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Screening for compulsive exercise: development of cutoff scores to identify individuals at risk

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Abstract

Compulsive exercise (CE) is proposed to be a unique disorder within the feeding and eating spectrum, with the potential to cause a range of physical and mental health outcomes. However, it often remains undetected, highlighting the need to enhance screening for CE, especially outside of eating disorder (ED) treatment settings. Although CE is commonly assessed using the Compulsive Exercise Test (CET), there are currently no established cutoff scores for identifying CE in community settings or outside of ED populations. This study utilized two samples—a general exercise population and a community sample recruited to capture individuals with elevated mental health symptoms—to identify a suitable cutoff for the CET. Receiver operating characteristic analyses were used, and CE cases were classified in three ways. The area under the curve was moderate to high for detecting CE, and optimal cutoff scores were consistent across CE markers and samples. The present study suggests that a cutoff score of 13.5, which increases sensitivity and balances specificity, can be used to detect possible cases of CE in the community. These results have practical implications for screening across diverse settings and can contribute to further research and understanding of CE.

Keywords: *exercise addiction*, *mental health*, *pathological exercise*, *dependence*, *disorder classification*, *detection*

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1. Introduction

Compulsive exercise (CE) is understood as an urge to engage in excessive exercise (i.e., in terms of frequency, intensity, and duration) to avoid feared outcomes, such as aversive emotions [1, 2]. CE has largely been observed and researched in individuals diagnosed with eating disorders (EDs), where it may function as a form of purging behavior or be driven by concerns related to weight reduction and/or body shape. There are also some suggestions that CE might be a precursor to the development of EDs [3, 4]. However, CE is widely observed outside of EDs [e.g., 5–7], where the focus of exercise is not necessarily on weight loss or calorie restriction, and it has been observed within exercise populations [6]. Recent evidence suggests that CE may be its own unique disorder within the feeding and eating disorder spectrum [8], highlighting the need for improved identification and detection of CE cases.

CE is associated with a range of adverse physical health sequelae [9, 10], as well as increased depression, substance use, psychological distress, and lower life satisfaction [11–14], and may reflect a maladaptive coping style [15, 16]. Prevalence estimates are limited by measurement issues [17] but suggest that 11% of male and 17% of female college students may engage in CE behaviors [18]. Despite this suggested prevalence, to date, identification of CE outside of ED treatment settings and populations remains limited, with many cases of CE often going undetected [19]. As a result, individuals with CE may be less likely to access treatment or support and may be vulnerable to the physical and mental health sequelae of CE, underscoring the critical need to enhance screening and detection [11].

To date, screening for CE has been largely limited by the lack of verified cutoff scores for identifying cases, with inconsistent methods for classifying CE cases used across the research literature [17, 20]. A widely used and well-validated measure of CE behaviors is the Compulsive Exercise Test (CET; 4). The CET has been translated into multiple languages and validated in a variety of countries [e.g., 21–23]. Validation in ED [e.g., 21, 24], and sport and exercise populations [e.g., 25, 26] consistently show favorable psychometric properties. To date, the CET has been used as a continuous measure indicating greater or lesser symptomatology. Only one study has reported a possible cutoff score (of 15) [24]; although this study is not without limitations, including the use of a female-only sample and limitations to classification of CE cases. Further, this cutoff score was developed to identify CE among those with an existing ED diagnosis, where exercise behavior may be a feature of the ED, and differences in CE symptoms relative to the general population are observed (e.g., greater weight control-driven exercise, avoidance, and rule-driven behavior in those with EDs and greater exercise for mood improvement in controls) [27]. CE can also represent a distinct set of concerns and behaviors [8] occurring outside of other ED diagnoses [5, 6]. These individuals are often missed in CE detection, partly due to a lack of screening methods

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[19] and insufficient awareness of CE among healthcare providers [28]. Therefore, to facilitate screening, there remains a need for cutoff scores that can adequality detect CE in the community. Improving the ability to classify CE will also enhance future research, contributing to a better understanding of CE nosology and guiding treatment [8]. Therefore, the current study investigated a CET cutoff score. The aims were to (a) identify a suitable cutoff score for detecting CE among the general exercise population and (b) verify this cutoff score in a second community sample with elevated mental health symptomatology.

2. Materials and methods

2.1. Participants

2.1.1. Sample 1

Participants in the first sample were an Australian exercise group recruited via online forums and social media sites, including sporting clubs, exercise and health groups, and flyers posted at sporting grounds and gyms. Inclusion criteria required individuals to be aged 18 and above, with any level of exercise behavior. Of the 1,401 participants who agreed to participate in the study, 247 failed to complete at least 30% of the survey and were removed. There were no differences found between those who completed the study measures and those who did not in terms of demographics, such as age, gender, education, or living situation. The final sample (N = 1157) was 77.4% female with a mean age of 36.4 years (SD = 12.9; range 18–89).

2.1.2. Sample 2

The second community sample was recruited from social media sites of mental health foundations and ED- and mental health-related support groups to include individuals with elevated mental health symptoms. A total of 363 participants aged 18 and over completed the study. Initially, 442 participants started the survey, but 79 were removed due to non-completion, with no differences detected between completers and non-completers on any demographic variables. Participant ages ranged from 18 to 65 (M = 32.9, SD = 10.6), and the majority (71.9%) were female. There was a broad range of exercise activity levels. This second sample was recruited to verify cutoff scores in a clinical/ subclinical sample.

