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Compulsive exercise and its relationship with mental health and psychosocial wellbeing in recreational exercisers and athletes

S.M. Cosh^{a,*}, D.G. McNeil^b, P.J. Tully^a^a School of Psychology, University of New England, Australia^b Institute of Health and Wellbeing, Federation University, Australia

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ABSTRACT

Objectives: Better understanding of compulsive exercise is needed in sports medicine. Whilst compulsive exercise may impact mental health, the limited research exploring the relationship between compulsive exercise and psychosocial outcomes is equivocal. The majority of studies have examined eating disorder populations where the eating disorder pathology might account for distress. This study explores relationships between compulsive exercise and mental health.

Design: Cross-sectional observational study.

Methods: Australian recreational exercisers and athletes (N = 1157; *M*_{age} 36.4, standard deviation = 12.9, 77 % female) recruited through sporting organisations, clubs, and gyms, completed measures of compulsive exercise, depression, anxiety, stress, life satisfaction, social physique anxiety, and self-esteem. Regression analyses examined relationships between dimensions of compulsive exercise and wellbeing.

Results: After adjustment for eating disorder symptoms and sporting level, compulsive exercise was associated with increased risk of clinically-significant anxiety, depression, and stress symptoms. Compulsive exercise was also associated with lower life satisfaction and self-esteem, and higher social physique anxiety. Notably, different dimensions of compulsive exercise had varying relationships with outcomes, and avoidance and rule-driven behaviour and lack of exercise enjoyment were associated with poorer mental health and wellbeing.

Conclusions: Results suggest that compulsive exercise is uniquely associated with a range of psychosocial and mental health outcomes. Results support the need to improve identification and treatment of compulsive exercise in sport and exercise settings. Results highlight that mental health intervention is an important component of treatment, and treatments targeting symptoms related to avoidance and rule-driven behaviour, and anhedonia may be valuable treatment components for those with compulsive exercise.

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Practical implications

- This study highlights that there is a need for assessment and identification of compulsive exercise as part of sports medicine.
- Compulsive exercise is related to psychological burden, thus intervention addressing physical and mental health sequelae in sport and exercise settings, such as delivered in a multi-disciplinary team, are warranted.
- Treatments with a specific focus on addressing avoidance and rule-driven behaviour and lack of exercise enjoyment would be beneficial.

1. Introduction

Pathological or unhealthy exercise poses a large health risk to athletes and exercisers, however, it often goes undetected within sports

medicine.¹ Unhealthy¹ exercise has been operationalised in various ways² with compulsive exercise (CE) being widely endorsed.³ CE is understood as an urge to engage in excessive (i.e. concerning frequency, intensity and/or duration) exercise in order to avoid aversive emotions, which negatively impacts one's life,⁴ with exercise maintained in order to avoid guilt or distress that may result from *not* exercising.² CE is argued to be a multi-dimensional construct,⁵ consisting of five dimensions: Avoidance and rule-driven behaviour (which reflects guilt when unable to exercise and following strict exercise rules), weight control exercise (which represents exercise behaviours taken to control weight and shape), mood improvement (the positive reinforcement through mood enhancement from the exercise), lack of exercise

¹ The current study examines Compulsive Exercise. A variety of definitions and operationalisations of unhealthy exercise have been used in the literature including exercise addiction, exercise dependence and obligatory exercise. In this paper, where we refer to unhealthy exercise, it is used as an umbrella term encompassing varying definitions, such as where citing multiple studies using varying operationalisations.

* Corresponding author.

E-mail address: scosh@une.edu.au (S.M. Cosh).

