needed to ensure adequate statistical power. Lastly, similar to most earlier survey studies, we used self-reported screening tools (e.g., GAD-7) rather than clinical diagnosis to determine the presence/absence of mental health symptoms. We suggest future research to follow clinical diagnosis if the results of initial screening are positive.

**Conclusion**

In conclusion, our study shows that nearly 20% of elite youth athletes present signs of GAD/depression and the participants have a moderate level of athlete burnout (as measured by the physical and emotional subscale). More importantly, our study expands upon previous research in that the five TDE factors are protective factors of GAD, depression, and athlete burnout in elite youth athletes. To enhance mental health of elite youth athletes, prevention measures or interventions based on their TDE scores and cluster memberships can be developed and adopted. Although developing effective TDEs could be useful for the prevention and management of mental health symptoms, further investigations are needed to better understand this important issue.

**References**

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders (DSM-5®)*. American Psychiatric Pub.

Beaumont, C., Maynard, I. W., & Butt, J. (2015). Effective ways to develop and maintain robust sport-confidence: Strategies advocated by sport psychology consultants. *Journal of Applied Sport Psychology*, *27*(3), 301-318. https://doi.org/10.1080/10413200.2014.996302

Bergeron, M. F., Mountjoy, M., Armstrong, N., Chia, M., Côté, J., Emery, C. A., . . . Léglise, M. (2015). International Olympic Committee consensus statement on youth athletic development. *British Journal of Sports Medicine*, *49*(13), 843-851. https://doi.org/10.1136/bjsports-2015-094962

Booth, M., Cobley, S., & Orr, R. (2018). The effect of training loads on performance measures and injury characteristics in rugby league players: A systematic review. *International Journal of Sports Physiology and Performance*, *13*(10), 1259-1272. https://doi.org/10.1123/ijspp.2017-0329

Chen, Z. S., & Zhou, A. G. (2007). Study on the measurement of athlete burnout and primary revision of ABQ. *China Sport Science*, *27*, 66-70. https://doi.org/10.16469/j.css.2007.08.008

Cohen, J. (1992). A power primer. *Psychological Bulletin*, *112*(1), 155-159. https://doi.org/10.1037/0033-2909.112.1.155

Du Preez, E. J., Graham, K. S., Gan, T. Y., Moses, B., Ball, C., & Kuah, D. E. (2017). Depression, anxiety, and alcohol use in elite rugby league players over a competitive season. *Clinical Journal of Sport Medicine*, *27*(6), 530-535. https://doi.org/10.1097/JSM.0000000000000411

Edison, B. R., Christino, M. A., & Rizzone, K. H. (2021). Athletic identity in youth athletes: A systematic review of the literature. *International Journal of Environmental Research and Public Health*, *18*(14). https://doi.org/10.3390/ijerph18147331

Eime, R. M., Young, J. A., Harvey, J. T., Charity, M. J., & Payne, W. R. (2013). A systematic review of the psychological and social benefits of participation in sport for children and adolescents: Informing development of a conceptual model of health through sport. *International Journal of Behavioral Nutrition and Physical Activity*, *10*(1), 1-21. https://doi.org/10.1186/1479-5868-10-98

Faul, F., Erdfelder, E., Buchner, A., & Lang, A. G. (2009). Statistical power analyses using G\*Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods*, *41*(4), 1149-1160. https://doi.org/10.3758/BRM.41.4.1149

Gerber, M., Kellmann, M., Brand, S., Gygax, B., Ludyga, S., Müller, C., … Jakowski, S. (2022)

Differences in mental health outcomes between adolescent elite athletes and peers not

engaged in elite sport. *Current Issues in Sport Science (CISS)*, *7*, 13.

https://doi.org/10.36950/2022ciss013

Gouttebarge, V., Castaldelli-Maia, J. M., Gorczynski, P., Hainline, B., Hitchcock, M. E., Kerkhoffs, G. M., . . . Reardon, C. L. (2019). Occurrence of mental health symptoms and disorders in current and former elite athletes: A systematic review and meta-analysis. *British Journal of Sports Medicine*, *53*(11), 700-706. https://doi.org/10.1136/bjsports-2019-100671

Gulliver, A., Griffiths, K. M., Mackinnon, A., Batterham, P. J., & Stanimirovic, R. (2015). The mental health of Australian elite athletes. *Journal of Science and Medicine in Sport*, *18*(3), 255-261. https://doi.org/10.1016/j.jsams.2014.04.006