2.2. Procedures

Approval was received from the university's Human Research Ethics Committee (HE18-072 and HE19-085). For both studies, participants were directed to an anonymous online questionnaire hosted by Qualtrics (Provo, UT) via a link in the recruitment materials. After providing informed consent, participants proceeded to the survey, which took approximately 20–30 minutes to complete. In each study, measures were presented in random order to reduce order effects.

2.3. Measures

Demographic data, including age, gender, and self-reported height (cm) and weight (kg), were collected. Body mass index (BMI) was calculated by dividing self-reported weight by height in meters squared. The same demographic data and measures were collected across both studies.

2.3.1. Compulsive exercise

The CET [4] is a 24-item measure that assesses a range of aspects of CE, including continuance, weight- or shape-driven exercise, exercise rigidity, and affect regulation. Responses are provided on a six-point Likert scale (ranging from "never true" to "always true"). A total scale score (range 0–30) is also calculated by summing the means of the subscale scores, with higher scores representing greater levels of CE. While some studies have suggested a shortened 18-item version [25], evidence for retention of all items remains [8, 11], and the 24 item version was used in the analysis. The CET demonstrates good internal consistency and construct validity in both nonclinical and ED samples [4, 29]. Internal consistency in the present studies was good, α = 0.86 and α = 0.87, respectively.

2.3.2. Exercise

The Godin Leisure-Time Exercise Questionnaire (GLTEQ) provides an indication of usual exercise frequency and intensity [30]. A score of 24 or above indicates that the individual is an active exerciser [31].

2.3.3. Disordered eating symptomology

The Eating Attitudes Test-26 (EAT-26) is a 26-item measure of disordered eating symptoms, with higher scores indicating a greater degree of symptom severity. The EAT-26 has good reliability and predictive validity, with internal consistency found to be good at α = 0.87 and α = 0.93, respectively.

In Study 2 only, eating-related questions from the Primary Care Evaluation of Mental Disorders Patient Health Questionnaire (PRIME-MD PHQ) [32] were also used. Participants were asked to report "Yes" or "No" on whether they have used exercise in purging/weight regulation behavior. The Patient Health Questionnaire (PHQ) is an efficient and diagnostically valid self-report measure for the screening and diagnosis of common mental disorders, showing good agreement between PHQ results and independent mental health professional assessments (κ = 0.65) [32].

2.3.4. Psychological distress

The Depression, Anxiety, and Stress Scale-21 (DASS-21) is a well-validated 21-item measure of psychological distress, assessing depression, anxiety, and stress [33]. Subscales for each of depression, anxiety, and stress can be calculated, with clinical cutoffs established for each, which demonstrate good sensitivity and specificity for predicting diagnoses [33]. The DASS-21 has good psychometric properties [33], and internal consistency was high, with α = 0.94 and α = 0.96, respectively.

2.4. Data analysis

To ascertain cutoff scores, receiver operating characteristic (ROC) analyses were conducted using Statistical Package for the Social Sciences (SPSS) v28. ROC curves assessed the ability of the CET to distinguish between cases with and without CE. While diagnostic criteria for CE have been proposed [1], these lack consensus and have received critique [34]. Given the lack of a definitive and agreed-upon diagnosis or standardized diagnostic interview for CE, cases of probable CE were determined using self-report measures, and several possible ways of classifying CE were utilized. Exploring multiple classifications of CE was undertaken in order to identify the most appropriate CET cutoff score and develop a more robust cutoff score that is valid across

classifications, thus reducing reliance on any one method of categorizing CE.

For all analyses, the area under the curve (AUC) was used to ascertain the predictive ability of the CET for each classification of CE. An AUC of 1.0 indicates perfect prediction, while 0.5 indicates that predication is no better than chance [35]. AUC values were characterized as follows: AUC <0.50–0.7 (poor), 0.7–0.8 (moderate), 0.8–0.9 (excellent), and above 0.9 (outstanding) [36]. Appropriate cutoff scores were determined through examination of sensitivity (percentage of true positives) and specificity (percentage of true negatives). A sensitivity and specificity of >75% has been argued to be desirable for clinical and screening purposes [35]. The Youden Index (sensitivity + specificity—100), which maximizes sensitivity and specificity [37], is reported, as are the positive predictive value (PPV) and negative predictive value (NPV). The optimal cutoff scores for the CET were ascertained through assessment of sensitivity and specificity as close to or above 75%, as well as consideration of the Youden Index.

Power for conducting ROC analyses has been proposed as at least 10 participants with a diagnosis, 10 without a diagnosis, 10 false positives, and 10 false negatives [38]. Due to a lack of formal diagnosis for CE, a final determination of false positives and negatives for CE was not possible. However, given that there were over 10 cases for presence and absence of each potential diagnosis (see **Table 1**) and the large sample sizes, it was considered appropriate to conduct the ROC analyses.

