**Assessment of maladaptive exercise history among individuals with eating disorders – Validation of a brief, self-report measure**

**Abstract**

**Introduction**

Within the context of an eating disorder, exercise has high potential to become a maladaptive behavior with compulsive qualities, which can interfere with both quality of life and eating disorder recovery 1–4. Existing research suggests that, among those with EDs, rates of maladaptive exercise are highest amongst individuals with anorexia nervosa (RATES AND CITES) followed by bulimia nervosa and other specified feeding and eating disorder(RATES AND CITES). While less research has investigated prevalence of maladaptive exercise among those with binge eating disorder, findings suggest that maladaptive exercise is also present in this population, though it occurs at lower rates.5,6 Further, maladaptive exercise may play a role in ED onset and exacerbation in some cases – for instance, among epidemiological samples, maladaptive exercise is prospectively associated with eating disorder symptoms, and eating disorder cognitions in middle adolescence are associated with greater odds of engaging in maladaptive exercise across adolescence and young adulthood.7,8

**Defining and Understanding Maladaptive Exercise in EDs**

Defining maladaptive exercise has led to substantial debate and myriad terminology, including: compulsive exercise, obligatory exercise, compensatory exercise, exercise addiction, excessive exercise, and driven exercise-- both theoretical definitions and measurement components of these terms overlap substantially (see **Table 1**). The term ‘maladaptive exercise’ is an umbrella term referring to exercise which fits any of these definitions.

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| **Table 1** | | | | |
| ***Construct*** | **Cognitive Features** | **Affective Features** | **Behavioral Features** | **Example Assessment Items** |
| *Compensatory Exercise* |  | Reduces feelings of guilt about overeating | \*Occurs after over-eating or binge eating | “Did you exercise to control your weight, alter your shape or amount of fat, or burn off calories in direct response to a loss of control episode?”  “Have you ever used [exercise] to compensate for episodes of binge eating or over eating?” |
| *Compulsive Exercise* | Weight/Shape AND/OR affect regulation motivation | Mood improvement  Guilt if missed.  Lack of Enjoyment  Avoidance of negative affect | Exercise Rigidity  Rule-Driven Behavior (Habit) | “I follow a set routine for my exercise sessions”  “I exercise to escape/avoid/stop bad feelings” |
| *Excessive Exercise* | Weight/Shape Motivation |  | \*Daily or almost daily; 1 hour or more | “Have you exercised as a means of controlling your weight, altering your shape or amount of fat, or burning off calories?”  “I felt that I needed to exercise nearly every day” |
| *Driven Exercise* | Weight/Shape AND/OR affect regulation motivation | Feeling ‘compelled’ or ‘driven’ to complete exercise | Interferes with life activities | “Have you exercised even when it might interfere with other commitments or do you harm?”  “Have you ever felt compelled to exercise –like you had to do it—to control your body shape or weight?” |
| *Exercise Addiction* | Weight/Shape AND/OR affect regulation motivation | Needing to exercise more to produce a similar effect over time | Exercising more than intended  Inability to reduce  Interferes with life activities | "I am unable to reduce how long I exercise” |
| *Obligatory Exercise* |  |  | Exercise Rigidity  Rule-Driven Behavior (Habit) | “I sometimes feel like I don’t want to exercise, but I go ahead and push myself anyway” |

To date, the few studies that have examined multiple definitions simultaneously find overlap in endorsement of compulsive and addictive exercise, with compensatory exercise, which refers to exercise that occurs specifically to counteract the effects of overeating or binge eating, showing some distinction from other maladaptive exercise definitions9,10. While initial accounts of maladaptive exercise in EDs included frequency and duration of exercise, defining ‘excessive’ exercise as exercise behavior that occurs daily or almost daily for a minimum duration (e.g. 1 hour or more), studies find that even individuals exercising at more moderate levels may report maladaptive components to exercise11,12, and that other individuals may exercise at high levels without negative consequences13,14. As such, more recent definitions of maladaptive exercise in EDs have reduced focus on frequency and duration of exercise15. Defining features that are common across multiple maladaptive exercise constructs include a problematic *psychological relationship* with exercise (e.g., exercise feels driven or compulsive; feelings of guilt when missing exercise; overreliance on exercise to manage affect and/or concerns about shape and weight) along with *life interfering symptoms* (e.g., inability to reduce exercise; exercising despite illness or injury; exercise routines interfering with work, school, or social functioning). While some defining features are shared across maladaptive exercise constructs, there remains a lack of consensus on the most vital components to assess for when defining maladaptive exercise among populations with EDs – a dilemma that becomes more pronounced when balancing brevity and depth of assessment.