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enjoyment (where exercise is viewed as a chore that does not result in pleasure or enjoyment), and exercise rigidity (the adoption of rigid schedules around exercise that are inflexible).⁶ Recently proposed diagnostic criteria for CE include that exercise negatively impacts social and occupational functioning, as well as causing physical or psychological burden.⁴ Whilst a range of physical health consequences of unhealthy exercise have been identified, including injuries, stress fractures, and cardiac dysfunction,^{7,8} only limited research has examined the relationship of CE with psychological burden.⁸ Although links between CE and eating disorder (ED) pathology are well established,^{5,9} mental health and wellbeing outcomes remain underexamined. Thus, the extent to which CE is related to psychological burden remains unclear and further understanding is important for guiding sports medicine.¹

The majority of the CE and mental health research to date has focused on ED samples, suggesting an association between CE and anxiety and depression¹⁰; although findings have remained mixed. Less research has been conducted outside of ED populations, thus the extent to which relationships between CE and wellbeing outcomes might be explained by ED pathology is uncertain, and there remains a need to better understand the relationship between CE and other psychological outcomes in exercise and athlete populations.¹¹ Of the limited evidence to date outside of ED samples, associations between anxiety and depression and unhealthy exercise have been observed,¹² with higher levels of depression and anxiety observed amongst professional athletes than recreational exercisers.¹³ Conversely, in an adolescent sample, anxiety, depression and social physique anxiety were not associated with CE.⁹ Similarly, no differences in depression and quality of life were reported between those with and without CE in a student sample.¹⁴ Further, some evidence points to higher body dissatisfaction for those who engage in unhealthy exercise,¹⁵ although not all studies have corroborated this finding.¹⁶ Collectively, research remains limited regarding CE and psychological outcomes, and findings are equivocal.

The current literature has been characterised by a variety of operationalisations and assessments of unhealthy exercise. Various definitions of unhealthy exercise have been proposed, and a lack of consensus on definition³ has limited assessment¹ and led to some inconsistencies in the literature (see 2,17). This is evident in the literature examining psychological outcomes, where use of varying conceptualisations of unhealthy exercise might have contributed to the mixed findings observed. Additionally, CE is a multi-dimensional construct,⁵ yet examination of the specific dimensions of CE has been minimal. Nascent dimensional research has shown that weight control exercise was negatively associated with depression in a student sample, whilst weight control exercise and avoidance and rule-driven behaviour were positively related to body dissatisfaction.¹⁵ Avoidance but not mood improvement was also associated with psychopathology in an adolescent ED sample.¹⁸ However, further dimensional examination, as per the multidimensional model of CE, is needed.¹¹

Despite proposed diagnostic criteria for CE indicating an impact on functioning and psychological burden, there remains limited research examining the psychological outcomes associated with CE, especially in recreational exercise and athlete populations. Given the limited and mixed findings to date, the current study was exploratory in nature and aimed to examine the relationships between dimensions of CE and mental health (depression, anxiety, stress) and psychosocial wellbeing (satisfaction with life, self-esteem and social physique anxiety) outcomes in a sample of recreational exercisers and athletes.

2. Method

2.1. Sample

Participants were an Australian adult sample of self-reported recreational exercisers and athletes. Inclusion criteria were broad; aged 18 + and engaging in exercise. Of the 1401 participants who agreed to participate, 237 failed to complete > 30 % of the survey and a further seven

cases who had not completed all study variables were removed via listwise deletion. There were no differences between those who did and did not complete study measures based on demographics such as age, gender, and education. There were no outliers on key study variables, however, $n = 10$ extreme outliers for the descriptive variable of exercise behaviour (GLTEQ) were identified. Given that scores on study variables were within normal range, these cases were removed pairwise. The final sample ($N = 1157$) was 77.4 % female with a mean age of 36.4 ($SD = 12.9$; range 18–89).

2.2. Procedure

Ethics approval was obtained from the University Research Ethics Committee, and this study was conducted in line with the *Australian Code for the Responsible Conduct of Research*. Participants were recruited via online forums and social media sites of sporting clubs, and exercise and health groups, and through sporting clubs, university sporting bodies and flyers posted at sporting grounds, clubs, and gyms. Participants were directed to an anonymous online questionnaire hosted by Qualtrics (Provo, UT). Measures of the study variables were presented in random order to minimise order effects.

2.3. Measures

Demographic data including age, gender, and self-reported exercise level (recreational, competitive/elite) were collected.