Table 1 • Sample characteristics

	Sample 1 (*N* = 1,157)		Sample 2 (*N* = 363)	
	***M* (SD)/*N* (%)**	**Range**	***M* (SD)/*N* (%)**	**Range**
Age	36.4 (12.9)	18–89	32.9 (10.6)	18–65
Female[a]	895 (77.4)		287 (79.1)	
Body mass index	26.0 (5.49)	16.7–53.3	25.6 (5.94)	15.2–46.3
Psychological distress				
Total Depression, Anxiety, and Stress Scale-21	26.3 (21.1)	0–118	31.3 (27.0)	0–120
Depression[a]	369 (31.9)		151 (41.6)	
Anxiety[a]	377 (32.6)		138 (38.0)	
Eating disorder symptoms				
Eating Attitudes Test-26 (EAT-26) total score	9.57 (9.48)	0–57	13.5 (13.5)	0–75
Above cutoff on EAT-26[a]	155 (13.4)		97 (26.7)	
Probable AN[a]	2 (0.2)		11 (3)	
EAT-26 exercise item: always[a]	77 (6.9)		58 (16.0)	
Patient Health Questionnaire exercise item: yes[a]	-	-	39 (10.5)	
Exercise behavior				
Compulsive Exercise Test	11.9 (3.03)	2–22.5	12.4 (3.20)	3–22
Godin Leisure-Time Exercise Questionnaire	38.6 (26.4)	0–146	41.4 (27.4)	0–182

[a]*N* (%).

AN: Anorexia Nervosa

2.4.1. Classification of compulsive exercise

In order to provide a robust determination of optimal cutoff scores, CE was classified in three ways based on the literature. Firstly, CE is understood as high levels of exercise accompanied by impairment and psychological burden [1]; thus, high exercise levels and the presence of psychological distress were used as indicators of CE. Those who scored above the cutoff for being an active exerciser on the GLTEQ (>24; 32) and had scores above the clinical cutoff for depression and/or anxiety (as assessed by the DASS-21) were defined as CE cases. Secondly, in line with and building on prior CET cutoff score research [24], exercise-based items from ED measures were also used to classify cases. Thus, CE cases were also classified based on item 12 of the EAT-26, where participants rate the frequency of how often they "Think about burning up calories when I exercise". Those who reported "Always" were classified as cases of CE, while all other responses were classified as non-cases. Additionally, CE was assessed using an exercise-for-weight-control item on the PHQ. All participants who responded "Yes" to this item were defined as cases (Study 2 only). This range of modes for classifying CE were used to assess possible cutoffs in three ways, with the aim of observing where cutoff scores may coalesce.

3. Results

Both samples reflected varied exercise levels and mental health symptomatology. As anticipated, the sample from Study 2 reported higher rates of psychological distress (see **Table 1**). CET scores ranged from 2 to 22.5 and 3 to 22, respectively. There were no significant differences between males and females on the CET.

3.1. Sample 1: Compulsive Exercise Test cutoff scores

3.1.1. Compulsive exercise defined as high exercise and presence of distress

The CET showed a modest to acceptable AUC of 0.642 (**Figure 1**), suggesting a moderate ability to detect CE. A cutoff

score of 12 maximized both sensitivity and specificity and had the highest Youden Index, although both specificity and sensitivity remained below the desired 75% threshold for use in screening (**Table 2**). NPV was high, and the PPV remained moderate.

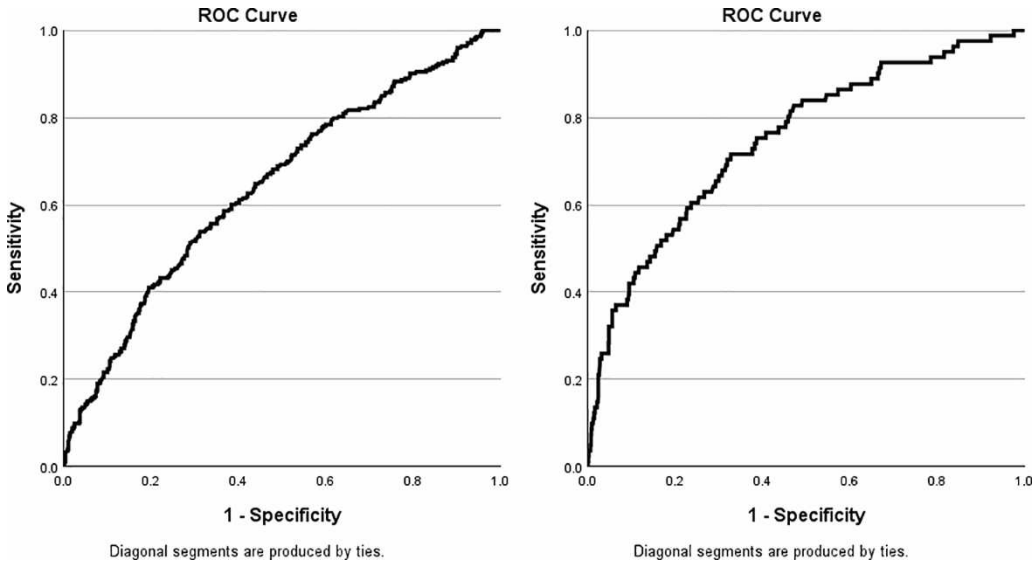

Figure 1 • Area Under the Curves from Study 1: high exercise and distress, Eating Attitudes Test-26 exercise item.