Gustafsson, H., Carlin, M., Podlog, L., Stenling, A., & Lindwall, M. (2018). Motivational profiles and burnout in elite athletes: A person-centered approach. *Psychology of Sport and Exercise*, *35*, 118-125. https://doi.org/10.1016/j.psychsport.2017.11.009

Gustafsson, H., DeFreese, J. D., & Madigan, D. J. (2017). Athlete burnout: Review and recommendations. *Current Opinion in Psychology*, *16*, 109-113. https://doi.org/10.1016/j.copsyc.2017.05.002

Gustafsson, H., Kenttä, G., Hassmén, P., & Lundqvist, C. (2007). Prevalence of burnout in competitive adolescent athletes. *Sport Psychologist*, *21*(1), 21-37. https://doi.org/10.1123/tsp.21.1.21

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate data analysis* (7th ed.). Pearson.

Håkansson, A., Moesch, K., & Kenttä, G. (2022). COVID-19-related impact on mental health and career uncertainty in student-athletes—Data from a cohort of 7,025 athletes in an elite sport high school system in Sweden. *Frontiers in Sports and Active Living*, *4*, 943402. https://doi.org/10.3389/fspor.2022.943402

Hall, A. J. A., Jones, L., & Martindale, R. J. J. (2019). The Talent Development Environment Questionnaire as a tool to drive excellence in elite sport environments. *International Sport Coaching Journal*, *6*(2), 187-198. https://doi.org/10.1123/iscj.2018-0041

Hammond, T., Gialloreto, C., Kubas, H., & Davis, H. (2013). The prevalence of failure-based depression among elite athletes. *Clinical Journal of Sport Medicine*, *23*(4), 273-277. https://doi.org/10.1097/JSM.0b013e318287b870

Henriksen, K., & Stambulova, N. (2023). The social environment of talent development in youth sport. *Frontiers in Sports and Active Living*, *5*,1127151. https://doi.org/ 10.3389/fspor.2023.1127151

Henriksen, K., Stambulova, N., & Roessler, K. K. (2010). Holistic approach to athletic talent development environments: A successful sailing milieu. *Psychology of Sport and Exercise*, *11*(3), 212-222. https://doi.org/10.1016/j.psychsport.2009.10.005

Hill, A., MacNamara, Á., Collins, D., & Rodgers, S. (2016). Examining the role of mental health and clinical issues within talent development. *Frontiers in Psychology*, *6*, 2042. https://doi.org/10.3389/fpsyg.2015.02042

Hong, F., Wu, P., & Xiong, H. (2005). Beijing ambitions: An analysis of the Chinese elite sports system and its Olympic strategy for the 2008 Olympic Games. *The International Journal of the History of Sport*, *22*(4), 510-529. https://doi.org/10.1080/09523360500126336

Howard, M. C., & Hoffman, M. E. (2018). Variable-centered, person-centered, and person-specific approaches: Where theory meets the method. *Organizational Research Methods*, *21*(4), 846-876. https://doi.org/10.1177/1094428117744021

Ivarsson, A., Stenling, A., Fallby, J., Johnson, U., Borg, E., & Johansson, G. (2015). The predictive ability of the talent development environment on youth elite football players' well-being: A person-centered approach. *Psychology of Sport and Exercise*, *16*, 15-23. https://doi.org/10.1016/j.psychsport.2014.09.006

King, L., Cullen, S. J., O'Connor, S., McGoldrick, A., Pugh, J., Warrington, G., . . . Losty, C. (2020). Common mental disorders among Irish jockeys: prevalence and risk factors. *The Physican and Sportsmedicine*, 1-7. https://doi.org/10.1080/00913847.2020.1808435

Kroenke, K., Spitzer, R. L., & Williams, J. B. (2003). The Patient Health Questionnaire-2: Validity of a two-item depression screener. *Medical Care*, *41*(11), 1284-1292.