The **Compulsive Exercise Test (CET)**⁶ is a 24-item measure of engagement in CE behaviours. Responses are provided on a six-point Likert scale (never true to always true). The CET contains five subscales, reflecting the five dimensions of CE: avoidance and rule-driven behaviour, weight control exercise, mood improvement, lack of exercise enjoyment, and exercise rigidity. Higher scores are indicative of increased CE behaviours, with clinical cut-off scores proposed.^{19,20} The CET has good internal consistency and construct validity in both non-clinical and eating disorder samples.^{5,19} Internal consistency in the present study was good; $\alpha = 0.87$.

The **Eating Attitudes Test-26 (EAT-26)**²¹ is a 26-item measure that was used to assess disordered eating symptoms. The EAT-26 has good reliability and predictive validity and a cut-off score of 20 has been proposed as indicating clinical symptomatology.²¹ Internal consistency in the present study was good; $\alpha = 0.87$.

The **Depression, Anxiety and Stress Scale-21 (DASS-21)** is a well-validated 21-item measure of psychological distress, assessing depression, anxiety and stress.²² Subscales for each of the three assessed conditions - depression, anxiety and stress - can be derived, and clinical cut-offs for each subscale have been established which have good sensitivity and specificity for predicting diagnoses.²² In the current sample, internal consistency was high; $\alpha = 0.94$.

The **Social Physique Anxiety Scale (SPAS)**²³ is a 12-item scale measuring the extent to which a person experiences anxiety related to perceived negative judgements others make about their body. The SPAS has demonstrated adequate internal consistency and test-retest reliability, and good construct validity.²³ In the present study, internal consistency was good; $\alpha = 0.91$.

The **Rosenberg Self-Esteem Scale (RSE)**²⁴ is a 10-item assessment with higher scores indicating greater self-esteem. The RSE has been widely shown to have good psychometric properties including internal consistency and test-retest reliability²⁴; internal consistency in the current study was high; $\alpha = 0.90$.

The **Satisfaction with Life Scale (SWLS)**²⁵ is a 5-item questionnaire that has been shown to be a valid and reliable measure.^{25,26} Internal consistency for the current sample was high; $\alpha = 0.90$.

The **Godin Leisure Time Exercise Questionnaire (GLTEQ)**²⁷ was used to assess activity level. Participants report the frequency within a 7-day period that they engage in strenuous, moderate and mild exercise for more than 15 min, from which a total leisure activity score is calculated.

Table 1
Sample characteristics.

	M (SD)/N (%)	Range
Age	36.4 (12.9)	18–89
Female	895 (77.4 %) ^a	
Exercise behaviour (Godin) ^b	38.6 (26.4)	3–116
Compulsive exercise (CET)	11.9 (3.03)/334 (28.9 %) ^a	2–23
Avoidance and rule-driven behaviour	1.79 (0.97)	0–4.9
Weight control exercise	2.52 (1.08)	0–5
Lack of exercise enjoyment	1.72 (1.19)	0–5
Mood improvement	3.17 (1.00)	0–5
Exercise rigidity	2.67 (1.17)	0–5
Psychological distress (DASS-21 Total)	26.3 (21.1)	0–118
Depression	369 (31.9 %) ^a	
Anxiety	377 (32.6 %) ^a	
Stress	385 (31.8 %) ^a	
Disordered eating symptoms (EAT-26)	9.57 (9.48)	0–57
Life satisfaction	14.43 (6.69)	5–35
Self-esteem	20.52 (5.51)	0–30
Social physique anxiety	32.23 (5.89)	12–57

^a N (%) above threshold.

^b n = 1147.

2.4. Data analysis

The relationships between CET subscales and outcome variables were assessed using regression analyses. Depression, anxiety and stress, were dichotomised based on the presence of clinically significant symptoms, as per clinical cut-offs.²² Relationships with these outcome variables were assessed using logistic regression analyses for each variable, with CET dimensions as predictors. For self-esteem and social physique anxiety, clinical cut-offs were not available and so these outcomes, along with life satisfaction, were examined as continuous variables in separate multiple regression analyses, with CET dimensions as predictors. For all outcomes, three models were conducted. In the first model, the five CET subscales were entered. In the second model, known covariates of gender and age were also entered. In the final models, exercise level was added as a known possible covariate,¹³ as were ED symptoms to examine if CE uniquely contributed to outcomes or if ED pathology explained associations. All regression model assumptions were checked and multicollinearity between predictors satisfied

according to tolerance and variance inflation factors. Analyses were conducted using SPSS version 28 and a p value of ≤.05 was considered statistically significant.