Table 2 • Cutoff scores identified from Sample 1

Score	Sensitivity	Specificity	Youden Index	Negative Predictive Value	Positive Predictive Value
High exercise with distress					
11.5	66.3%	53.5%	19.8	79.5	51.2
12	**60.1%**	**61.2%**	**21.3**	**76.2**	**42.6**
12.5	54.6%	66.5%	21.1	75.3	43.8
13	47.3%	73%	20.3	74.4	45.6
13.5	41.8%	79.1%	20.9	73.9	48.3
14	34.8%	83.3%	18.1	72.8	50.3
14.5	25.6%	88.1%	13.7	68.1	63.1
15	20.9%	90.9%	11.8	66.7	62.0
Eating Attitudes Test-26 exercise item					
11.5	84%	47.5%	31.5	97.5	10.9
12	77.8%	55%	32.8	97	11.6
12.5	75.3%	60.7%	36.0	97	12.7
13	**70.4%**	**68.1%**	**38.5**	**96.9**	**14.2**
13.5	63%	72.9%	35.9	96.3	15.1
14	56.8%	78.3%	35.1	96.0	16.7
14.5	50.6%	83.7%	34.3	95.7	19.2
15	44.4%	88.4%	32.8	95.5	23.0

Suggested optimal cutoff scores are highlighted in bold font.

3.1.2. Compulsive exercise defined by exercise engagement on Eating Attitudes Test-26

The CET showed an acceptable AUC of 0.750, suggesting moderate diagnostic prediction (**Figure 1**). A cutoff of 13 maximized both sensitivity and specificity, with both tending toward 75%, and yielded the highest Youden Index (**Table 2**). Across all possible cutoff scores, NPV was high; however, PPV remained poor, suggesting a higher rate of false positives and less discrimination between CE and disordered eating.

3.2. Sample 2: Compulsive Exercise Test cutoff scores

3.2.1. Compulsive exercise defined as high exercise and presence of distress

The CET had an acceptable to high AUC of 0.708 (see **Figure 2**). Cutoffs of 12.5 and 13 had the highest Youden Index scores (**Table 3**). A cutoff of 13 improved sensitivity and was thus deemed preferable.

3.2.2. Compulsive exercise defined as exercise engagement on Eating Attitudes Test-26

The CET showed a very high AUC of 0.848, indicating excellent diagnostic prediction (**Figure 2**). A cutoff of 13.5 maximized both sensitivity and specificity, yielding the highest Youden Index and meeting the 75% threshold for both sensitivity and specificity (see **Table 3**). Across all scores, NPV remained high.

3.2.3. Compulsive exercise defined as exercise behavior on the Patient Health Questionnaire

The CET showed a very high AUC of 0.801 (**Figure 2**), again indicting very good diagnostic prediction. A cutoff of 13.5 maximized both sensitivity and specificity, resulting in a high Youden Index (**Table 3**). The Youden Index for a cutoff of 12.5 was slightly higher; however, this score resulted in reduced specificity of 60.4% and a poorer PPV. A cutoff of 13.5 yielded closer to 75% threshold for specificity and sensitivity, with only a slightly lower NPV and Youden Index, and was thus deemed preferable.

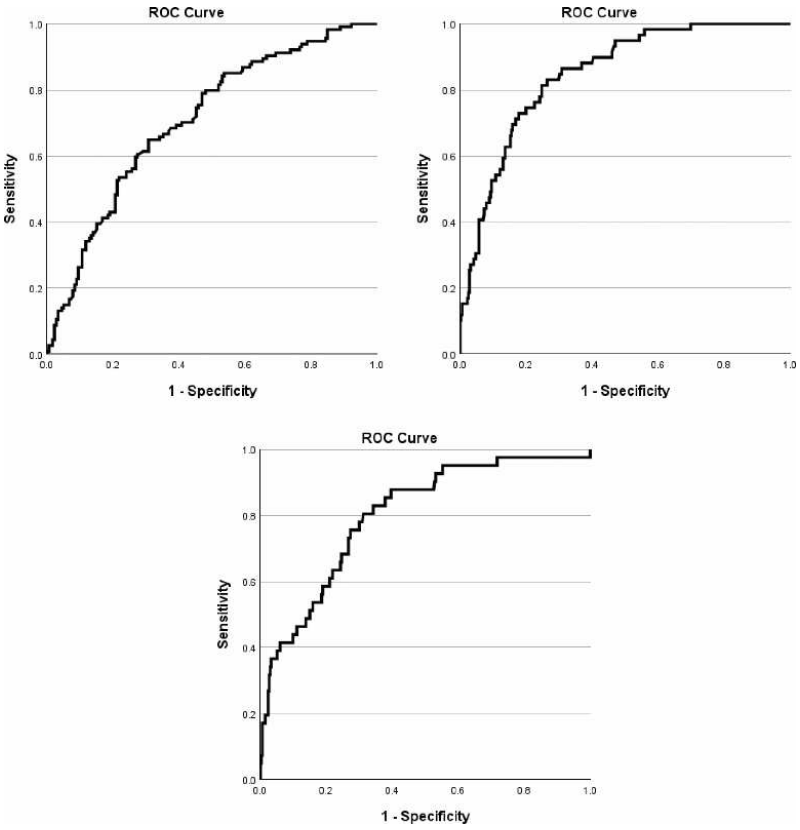

Figure 2 • Area Under the Curves from Study 2: high exercise and distress, Eating Attitudes Test-26 exercise item, Patient Health Questionnaire exercise item.