Kuettel, A., & Larsen, C. H. (2019). Risk and protective factors for mental health in elite athletes: A scoping review. *International Review of Sport and Exercise Psychology*, 1-35. https://doi.org/10.1080/1750984X.2019.1689574

Kuettel, A., Pedersen, A. K., & Larsen, C. H. (2021). To Flourish or Languish, that is the question: Exploring the mental health profiles of Danish elite athletes. *Psychology of Sport and Exercise*, *52*, 101837. https://doi.org/10.1016/j.psychsport.2020.101837

Li, C., Fan, R., Sun, J., & Li, G. (2021). Risk and protective factors of generalized anxiety disorder of elite collegiate athletes: A cross-sectional study. *Frontiers in Public Health*, *9*, 607800. https://doi.org/10.3389/fpubh.2021.607800

Li, C., Kee, Y. H., Wang, X., & Guo, Q. (2018). The Big Five Personality Traits and physical and emotional exhaustion among athletes: The mediating role of autonomous and controlled motivation. *International Journal of Sport Psychology*, *49*(1), 1-16. https://doi.org/10.7352/ijsp2018.49.001

Li, C., Martindale, R., & Sun, Y. (2019). Relationships between talent development environments and mental toughness: The role of basic psychological need satisfaction. *Journal of Sports Sciences*, *37*(18), 2057-2065. https://doi.org/10.1080/02640414.2019.1620979

Li, C., Martindale, R., Wu, Y., & Si, G. (2018). Psychometric properties of the Talent Development Environment Questionnaire with Chinese talented athletes. *Journal of Sports Sciences*, *36*(1), 79-85. https://doi.org/10.1080/02640414.2017.1282619

Li, C., Wang, C. K., Pyun, D. Y., & Martindale, R. (2015). Further development of the talent development environment questionnaire for sport. *Journal of Sports Sciences*, *33*(17), 1831-1843. https://doi.org/10.1080/02640414.2015.1014828

Li, C., Wang, C. K. J., & Pyun, D. Y. (2017). Impacts of talent development environments on athlete burnout: A self-determination perspective. *Journal of Sports Sciences*, *35*(18), 1-8. https://doi.org/10.1080/02640414.2016.1240370

Lin, C. H., Lu, F. J. H., Chen, T. W., & Hsu, Y. W. (2022). Relationship between athlete stress and burnout: A systematic review and meta-analysis. *International Journal of Sport and Exercise Psychology*, 21. https://doi.org/10.1080/1612197x.2021.1987503

Martindale, R. J., Collins, D., Wang, J. C., McNeill, M., Lee, K. S., Sproule, J., & Westbury, T. (2010). Development of the talent development environment questionnaire for sport. *Journal of Sports Sciences*, *28*(11), 1209-1221. https://doi.org/10.1080/02640414.2010.495993

Martindale, R. J. J., Collins, D., & Daubney, J. (2005). Talent development: A guide for practice and research within sport. *Quest*, *57*(4), 353-375. https://doi.org/10.1080/00336297.2005.10491862

McLoughlin, E., Fletcher, D., Slavich, G. M., Arnold, R., & Moore, L. J. (2021). Cumulative lifetime stress exposure, depression, anxiety, and well-being in elite athletes: A mixed-method study. *Psychology of Sport and Exercise*, *52*, 101823. https://doi.org/10.1016/j.psychsport.2020.101823

Perry, C., Chauntry, A. J., & Champ, F. M. (2022). Elite female footballers in England: An exploration of mental ill-health and help-seeking intentions. *Science and Medicine in Football*. https://doi.org/10.1080/24733938.2022.2084149

Rice, S. M., Gwyther, K., Santesteban-Echarri, O., Baron, D., Gorczynski, P., Gouttebarge, V., . . . Purcell, R. (2019). Determinants of anxiety in elite athletes: A systematic review and meta-analysis. *British Journal of Sports Medicine*, *53*(11), 722-730. https://doi.org/10.1136/bjsports-2019-100620

Sanhueza, J. A., Zambrano, T., Bahamondes-Avila, C., & Salazar, L. A. (2016). Association of anxiety-related polymorphisms with sports performance in Chilean long distance triathletes: a pilot study. *Journal of Sports Science & Medicine*, *15*(4), 554-561.

Schinke, R. J., Giffin, C., Cosh, S., Douglas, K., Rhind, D., Harwood, C., ... Papaiounnou, A. (2022). International society of sport psychology position stand: Mental health through occupational health and safety in high performance sport. *International Journal of Sport and Exercise Psychology*, *20*(6), 1711-1733. https://doi.org/10.1080/1750984X.2022.2129423

Spitzer, R. L., Kroenke, K., Williams, J. B., & Löwe, B. (2006). A brief measure for assessing generalized anxiety disorder: The GAD-7. *Archives of Internal Medicine*, *166*(10), 1092-1097. https://doi.org/10.1001/archinte.166.10.1092