3. Results

Of the sample, the majority indicated being recreational exercisers (n = 934, 81 %), with 19 % being competitive/elite athletes (n = 223; see Table 1).

In all models examining clinically-significant anxiety symptoms, lack of exercise enjoyment and avoidance and rule-driven behaviour were associated with a greater likelihood of having anxiety symptoms (Table 2). Mood improvement, on the other hand, had a small association with reduced anxiety. Across all models, avoidance and rule-driven behaviour, and lack of exercise enjoyment were associated with increased odds of experiencing clinically-relevant depression symptoms. Exercise rigidity, on the other hand, was associated with a reduction in depression symptoms. Stress was also significantly predicted in all three models by avoidance and rule-driven behaviour, and lack of exercise enjoyment. Exercise rigidity showed an association with stress and anxiety in Model 1, however, this was no longer significant after adjustment; all other relationships were not attenuated by adjustment.

Dimensions of CE were also shown to significantly predict social physique anxiety (Table 3). In the final model, avoidance and rule-driven behaviour, mood improvement, and lack of exercise enjoyment were all associated with increased social physique anxiety; whereas weight control exercise was no longer a significant predictor after adjustment for ED symptoms. Examination of the relationship between CE and life satisfaction showed that all dimensions of CE were significant. Notably, avoidance and rule-driven behaviour, weight control exercise, and lack of exercise enjoyment were associated with decreased life satisfaction. Mood improvement and exercise rigidity were associated with higher life satisfaction. Examination of the relationship between CE and self-esteem indicated that avoidance and rule-driven behaviour, weight control exercise, and lack of exercise enjoyment were all significantly associated with lower self-esteem (Table 3). Mood improvement and exercise rigidity had a significant and positive relationship with self-esteem.

Table 2
CET subscales as predictors of presence of clinically relevant anxiety, depression and stress symptoms.

	Model 1			Model 2			Model 3					
	OR	95 % CI	p	OR	95 % CI	p	OR	95 % CI	p			
<i>Anxiety</i>												
ARB	1.84	1.54	2.20	<.001	1.68	1.40	2.02	<.001	1.59	1.32	1.93	<.001
WCE	1.12	0.97	1.29	.116	1.07	0.92	1.23	.403	1.00	0.85	1.16	.958
MI	0.78	0.66	0.93	.005	0.79	0.66	0.95	.010	0.82	0.68	0.98	.032
LEE	1.34	1.18	1.52	<.001	1.35	1.18	1.54	<.001	1.34	1.17	1.53	<.001
ER	0.86	0.75	0.98	.022	0.88	0.77	1.01	.078	0.89	0.78	1.03	.108
<i>Depression</i>												
ARB	2.18	1.81	2.63	<.001	2.07	1.71	2.51	<.001	2.00	1.64	2.43	<.001
WCE	1.02	0.88	1.18	.783	1.00	0.86	1.16	.968	0.94	0.81	1.10	.450
MI	0.90	0.75	1.07	.224	0.93	0.77	1.11	.410	0.96	0.80	1.15	.639
LEE	1.53	1.34	1.74	<.001	1.57	1.37	1.80	<.001	1.56	1.36	1.79	<.001
ER	0.78	0.68	0.89	<.001	0.80	0.69	0.92	.001	0.80	0.70	0.92	.002
<i>Stress</i>												
ARB	2.10	1.74	2.52	<.001	1.96	1.61	2.37	<.001	1.92	1.58	2.34	<.001
WCE	0.98	0.84	1.13	.744	0.92	0.79	1.07	.288	0.92	0.79	1.08	.312
MI	1.07	0.90	1.29	.448	1.09	0.90	1.31	.383	1.10	0.91	1.33	.324
LEE	1.65	1.44	1.89	<.001	1.67	1.45	1.93	<.001	1.71	1.48	1.97	<.001
ER	0.84	0.74	0.97	.015	0.87	0.76	1.01	.059	0.87	0.75	1.00	.056

ARB: avoidance and rule-driven behaviour; WCE: weight control exercise; MI: mood improvement; LEE: lack of exercise enjoyment; ER: exercise rigidity; OR: odds ratio; CI: confidence interval.