Table 3 • Cutoff scores identified from Sample 2

Score	Sensitivity	Specificity	Youden Index	Negative Predictive Value	Positive Predictive Value
High exercise with distress					
11.5	77.2%	53.1%	30.3	79.5	51.2
12	69.3%	59.8%	29.1	75.5	52.3
12.5	66.7%	64.2%	30.9	75.3	53.8
13	**61.4%**	**70.9%**	**32.3**	**75.2**	**57.0**
13.5	53.5%	78.2%	31.7	72.4	60.4
14	41.2%	83.2%	24.4	68.8	60.3
14.5	35.1%	86.6%	21.7	68.1	63.1
15	27.2%	89.4%	16.6	66.7	62.0
Eating Attitudes Test-26 exercise item					
11.5	94.9%	49.5%	44.4	98.0	25.7
12	89.8%	56.8%	46.6	96.7	28.0

12.5	88.1%	61%	49.1	96.4	29.4
13	86.4%	67%	53.4	96.3	32.1
13.5	**79.7%**	**75.2%**	**54.9**	**95.5**	**37.5**
14	72.9%	81%	53.9	94.1	41.0
14.5	66.4%	84.8%	51.2	93.3	44.8
15	54.2%	87.9%	42.1	91.4	45.7
Patient Health Questionnaire exercise item					
11.5	92.7%	46.8%	39.5	98.0	17.4
12	87.8%	55%	42.8	97.3	19.0
12.5	87.8%	60.4%	48.2	97.5	20.3
13	82.9%	64.3%	47.2	96.7	21.4
13.5	**75.6%**	**71.8%**	**47.4**	**95.9**	**24.2**
14	63.4%	76.9%	40.3	94.4	24.8
14.5	56.1%	81.1%	37.2	94.0	27.6
15	48.8%	85%	33.8	93.4	28.6

Suggested optimal cutoff scores are highlighted in bold font.

4. Discussion

A number of possible markers of CE were used to identify a cutoff score, and across all markers, optimal cutoff scores consistently coalesced. Based on considerations of predictive ability, Youden Indices and sensitivity and specificity, we propose that a cutoff score of 13.5 is feasible across general exercise and mental health populations. A cutoff of 15, as previously proposed for an ED population [24], limited sensitivity and might be too conservative for detecting CE in non-ED and exercise populations. Lower cutoff scores increased sensitivity at the expense of specificity, with greater specificity tending to be preferable when screening for follow-up or intervention [see 39]. Thus, we suggest that the CET can be feasibly used with a cutoff score of 13.5, which best balances sensitivity and specificity, for detecting individuals with CE behaviors who may warrant support and/or intervention.

Overall, the CET was found to have a low false negative rate but a higher false positive rate, suggesting somewhat poor ability to discriminate between CE and assessed outcomes, which may reflect the use of proxies for CE rather than a definitive assessment of CE. However, the AUC indicated that the CET had moderate to excellent predictive ability for identifying CE, and results suggest that the CET is able to distinguish between exercise behavior and CE. While the CET has often been used to assess CE behaviors within ED populations [40], the present results suggest that the CET can also be used to discriminate CE in nonclinical and exercise population samples. Results thus provide some support for the feasibility of the CET as a screening tool for CE across more diverse populations, including in exercise, sport, and mental health settings, where CE often goes undetected [19]. Given that CE can represent a distinct disorder [8] outside of other ED diagnoses, which is associated with psychological burden [11] and may be part of the development of further EDs [4], the ability to screen for CE and facilitate early intervention may be crucial for supporting individuals across a range of settings.

CE research has remained limited by assessment issues [17]. As the field moves toward a singular understanding of CE [41], there is also a need for consistent measurement to allow for comparison of research findings; however, heterogeneity in assessment of CE remains [20]. Having a viable cutoff score on the CET may aid in overcoming limitations in the existing research. In particular, it may support prevalence studies where findings vary widely, partly due to the varied assessments [17], as well as assist in under-researched aspects of CE, such as sociocultural factors [42]. CE in males is also less understood, with mixed findings and limited validation of measurement tools for this group [20]. Thus, the assessment of cutoff scores for CE within the mixed-gender samples performed here may also inform research into males and CE. Improved classification of cases of CE will also support research on nosology and treatment [8]. Furthermore, better classification of CE will aid in intervention research. While mixed results are reported for treatments for CE behaviors within ED samples [43–46], further research is needed to guide CE treatment [17, 47], especially outside of ED populations.

4.1. Limitations

The study is presented with several weaknesses. The definition and assessment of CE still lack consensus, due to limited research and methodological variation [17]. Proposed diagnostic criteria are recent [1] and not universally agreed upon, as there are suggestions that they do not cover the full diversity of CE or that CE might better align with obsessive–compulsive disorder (OCD) symptoms [34]—albeit with evidence consistently showing less alignment with OCD [e.g., 8]. Consequently, a formal standardized diagnostic assessment of CE remains to be verified. This limits the ability to examine the predictive ability of the CET and optimal cutoff score against a definitive CE diagnosis (and to adequately assess power). However, while assessment against a diagnostic interview is preferable, the use of self-reported measures for classifying disorders in order to ascertain cutoff scores has been widely used throughout the literature [48–50], even when diagnostic interviews are available. While there is no easy way to classify individuals as having CE, the ability to further understand CE and progress diagnostic criteria will remain limited. Thus, developing cutoff scores against self-report measures in this instance helps to progress the field by providing

an approach to consistently classify those with and without CE, which is crucially needed [17, 20]. Such consistent classification of individuals with CE can support research necessary for progressing CE toward recognition as a disorder in diagnostic taxonomies, with validated diagnostic criteria. In the future, should CE be included in international diagnostic taxonomies and a "gold standard" standardized clinical interview for CE be developed, further validation of the cutoff scores would be valuable.