Tahtinen, R. E., Kristjánsdóttir, H., þorgeirsson, S., Oddson, H. R., Saavedra, J. M., & Morris, R. (2021). Depressive symptoms in Icelandic elite athletes: A prospective examination through the lens of the response styles theory. *Psychology of Sport and Exercise*, *56*. https://doi.org/10.1016/j.psychsport.2021.101964

Thomas, C. E., Gastin, P. B., Abbott, G., & Main, L. C. (2021). Impact of the talent development environment on the wellbeing and burnout of Caribbean youth track and field athletes. *European Journal of Sport Science*, *21*(4), 590-603. https://doi.org/10.1080/17461391.2020.1775894

Thompson, R. A., & Sherman, R. (2014). Reflections on athletes and eating disorders. *Psychology of Sport and Exercise*, *15*(6), 729-734. https://doi.org/10.1016/j.psychsport.2014.06.005

Zhu, X., Haegele, J. A., Liu, H., & Yu, F. (2021). Academic stress, physical activity, sleep, and

mental health among Chinese adolescents. *International Journal of Environmental*

*Research and Public Health*, *18*(14), 7257. https://doi.org/10.3390/ijerph18147257

Table 1

*Participant Characteristics (n = 248)*

|  |  |
| --- | --- |
| Variable | *M* (*SD*) / *n* (%) |
| Age (year) | 18.34 (3.11) |
| Gender  Male  Female | 167 (67.3%)  81 (32.7%) |
| Sport  Table tennis  Fencing  Wrestling  Cycling  Synchronized swimming  Martial arts  Diving  Others a | 134 (54.0%)  15 (6.0%)  15 (6.0%)  14 (5.6%)  12 (4.8%)  12 (4.8%)  11 (4.4%)  35 (14.1%) |
| Training hours/week | 35.14 (15.26) |
| Talent development environments  Long-term development focus (1-6) b  Alignment of expectations (1-6) b  Communication (1-6) b  Holistic quality preparation (1-6) b  Support network (1-6) b | 4.65 (0.77)  4.38 (0.94)  4.81 (0.89)  4.27 (0.87)  4.44 (0.92) |
| Generalised anxiety disorder (0-21) b | 5.46 (5.06) |
| No  Yes | 201 (81.0%)  47 (19.0%) |
| Depression (0-6) b | 1.36 (1.68) |
| No  Yes | 200 (80.6%)  48 (19.4%) |
| Athlete burnout (1-5) b | 2.56 (0.95) |

Note. a Others are those sports each represented by less than 10 athletes, including athletics, badminton, gymnastics, rhythmic gymnastics, shooting, tennis, volleyball, water polo, and weight lifting. b possible range.

Table 2

*Zero-order Correlations among Study Variables (n = 248)*

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. |
| 1. Age | — |  |  |  |  |  |  |  |  |  |
| 2. Gender | -0.02 | — |  |  |  |  |  |  |  |  |
| 3. Training hours/week | 0.04 | 0.20\*\* | — |  |  |  |  |  |  |  |
| 4. Long-term development focus | -0.13\* | -0.12 | -0.07 | — |  |  |  |  |  |  |
| 5. Alignment of expectations | -0.13\* | -0.15\* | -0.14\* | 0.74\*\* | — |  |  |  |  |  |
| 6. Communication | -0.07 | -0.13\* | -0.17\*\* | 0.68\*\* | 0.78\*\* | — |  |  |  |  |
| 7. Holistic quality preparation | -0.03 | -0.15\* | -0.19\*\* | 0.67\*\* | 0.75\*\* | 0.73\*\* | — |  |  |  |
| 8. Support network | -0.05 | -0.09 | -0.14\* | 0.58\*\* | 0.61\*\* | 0.61\*\* | 0.77\*\* | — |  |  |
| 9. Generalised anxiety disorder | 0.09 | 0.08 | 0.10 | -0.21\*\* | -0.27\*\* | -0.17\*\* | -0.26\*\* | -0.27\*\* | — |  |
| 10. Depression | 0.05 | -0.01 | 0.10 | -0.21\*\* | -0.28\*\* | -0.19\*\* | -0.25\*\* | -0.23\*\* | 0.74\*\* | — |
| 11. Athlete burnout | 0.24\*\* | 0.01 | 0.12 | -0.27\*\* | -0.30\*\* | -0.23\*\* | -0.32\*\* | -0.26\*\* | 0.55\*\* | 0.54\*\* |

Note. Gender (0 = male, 1 = female). \*\* *p* < 0.01 (2-tailed). \* *p* < 0.05 (2-tailed).