**Assessing History of Maladaptive Exercise**

In addition to lack of consensus regarding the most vital components of maladaptive exercise to assess, most available assessment tools which attempt to capture maladaptive exercise – and all of the available self-report tools – focus only on *current* maladaptive exercise. As such, most studies examining maladaptive exercise in patient samples using self-report methodology evaluate exercise behavior at time of enrollment/intake, but do not consider whether maladaptive was present at previous points during an ED. Currently, there are no validated self-report measures that capture history of maladaptive exercise. Regarding interview-based measures, the Eating Disorder Examination (EDE) does capture history of maladaptive exercise, though this is currently assessed via a single item which may not capture different facets (e.g. compulsive vs. compensatory functions, addictive qualities) of maladaptive exercise which could differentially relate to ED course and outcome.

**Correlates of Maladaptive Exercise**

Of note, maladaptive exercise is present among only a subset of individuals with EDs, and further research is necessary to better identify those at highest risk for this ED feature. At a phenotypic level, both compulsive and perfectionistic traits/symptoms associate with maladaptive exercise across EDs1,216–18. Genetic findings further the narrative that risk for obsessive-compulsive disorder may be specifically related to maladaptive exercise19. For instance, genetic links between anorexia nervosa and *both* obsessive compulsive disorder and physical activity suggest that some shared genetic liability among these traits may influence the degree to which exercise behavior is experienced as reinforcing. Phenotypically, compulsive and perfectionistic traits may moderate the degree to which individuals are at risk for maladaptive exercise, with those with the highest levels of compulsivity and perfectionism also displaying the highest risk for maladaptive exercise. As such, when evaluating convergent validity of a brief measure of maladaptive exercise history, we expect that, consistent with prior research, endorsement of maladaptive exercise would associate with more general perfectionistic and compulsive traits.

**Current study**

The current study aims to validate a 12-item self-report measure which assesses lifetime history of maladaptive exercise – via multiple conceptualizations – in a large, transdiagnostic ED sample. Aims and Hypotheses include:

**Preliminary:** Develop a scoring algorithm for a brief assessment of maladaptive exercise based on theoretical literature and available ED100k items, which captures history of Maladaptive exercise (broad), Compulsive Exercise (Ever, Regular), Exercise Addiction, Excessive Exercise, and Compensatory Exercise; along with current compulsive exercise.

**Aim 1.** Evaluate patterns of response across multiple exercise constructs, to identify the degree to which these constructs overlap in membership or capture distinct groups**.** **H1**. Those indicating that they have ‘exercise excessively’ more often in the initial screening item will also be likely to meet criteria for compulsive exercise, exercise addiction, and excessive exercise (high sensitivity), and moderately likely to meet criteria for compensatory exercise (moderate sensitivity; high negative predictive value)

**Aim 2.** Demonstrate Prevalence of Maladaptive (Broad), Compulsive, Addictive, Excessive, and Compensatory Exercise across Diagnostic Groups. **H2a.** Maladaptive exercise, compulsive exercise, and exercise addiction will be a common symptom across diagnoses. More common in AN and BN than BED. H2b. Compensatory exercise will be more common among those with AN mixed and BN as compared to AN only .