Each possible marker of CE is also not without limitations. For example, the self-report measures, such as the GLTEQ, can be subject to bias, and we lack verification of actual exercise behaviors. However, the present study builds on prior research, which used one item to identify cutoff scores in a sample of females with EDs, by providing multiple assessments of CET cutoffs across various CE markers in two samples. The consistency of results across these markers and samples can increase confidence in the conclusions, given that results consistently coalesced around similar cutoff points, and that each marker of CE overcame some of the limitations of the other markers. The samples were both overrepresented by females; however, the findings did expand on prior cutoff research that focused solely on females [24]. Evidence suggests that there are only small gender differences in problematic exercise behavior [51], and sensitivity analyses showed no gender differences; thus, the full samples were retained for analysis. Additionally, the CET, as a unidimensional construct, has faced some critique [25]. Thus, scores above the threshold might not capture individuals whose exercise behavior remains pathological in only one or certain domains of CE. Future consideration of cutoff scores for the CET subscales may be beneficial in reflecting the multidimensional nature of CE [52].

5. Conclusions

Based on the analysis of the CET for predicting a range of possible markers of CE, we suggest that the previously proposed cutoff score of 15 limits sensitivity for general exercise and non-ED populations. We propose that a cutoff of 13.5 is more feasible for maximizing both sensitivity and specificity. The presence of a tested cutoff score, validated across two studies, will support the ability to screen for and detect CE in the community, providing a viable cut point for classifying CE. Adopting screening with the identified cutoff score across various settings may improve the detection of those at risk and improve access to support. Furthermore, utilizing this cutoff in future research may also contribute to a deeper understanding of CE.

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Author contributions

Conceptualization, S.M.C.; methodology, S.M.C. and D.G.M.; formal analysis, S.M.C. and P.J.T.; data curation, P.J.T.; writing—original draft preparation, S.M.C.; writing—review and editing, D.G.M. and P.J.T.; project administration, S.M.C. All authors have read and agreed to the published version of the manuscript.

Conflict of interest

The authors declare no conflict of interest.

Data availability statement

Data supporting these findings are available within the article, at https://doi.org/10.20935/MHealthWellB7364, or upon request.

Institutional review board statement

The study was conducted in accordance with the Declaration of Helsinki and was approved by the Institutional Review Board (or Ethics Committee) of the University of New England (HE18-072, approved on 16 April 2018, and HE19-085, approved on 13 May 2019).

Informed consent statement

Informed consent was obtained from all participants involved in the study.

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References

1. Dittmer N, Jacobi C, Voderholzer U. Compulsive exercise in eating disorders: proposal for a definition and a clinical assessment. J Eat Disord. 2018;6(1):42. doi: 10.1186/s40337-018-0219-x
2. Scharmer C, Gorrell S, Schaumberg K, Anderson D. Compulsive exercise or exercise dependence? Clarifying conceptualizations of exercise in the context of eating disorder pathology. Psychol