Anxiety; Model 1: p < .001; Model 2 adjusted for gender and age: p < .001; Model 3 adjusted for gender, age, eating disorder symptoms and exercise level: p < .001.

Depression; Model 1: p < .001; Model 2 adjusted for gender and age: p < .001; Model 3 adjusted for gender, age, eating disorder symptoms and exercise level: p < .001.

Stress; Model 1: p < .001; Model 2 adjusted for gender and age: p < .001; Model 3 adjusted for gender, age, eating disorder symptoms and exercise level: p < .001.

Table 3
CET subscales as predictors of wellbeing and social physique anxiety outcomes.

	Model 1			Model 2			Model 3		
	B	SE	p	β	SE	p	B	SE	p
<i>Social physique anxiety</i>									
ARB	1.20	0.222	<.001	0.795	0.216	<.001	0.560	0.094	.010
WCE	0.724	0.182	<.001	0.587	0.175	<.001	0.302	0.057	.093
MI	0.389	0.220	.078	0.385	0.211	.069	0.534	0.210	.011
LEE	0.917	0.162	<.001	0.842	0.155	<.001	0.771	0.155	<.001
ER	-0.027	0.167	.874	0.122	0.160	.446	0.160	0.158	.311
<i>Life satisfaction</i>									
ARB	-1.22	0.259	<.001	-1.16	0.265	<.001	-1.18	0.270	<.001
WCE	-0.652	0.212	.002	-0.688	0.214	.001	-0.647	0.223	.004
MI	0.570	0.257	.027	0.536	0.259	.039	0.527	0.261	.044
LEE	-1.07	0.188	<.001	-1.11	0.189	<.001	-1.063	0.193	<.001
ER	0.705	0.194	<.001	0.703	0.195	<.001	0.700	0.197	<.001
<i>Self-esteem</i>									
ARB	-1.93	0.202	<.001	-1.75	0.203	<.001	-1.64	0.206	<.001
WCE	-0.764	0.165	<.001	-0.649	0.164	<.001	-0.546	0.171	.001
MI	0.785	0.200	<.001	0.789	0.199	<.001	0.720	0.200	<.001
LEE	-1.33	0.146	<.001	-1.31	0.146	<.001	-1.30	0.148	<.001
ER	0.589	0.152	<.001	0.503	0.151	<.001	0.491	0.151	.001

ARB: avoidance and rule-driven behaviour; WCE: weight control exercise; MI: mood improvement; LEE: lack of exercise enjoyment; ER: exercise rigidity.

Social physique anxiety; Model 1: $Adj. R^2 = 0.112$, $F = 30.79$, $p < .001$; Model 2 adjusted for gender and age: $Adj. R^2 = 0.197$, $F = 41.79$, $p < .001$; Model 3; adjusted for gender, age, eating disorder symptoms and exercise level: $Adj. R^2 = 0.222$, $F = 37.81$, $p < .001$.

Life satisfaction; Model 1: $Adj. R^2 = 0.084$, $F = 21.62$, $p < .001$; Model 2 adjusted for gender and age: $Adj. R^2 = 0.086$, $F = 16.57$, $p < .001$; Model 3; adjusted for gender, age, eating disorder symptoms and exercise level: $Adj. R^2 = 0.085$, $F = 13.02$, $p < .001$.

Self-esteem; Model 1: $Adj. R^2 = 0.185$, $F = 54.74$, $p < .001$; Model 2 adjusted for gender and age: $Adj. R^2 = 0.214$, $F = 46.23$, $p < .001$; Model 3; adjusted for gender, age, eating disorder symptoms and exercise level: $Adj. R^2 = 0.218$, $F = 37.04$, $p < .001$.