**Aim 3.** Evaluate Convergent and Discriminant Validity between history of *maladaptive* and c*ompulsive* exercise and: current compulsive exercise, perfectionism, and OCD symptoms. **H3a**: Individuals who do not report *any* *history* of maladaptive and compulsive exercise will not report current compulsive exercise (high negative predictive value).  **H3b**: Comparing those with and without history of compulsive exercise, those with history of compulsive exercise will report higher current compulsive exercise symptoms (all CET subscales) than those without. Those reporting current compulsive exercise will report the highest CET scores. **H3c**: Within diagnostic groups - those with vs. without history of maladaptive exercise will report higher Frost MPS and OCD symptoms**. H3d**: Associations with the MPS and OCD measure will be weaker than with the CET.

**Method**

**Participants**

The analysis sample comes from EDGI survey data collection in the USA. Replicating in NZ and Sweden.

**Procedure**

**Measures**

**Sociodemographic Data:** Age (at assessment), gender, race, and ethnicity were reported on the ED100k-v3.20 Include options and question wording

**Body mass index:** Current BMI was reported on the ED100k-v320

**Eating Disorder Examination-Questionnaire (EDE-Q v 6.0**)21,22 is a valid, reliable self-report questionnaire of cognitive and behavioral symptoms of eating disorders over the prior four weeks. The questionnaire has four subscales (Restraint, Eating Concern, Shape Concern, Weight Concern), a Global scale, and items that measure fasting (item 2), objective binge eating (item 15), self-induced vomiting (item 16), laxative use (item 17), and driven exercise (item 18), “Over the past 28 days, how many times have you exercised in a driven or compulsive way as a means of controlling your weight, shape, or amount of fat, or to burn off calories)”.

**ED100K-v3**. The ED100k is a self-report diagnostic questionnaire for eating disorders that is based on the Structured Clinical Interview for DSM-5 (SCID). The ED100K-v2 yields DSM-5 lifetime diagnoses of AN, BN, and BED. The ED100K has previously been validated against the SCID.20 For the purposes of the current study, diagnoses are coded as ‘AN only’, ‘AN-Mixed’, ‘BN only’, ‘BN-BED’ and ‘BED only’. Different questions capture different timeframes (i.e., lifetime, current). Exercise-related items are presented in **Supplemental Table 1.**

**Compulsive Exercise Test (CET**).17 The CET is a 24-item self-report measure designed to assess the core features of excessive exercise in the eating disorders; compulsivity (e.g. continuing to exercise despite illness or injury, lack of exercise enjoyment, the experience of extreme guilt when unable to exercise, making up for missed exercise sessions), affect regulation (e.g. the positive and negative reinforcement properties of exercise), weight and shape driven exercise (e.g. exercising solely to burn calories), and exercise rigidity (rigid adherence to a strict and repetitive exercise routine). Items were generated from a comprehensive appraisal of the eating disorder and excessive exercise literature, consultation with clinical eating disorder specialists, interviews with eating disorder patients, and a critical review of existing scales, and were included based on theoretical relevance and clinical specificity. The CET uses a 6-point Likert scale anchored by 0 (never true) and 5 (always true) with higher scores indicative of greater pathology. Validation of the scales shows good internal consistency, content validity, and concurrent validity. The CET also demonstrates strong positive associations with measures of eating pathology and known correlates of disordered eating. It is concluded that the CET could be a reliable and valid instrument for use in both clinical and research settings.

**Frost Multidimensional Perfectionism Scale (Frost MPS).** The Frost MPS contains 35 items, rated on a five-point scale, that make up six subscales. The MPS is one of the most commonly used measures of multidimensional perfectionism. There is evidence for two underlying factors of maladaptive and adaptive perfectionism.

**Maudsley Obsessive Compulsive Inventory (MOCI).** The MOCI (Hodgson & Rachman, [**1977**](https://onlinelibrary.wiley.com/doi/full/10.1002/erv.1072#erv1072-bib-0019)) is a 30-item self-report scale with a yes/no response format. It produces a total score in addition to four subscales: Checking, washing, doubting and slowness. It is a well-validated instrument, used in numerous studies of obsessionality in various populations (Alegret, Junque, Valldeoriola, Vendrell, Marti, & Tolosa, [**2001**](https://onlinelibrary.wiley.com/doi/full/10.1002/erv.1072#erv1072-bib-0002); Kano, Ohta, Nagai, Pauls, & Leckman, [**2004**](https://onlinelibrary.wiley.com/doi/full/10.1002/erv.1072#erv1072-bib-0022); Li & Chen, [**2007**](https://onlinelibrary.wiley.com/doi/full/10.1002/erv.1072#erv1072-bib-0024)), including those with EDs23.