Sport Exerc. 2020;46:101586. doi: 10.1016/j.psychsport.2019.101586

3. Davis C, Blackmore E, Katzman DK, Fox J. Female adolescents with anorexia nervosa and their parents: a case-control study of exercise attitudes and behaviours. Psychol Med. 2005;35(3):377–86. doi: 10.1017/s0033291704003447
4. Taranis L, Touyz S, Meyer C. Disordered eating and exercise: development and preliminary validation of the compulsive exercise test (CET). Eur Eat Disord Rev. 2011;19(3):256–68. doi: 10.1002/erv.1108
5. Goodwin H, Haycraft E, Meyer C. The relationship between compulsive exercise and emotion regulation in adolescents. Br J Health Psychol. 2012;17(4):699–710. doi: 10.1111/j.2044-8287.2012.02066.x
6. Turton R, Goodwin H, Meyer C. Athletic identity, compulsive exercise and eating psychopathology in long-distance runners. Eat Behav. 2017;26:129–32. doi: 10.1016/j.eatbeh.2017.03.001
7. Gjestvang C, Bratland-Sanda S, Mathisen TF. Compulsive exercise and mental health challenges in fitness instructors; presence and interactions. J Eat Disord. 2021;9(1):107. doi: 10.1186/s40337-021-00446-0
8. Cosh SM, Eshkevari E, McNeil DG, Tully PJ. Classifying excessive exercise: examining the relationship between compulsive exercise with obsessive-compulsive disorder symptoms and disordered eating symptoms. Eur Eat Disord Rev. 2023;31(6):769–80. doi: 10.1002/erv.3002
9. Lavie CJ, O'Keefe JH, Sallis RE. Exercise and the heart--the harm of too little and too much. Curr Sports Med Rep. 2015;14(2):104–9. doi: 10.1249/jsr.0000000000000134
10. Karr TM, Bauer KW, Graham DJ, Larson NI, Neumark Sztainer DR. Exercise identity: healthy and unhealthy outcomes in a population-based study of young adults. J Sport Behav. 2014;37(2).
11. Cosh SM, McNeil DG, Tully PJ. Compulsive exercise and its relationship with mental health and psychosocial wellbeing in recreational exercisers and athletes. J Sci Med Sport. 2023;26(7):338–44. doi: 10.1016/j.jsams.2023.05.006
12. Back J, Josefsson T, Ivarsson A, Gustafsson H. Psychological risk factors for exercise dependence. Int J Sport Exerc Psychol. 2021;19(4):461–72. doi: 10.1080/1612197X.2019.1674902
13. Edlund K, Johansson F, Lindroth R, Bergman L, Sundberg T, Skillgate E. Body image and compulsive exercise: are there associations with depression among university students? Eat Weight Disord. 2022;27(7):2397–405. doi: 10.1007/s40519-022-01374-x
14. Ganson KT, Lavender JM, Rodgers RF, Cunningham M, Nagata JM. Compulsive exercise and vaping among a sample of U.S. College students aged 18–26 years. Eat Weight Disord. 2022;27(3):1153–61. doi: 10.1007/s40519-021-01251-z
15. Pike C, Taylor A, Cosh S. Compulsive exercise, exercise identity, and coping styles. Z Sportpsychol. 2022;29(4):129–40. doi: 10.1026/1612-5010/a000361
16. Cuesta-Zamora C, González-Martí I, García-López LM, Ros L, Plateau CR, Ricarte JJ. Emotion dysregulation as a mediator of the relationship between anxiety, compulsive exercise and eating disorder symptoms in adolescents. Children. 2021;8(12):1088. doi: 10.3390/children8121088
17. Lichtenstein MB, Hinze CJ, Emborg B, Thomsen F, Hemmingsen SD. Compulsive exercise: links, risks and challenges faced. Psychol Res Behav Manag. 2017;10:85–95. doi: 10.2147/PRBM.S113093
18. Ganson KT, Mitchison D, Rodgers RF, Cunningham ML, Murray SB, Nagata JM. Compulsive exercise among college students: 5-year time trends in prevalence and demographic, substance use, and mental health correlates. Eat Weight Disord. 2022;27(2):717–28. doi: 10.1007/s40519-021-01210-8
19. Narducci DM. Black box warning: when exercise is not medicine. Br J Sports Med. 2023;57(3):134. doi: 10.1136/bjsports-2022-106291
20. Hallward L, Di Marino A, Duncan LR. A systematic review of treatment approaches for compulsive exercise among individuals with eating disorders. Eat Disord. 2022;30(4):411–36. doi: 10.1080/10640266.2021.1895509
21. Schlegl S, Vierl L, Kolar DR, Dittmer N, Voderholzer U. Psychometric properties of the compulsive exercise test in a large sample of female adolescent and adult inpatients with anorexia nervosa and bulimia nervosa. Int J Eat Disord. 2022;55(4):494–504. doi: 10.1002/eat.23694
22. Campos PF, Frazier LD, Almeida M, de Carvalho PHB. Validation and measurement invariance of the compulsive exercise test among Brazilian and American young adults. Eat Weight Disord. 2024;29(1):2. doi: 10.1007/s40519-023-01627-3
23. Vrabel K, Bratland-Sanda S. Exercise obsession and compulsion in adults with longstanding eating disorders: validation of the Norwegian version of the compulsive exercise test. Front Psychol. 2019;10:2370. doi: 10.3389/fpsyg.2019.02370
24. Meyer C, Plateau CR, Taranis L, Brewin N, Wales J, Arcelus J. The compulsive exercise test: confirmatory factor analysis and links with eating psychopathology among women with clinical eating disorders. J Eat Disord. 2016;4:22. doi: 10.1186/s40337-016-0113-3
25. Limburg K, Bodill K, Watson HJ, Kane RT, Hagger MS, Egan SJ. Validity of the compulsive exercise test in regular exercisers. Eat Disord. 2021;29(5):447–62. doi: 10.1080/10640266.2019.1677130
26. Plateau CR, Shanmugam V, Duckham RL, Goodwin H, Jowett S, Brooke-Wavell KSF, et al. Use of the compulsive exercise test with athletes: norms and links with eating psychopathology. J Appl Sport Psychol. 2014;26(3):287–301. doi: 10.1080/10413200.2013.867911
27. Sauchelli S, Arcelus J, Granero R, Jiménez-Murcia S, Agüera Z, Del Pino-Gutiérrez A, et al. Dimensions of compulsive exercise across eating disorder diagnostic subtypes and the validation of the Spanish version of the compulsive exercise test. Front Psychol. 2016;7:1852. doi: 10.3389/fpsyg.2016.01852

28. Hallward L, Duncan LR. "Compulsive exercise is a socially acceptable prison cell": exploring experiences with compulsive exercise across social media. Int J Eat Disord. 2021;54(9):1663–71. doi: 10.1002/eat.23577

29. Mathisen TF, Bratland-Sanda S, Rosenvinge JH, Friborg O, Pettersen G, Vrabel KA, et al. Treatment effects on compulsive exercise and physical activity in eating disorders. J Eat Disord. 2018;6:43. doi: 10.1186/s40337-018-0215-1

30. Godin G, Shephard RJ. Godin leisure-time exercise questionnaire. Med Sci Sports Exerc. 1997;26(Suppl 6):S36–S8.

31. Godin G. The Godin-Shephard leisure-time physical activity questionnaire. Health Fit J Canada. 2011;4(1):18–22. doi: 10.14288/hfjc.v4i1.82