4. Discussion

This study builds on understandings around the psychological burden of CE amongst recreational exercisers and athletes. Building on the limited research examining CE and wellbeing to date,^{8,11} our results showed that CE is related to a range of negative mental health and psychosocial wellbeing outcomes, such as increased depression, anxiety, stress, and social physique anxiety, and reduced self-esteem and life satisfaction, and these were not attenuated by adjustment for ED symptoms. Further, patterns of association varied between dimensions of CE and outcomes, which might help to explain mixed findings in the literature to date. Results underscore the need to better identify and support those engaging in CE within sport and exercise settings, something that is not currently always well detected within sports medicine.¹ In demonstrating a unique association between CE and mental health outcomes, results also further underscore that mental health intervention for CE is necessary, alongside physical management, including to manage associated psychological burden. Ascertaining clarity regarding whether the CE exists as part of another pathology or independently may also valuably guide intervention.¹

The present study included an examination of stress, which to our knowledge has not previously been explored, and found that avoidance and rule-driven behaviour, and lack of exercise enjoyment were associated with increased likelihood of having clinically-meaningful stress symptoms. Results also suggested that CE was related to anxiety and depression, in particular, avoidance and rule-driven behaviour, and lack of exercise enjoyment were associated with increased likelihood of having anxiety and depression symptoms. Mixed results have been observed in ED samples,^{10,18,28} whilst in studies of UK adolescents⁹ and US students,¹⁴ no relationships between CE and depression or anxiety were reported. Such differences may relate to the age of samples studied,⁹ where impairment might only become more pronounced into adulthood, or may reflect non-validated CE assessment¹⁴ or varying operationalisation of unhealthy exercise previously used.^{10,28} Our

findings thus provide evidence of the relationship between CE and anxiety and depression in adult exercisers and athletes, across exercise levels. Whilst exercise can have anti-depressant and anxiolytic effects regardless of intensity,^{29,30} results support that exercise can become unhealthy¹ and this appears to ameliorate the protective effects of exercise and may result in impairment. The extent to which a) the compulsive nature of the behaviour, b) the presence of exercise-obsessions,³¹ c) the absence of engagement in other activities or d) the related impacts on social and occupational functioning⁴ might be the pathway through which CE poses psychological impairment remains less certain and further research explicating causal pathways would be beneficial.

This study also explored the relationship with social physique anxiety. Body image and body dissatisfaction have been widely shown to be related to EDs.^{32,33} Whilst CE can be observed within ED populations as part of the ED pathology⁵ with weight and shape concern being a key aetiological and maintaining factor of ED behaviour,³⁴ less research has examined body dissatisfaction specifically in relation to CE, especially outside of ED-only samples and after adjustment for ED symptoms. Previous research showed a relationship between weight control exercise and body dissatisfaction,¹⁵ however, weight control exercise was no longer significant after adjustment for ED symptoms in our study. Given that exercise for weight control is related to ED pathology and most closely associated with dietary practices,³⁵⁻³⁸ results suggest that weight control exercise might be associated with body dissatisfaction though ED symptomatology (i.e., ED pathology appears to explain the observed association in unadjusted models between weight control exercise and social physique anxiety). Our study showed an association between three factors of CE (avoidance and rule-driven behaviour, mood improvement, and lack of exercise enjoyment) and social physique anxiety, even after adjustment for ED symptoms; indicating a unique association between these dimensions of CE and body dissatisfaction. Previous research has found no association between CE and social physique anxiety in adolescents,⁹ but has shown a link between unhealthy exercise and body dissatisfaction in adult samples,¹⁵ suggesting that the link between CE and body dissatisfaction may only appear in adulthood, or may stem from time spent engaging in CE. Longitudinal studies to better understand trajectory and directionality are needed.

Research examining self-esteem and CE is scant, with an association between lower self-esteem and CE observed in ED samples.¹⁸ This study highlights a relationship between CE and self-esteem in exercise and athlete populations. All five CE dimensions were related to self-esteem; however, relationships were mixed. Avoidance and rule-driven behaviour, lack of exercise enjoyment, and weight control exercise were associated with reduced self-esteem, whereas exercise rigidity and mood improvement were related to higher self-esteem. Our results also showed that avoidance and rule-driven behaviour, lack of exercise enjoyment, and weight control exercise were related to reduced life satisfaction, whereas, mood improvement and exercise rigidity were associated with enhanced life satisfaction. Therefore, CE appears to have a nuanced relationship with life satisfaction and self-esteem, such that reasons for engaging in the exercise behaviours may influence outcomes for individuals.