Table 3

*Regression Analyses of Mental Health Predictors (n = 248)*

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Generalised anxiety disorder | |  | Depression | |  | Athlete burnout a | |
| β (95% CI) | *p* |  | β (95% CI) | *p* |  | β (95% CI) | *p* |
| Long-term development focus | -0.01 (-0.20, 0.18) | 0.92 |  | 0.00 (-0.19, 0.19) | 0.98 |  | -0.05 (-0.23, 0.14) | 0.60 |
| Alignment of expectations | **-0.24 (-0.47, -0.02)** | **0.04** |  | **-0.26 (-0.49, -0.04)** | **0.02** |  | -0.12 (-0.34, 0.10 ) | 0.30 |
| Communication | 0.19 (-0.02, 0.40) | 0.07 |  | 0.12 (-0.09, 0.33) | 0.25 |  | 0.11 (-0.09, 0.31) | 0.29 |
| Holistic quality preparation | -0.08 (-0.32, 0.16) | 0.50 |  | -0.09 (-0.33, 0.15) | 0.46 |  | **-0.26 (-0.49, -0.03)** | **0.03** |
| Support network | -0.17 (-0.36, 0.02) | 0.09 |  | -0.07 (-0.26, 0.12) | 0.48 |  | -0.01 (-0.19, 0.18) | 0.95 |
| *R2* | 10.2% | |  | 8.7% | |  | 15.9% | |

Note. a Model adjusted for age (βage = 0.21, *p* < 0.001). Significant standardised regression coefficients (*p* < 0.05) are in boldface. Two-tailed tests are used.

Table 4

*Descriptive Statistics for the Three-Cluster Solution and Outcomes (n = 248)*

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Variables |  | Cluster 1 “slightly below  average TDE” (*n* = 123) | |  | Cluster 2 “high TDE”  (*n* = 85) | |  | Cluster 3 “very low  TDE” (*n* = 40) | |  | *F* | η*p*2 |
|  | *M (SD)* | *Z* |  | *M (SD)* | *Z* |  | *M (SD)* | *Z* |  |
| *Clustering variables* | | |  |  |  |  |  |  |  |  |  |  |
| LTF |  | 4.46 (0.49) a | -0.24 |  | 5.36 (0.48) b | 0.93 |  | 3.70 (0.59) c | -1.24 |  | 166.76\*\* | 0.58 |
| AOE |  | 4.25 (0.52) a | -0.13 |  | 5.25 (0.51) b | 0.92 |  | 2.92 (0.64) c | -1.53 |  | 261.65\*\* | 0.68 |
| COM |  | 4.78 (0.53) a | -0.03 |  | 5.51 (0.43) b | 0.80 |  | 3.37 (0.70) c | -1.62 |  | 223.70\*\* | 0.65 |
| HQP |  | 4.10 (0.47) a | -0.20 |  | 5.10 (0.54) b | 0.95 |  | 3.04 (0.59) c | -1.41 |  | 231.74\*\* | 0.65 |
| SN |  | 4.23 (0.69) a | -0.23 |  | 5.26 (0.55) b | 0.89 |  | 3.35 (0.64) c | -1.18 |  | 135.10\*\* | 0.52 |
| *Outcomes* |  |  |  |  |  |  |  |  |  |  |  |  |
| GAD |  | 6.07 (4.56) a | 0.12 |  | 3.76 (5.39) b | -0.33 |  | 7.20 (4.88) a | 0.34 |  | 8.51\*\* | 0.07 |
| Depression |  | 1.52 (1.71) a | 0.10 |  | 0.79 (1.48) b | -0.34 |  | 2.08 (1.62) a | 0.42 |  | 9.81\*\* | 0.07 |
| Athlete burnout |  | 2.61 (0.88) a | 0.06 |  | 2.23 (0.92) b | -0.35 |  | 3.09 (0.98) c | 0.55 |  | 12.54\*\* | 0.09 |

Note. TDE = talent development environment, LTF = long-term development focus, AOE = alignment of expectations, COM = communication, HQP = holistic quality preparation, SN = support network, GAD = generalised anxiety disorder. Means in the same row that do not share subscripts differed at *p* < 0.05 using Tukey’s honest significance difference (HSD) test. Partial eta-squared (η*p*2) effect sizes for between-cluster differences are interpreted as small (0.01), medium (0.06), and large (0.14), respectively (Cohen, 1992). \**p* < 0.05 (two-tailed), \*\**p* < 0.01 (two-tailed).