32. Spitzer RL, Kroenke K, Williams JB. Validation and utility of a self-report version of PRIME-MD: the PHQ primary care study. Primary care evaluation of mental disorders. Patient health questionnaire. JAMA. 1999;282(18):1737–44. doi: 10.1001/jama.282.18.1737

33. Lovibond PF, Lovibond SH. The structure of negative emotional states: comparison of the depression anxiety stress scales (DASS) with the beck depression and anxiety inventories. Behav Res Ther. 1995;33(3):335–43. doi: 10.1016/0005-7967(94)00075-u

34. Bratland-Sanda S, Mathisen TF, Sundgot-Borgen J, Rosenvinge JH. Defining compulsive exercise in eating disorders: acknowledging the exercise paradox and exercise obsessions. J Eat Disord. 2019;7:8. doi: 10.1186/s40337-019-0238-2

35. Hanley JA, Mcneil BJ. The meaning and use of the area under a receiver operating characteristic (ROC) curve. Radiology. 1982;143:29–36. doi: 10.1148/radiology.143.1.7063747

36. Hosmer DW, Lemeshow S. Applied logistic regression. New York: John Wiley and Sons; 2000.

37. Berrar D. Performance measures for binary classification. Encycl Bioinform Comput Biol. 2019;1:546–60. doi: 10.1016/B978-0-12-809633-8.20351-8

38. Kraemer HC. Evaluating medical tests: objective and quantitative guidelines. Newbury Park, CA: Sage; 1992.

39. Trevethan R. Sensitivity, specificity, and predictive values: foundations, pliabilities, and pitfalls in research and practice. Front Public Health. 2017;5:307. doi: 10.3389/fpubh.2017.00307

40. Plateau CR, Arcelus J, Meyer C. Detecting eating psychopathology in female athletes by asking about exercise: use of the compulsive exercise test. Eur Eat Disord Rev. 2017;25(6):618–24. doi: 10.1002/erv.2561

41. Noetel M, Dawson L, Hay P, Touyz S. The assessment and treatment of unhealthy exercise in adolescents with anorexia nervosa: a Delphi study to synthesize clinical knowledge. Int J Eat Disord. 2017;50(4):378–88. doi: 10.1002/eat.22657

42. Reynolds KA, Plateau CR, Haycraft E. Sociocultural influences on compulsive exercise in young people: a systematic review. Adolesc Res Rev. 2023;8(2):179–94. doi: 10.1007/s40894-022-00180-x

43. Donelli V, Artoni P, Artoni G, Minneci D, Scita F, editors. The compulsive exercise activity therapy (LEAP) in anorexic inpatient patients: a preliminary case-control efficacy study. Atti del Congresso. SISDCA; 2019.

44. Monell E, Meyer C, Szwajda A, Forsén Mantilla E. Taking the LEAP: study protocol for a randomized, multicentre, naturalistic, efficacy trial of the compulsive exercise activity therapy (LEAP) - a cognitive behavioral program specifically targeting compulsive exercise in patients with eating disorders. BMC Psychiatry. 2021;21(1):369. doi: 10.1186/s12888-021-03356-2

45. Dittmer N, Voderholzer U, Mönch C, Cuntz U, Jacobi C, Schlegl S. Efficacy of a specialized group intervention for compulsive exercise in inpatients with Anorexia Nervosa: a randomized controlled trial. Psychother Psychosom. 2020;89(3):161–73. doi: 10.1159/000504583

46. Mang L, Garghan A, Grant J, Lacey H, Matthews R. An evaluation of efficacy and acceptability of a novel manualised junior LEAP group programme for compulsive exercise, for children and adolescents with anorexia nervosa, within an inpatient setting. Eat Weight Disord. 2021;26(2):591–7. doi: 10.1007/s40519-020-00884-w

47. Martenstyn JA, Aouad P, Touyz S, Maguire S. Treatment of compulsive exercise in eating disorders and muscle dysmorphia: a systematic review and meta-analysis. Clin Psychol Sci Pract. 2022;29(2):143–61. doi: 10.1186/s40337-021-00375-y

48. Evans L, Haeberlein K, Chang A, Handal P. Convergent validity and preliminary cut-off scores for the anxiety and depression subscales of the DASS-21 in US adolescents. Child Psychiatry Hum Dev. 2021;52(4):579–85. doi: 10.1007/s10578-020-01050-0

49. Yu Y, Liu Z-W, Zhou W, Zhao M, Qiu D, Li Y-L, et al. Cutoff of the Zarit Burden interview in predicting depression and anxiety. Qual Life Res. 2019;28(9):2525–33. doi: 10.1007/s11136-019-02208-7

50. Snijkers JTW, van den Oever W, Weerts ZZRM, Vork L, Mujagic Z, Leue C, et al. Examining the optimal cutoff values of HADS, PHQ-9 and GAD-7 as screening instruments for depression and anxiety in irritable bowel syndrome. Neurogastroenterol Motil. 2021;33(12):e14161. doi: 10.1111/nmo.14161

51. Alcaraz-Ibáñez M, Paterna A, Griffiths MD, Demetrovics Z, Sicilia Á. Gender-related differences in self-reported exercise symptoms: a systematic review and meta-analysis. Psychol Sport Exerc. 2022;63:102280. doi: 10.1016/j.psychsport.2022.102280

52. Meyer C, Taranis L, Goodwin H, Haycraft E. Compulsive exercise and eating disorders. Eur Eat Disord Rev. 2011;19(3):174–89. doi: 10.1002/erv.1122