Notably, our results showed that CE dimensions of mood improvement and exercise rigidity were associated with several positive outcomes. In the present study, mood improvement was related to reduced anxiety, and improved self-esteem and life satisfaction. Mood improvement, as assessed by the CET, reflects the positive reinforcement of exercise through improved mood,⁶ and our results suggest that the reinforcement gained through positive mood might enhance other aspects of life. Although it should be noted that mood improvement was associated with increased social physique anxiety, indicating that mood improvement does not always equate with positive outcomes. Whilst mood improvement was related to reduced anxiety, and improved self-esteem and life satisfaction in the current study, this dimension of CE was not associated with any outcomes in an inpatient ED sample.¹⁸ Mood improvement is not associated with ED

pathology,⁶ suggesting that exercising to enhance mood may be less common in those with EDs, and may be largely protective in exercise settings. It has been argued that those individuals engaging in CE behaviours to regulate emotion through enhancing mood may have different outcomes to those who engage in CE as an avoidant coping strategy.³⁹ Results from our study suggest that those engaging in CE for mood improvement may have better outcomes.

Exercise rigidity was also associated with lower depression symptoms, and higher self-esteem and life satisfaction, yet may be an aspect of CE that leaves individuals vulnerable to physical health sequelae.¹ Exercise rigidity relates to maintaining exercise schedules and behaviours,⁶ which may be protective with regard to depression as it can buffer against behavioural inertia, which has a bidirectional relationship with depression.⁴⁰ In addition, the ability to follow exercise schedules and routines (exercise rigidity) may enhance self-esteem, or enhanced self-esteem may facilitate adherence to such schedules. Further, rigidity around exercise may reflect perfectionism.³⁴ Given that perfectionism is related to self-esteem,⁴¹ it may mediate this relationship. It remains possible that the improvement in self-esteem and depression might lead to enhanced life satisfaction. Whilst analyses adjusted for age, length of time spent engaging in CE may also interact with this relationship and future exploration of the pathways, directionality and longer-term outcomes of such findings is warranted. Future examination of exercise rigidity and mood improvement with related outcomes would be warranted to corroborate and further understand these associations and the possible protective or harmful role they may play in outcomes of those with CE, especially over time.

Our findings underscore that identification of CE in exercise and sport settings is of importance. Whilst it has been argued that CE might reflect the presence of subclinical eating pathology,¹¹ our results highlight that these relationships remained after adjustment for ED symptoms and, therefore, indicate that CE is uniquely associated with a range of mental health and psychosocial outcomes. Furthermore, our results highlight the presence of adverse outcomes in both recreational exercisers as well as competitive athletes, with associations remaining after adjustment for sporting level. This finding indicates that identifying, managing, and treating CE are necessary across exercise as well as sport settings. Thus, sport practitioners need to be alert to identifying CE, which often goes undetected.¹ Given that CE is related to potential physical burden^{7,8} as well as psychological burden, multi-disciplinary approaches may be valuable and there is a role for mental health treatment alongside physical management to address behaviour and associated psychological burden as part of intervention for CE.

Consistently our results showed that avoidance and rule-driven behaviour, as well as lack of exercise enjoyment were related to all outcomes studied (depression, anxiety, stress, reduced self-esteem, reduced life satisfaction and increased social physique anxiety). Lack of exercise enjoyment is characterised by viewing exercise as a chore from which pleasure is not derived.⁶ The present findings are thus consistent with observations that low positive emotionality, such as observed where an activity is undertaken that does not result in enjoyment or pleasure, is related to disorders including depression and anxiety.^{42,43} Avoidance and rule-driven behaviour partly reflects the avoidance of the negative affect arising from *not* exercising, which then reinforces and perpetuates exercise behaviour.⁵ Whilst reducing negative affect can produce short-term benefits, such avoidant approaches to coping typically lead to distress in the longer term,⁴⁴ which might contribute to the observed associations. These aspects of CE may thus be especially critical to detect amongst athletes and exercisers, as these dimensions are associated with the greatest impairment. Further, treatments specific for CE currently remain limited and underdeveloped, despite a need for treatment insights for practitioners.⁸ These findings suggest it may be beneficial for interventions to target and address these core symptom areas, drawing on components of existing interventions, or adapting therapies to include a focus on these symptoms.

In particular, lack of exercise enjoyment predicted all negative outcomes, and this result coupled with the finding that mood improvement predicted a range of positive outcomes suggests that a focus on enhancing positive affect might be an avenue as a treatment component for CE. Notably, behavioural activation has limited impact on positive affect,⁴⁵ underscoring that engagement in an activity alone, such as in CE, does not necessarily address positive affect nor reduce anhedonia symptoms of lack of pleasure.⁴⁶ As such, positive affect approaches designed for anhedonia might feasibly be applied as one component to CE treatments. The association of avoidance and rule-driven behaviour with outcomes suggests that enhancing coping strategies and emotion regulation,³⁹ as well as treatments developed for rule-driven behaviour such as in the obsessive-compulsive personality disorder literature, might also be beneficially adapted for CE treatment. Further, preliminary research has explored Compulsive Exercise Activity Therapy (LEAP) for addressing CE behaviour within ED samples as add-on therapy to CBT for AN, with mixed results across patient reported outcomes and anthropometric measures.^{47–49} Given that treatments for CE outside of ED settings are especially underdeveloped,⁸ the application of LEAP outside of ED populations might be beneficial. The potential adaptation of LEAP to address core symptoms associated with psychological impairment, as identified in the present study, might also be valuable. Ongoing research to better understand underlying processes that drive avoidance and rule-driven behaviour and lack of exercise enjoyment may also help to guide future intervention.

This study is presented with several limitations. Data for the present study are cross-sectional and assessed using regression analyses, limiting conclusions to associations only. The extent to which CE might lead to adverse outcomes, or the extent to which social physique anxiety, depression, stress, low self-esteem, anxiety and low life satisfaction might lead to CE behaviours being initiated and/or maintained warrants ongoing longitudinal examination. Further, ED symptoms and CE were assessed at a single time point and disorder history was not ascertained, as such the study does not assess ED recovery or disorder trajectory. Assessment was through self-report only, which may be subject to bias or impacted by lack of insight, lack of understanding, or the ego-syntonic nature of disordered eating and CE,¹ with self-reports of mental health not always matching clinician assessment.⁵⁰ Additionally, disordered eating behaviour was assessed by the EAT-26 which might not encapsulate all aspects of ED behaviours, although does have good predictive ability and high accuracy in discriminating between those with and without EDs.⁵¹ Whilst analyses adjusted for key covariates, which largely did not attenuate results, not all potential confounding variables were included. Sporting and exercise levels were self-reported and we cannot verify athlete status and the number of athletes in the sample was smaller than for exercisers, thus results may better reflect exercise settings. There was a higher proportion of females, however, a recent meta-analysis indicated only small gender differences in unhealthy exercise behaviour⁵² and analyses adjusted for gender.

5. Conclusion

This study highlighted that CE is associated with a range of mental health and psychosocial outcomes including increased depression, anxiety, stress, and social physique anxiety and reduced life satisfaction and self-esteem. Findings also highlight that avoidance and rule-driven behaviour and lack of exercise enjoyment were related to all negative outcomes and thus may be crucial components of identification and treatment of CE. Enhanced identification and treatment of CE by sports practitioners within sport and exercise settings are important due to psychological burden associated with compulsive exercise.

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Confirmation of ethical compliance

This study received ethical approval from the University of New England's Human Research ethics committee and was conducted in accordance with the *Australian Code for the Responsible Conduct of Research*.

CRedit authorship contribution statement

SC developed the study, undertook data analysis and contributed to preparation of the manuscript.

DM contributed to study development and preparation of the manuscript.

PT contributed to data analysis and preparation of the manuscript.

Data sharing statement

Deidentified data are available from the corresponding author upon reasonable request.

Declaration of interest statement

None.

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