**Results**

**Preliminary Aim**

The preliminary aim of the paper included development of a scoring algorithm for a brief assessment of maladaptive exercise based on theoretical literature and available ED100k items, which captures history of Maladaptive exercise (broad), Compulsive Exercise (Ever, Regular), Exercise Addiction, Excessive Exercise, and Compensatory Exercise; along with current compulsive exercise.

**Scoring**. The ED100k included 12 questions regarding maladaptive exercise. The first question which all participants were asked, inquires as to whether individuals ever exercised to intentionally control weight and shape (Q1). Only those who endorsed EVER Exercising to intentionally control weight or shape were asked to respond to two additional questions which asked about exercise in more detail, including two questions (Q2, Q3) about whether individuals ever felt compelled to exercise and whether they felt uneasy or distressed if unable to exercise. In a third step, those who reported ever exercising to intentionally control weight and shape and answered ‘Yes’ to either Q2 or Q3 were additionally asked three questions (Q4-Q6) about whether exercise interfered with life activities or diet, along with questions regarding the onset (Q7), duration (Q8), and frequency (Q9) of their compulsive exercise, along with whether they engaged in the behavior currently (Q10) and the last age at which they engaged in the behavior (Q11). In a separate section, all participants were asked whether they had ‘exercised excessively’ specifically to *compensate* for episodes of binge eating or overeating (Q12). During recoding, those (n = 945) who reported no to Q1 - exercise to control shape and weight, were marked as ‘0’ for follow-up questions. Those who reported that they had engaged in exercise to for weight and shape control but ‘No’ to both Q2 & Q3 (n = 200) were marked as ‘0’ for Q4-Q11.

Scoring algorithms for each subconstruct are presented in Table 2.

Table 2. Algorithm defining exercise-related constructs in the ED100k

| **Construct** | Criteria | Nested Within |
| --- | --- | --- |
| **Exercise for Weight Control** | * To control weight and shape – participant endorses that they have exercised excessively (e.g. felt compelled to exercise, felt uneasy or distressed if unable to exercise) = ‘a few times, but it never became a habit’ or more | NA |
| **Regular Exercise for Weight Control** | * To control weight and shape – participant endorses that they have exercised excessively  (e.g. felt compelled to exercise, felt uneasy or distressed if unable to exercise) = ‘more often’ | NA |
| **Compulsive Exercise** | * Exercise for Weight Control * Ever felt compelled to exercise == ‘YES’ OR Ever uneasy or distressed when unable to exercise == ‘YES’ | * Exercise for Weight Control |
| **Regular Compulsive Exercise** | * Regular Exercise for Weight Control * Ever felt compelled to exercise == ‘YES’ OR Ever uneasy or distressed when unable to exercise == ‘YES’ | * Exercise for Weight Control * Regular Exercise for Weight Control * Compulsive Exercise |
| **Current Compulsive Exercise** | * Compulsive Exercise * Do you currently exercise to control weight and shape AND feel compelled to exercise or distress if unable to exercise? == ‘YES’ | * Exercise for Weight Control * Compulsive Exercise |
| **Addictive Exercise** | * Regular Compulsive Exercise lasting at Least 3 month * 1 or more of the following: caused them to change eating habits * -decline opportunities to be with friends * -exercised despite illness or injury | * Exercise for Weight Control * Regular Exercise for Weight Control * Compulsive Exercise * Regular Compulsive Exercise |
| **Excessive Exercise** | * Compulsive Exercise * Duration >= 1 month * Frequency = ‘Every Day’ or ‘Nearly Every Day’ | * Exercise for Weight Control * Compulsive Exercise |
| **Compensatory Exercise** | * Have you ever used any of the following to compensate for episodes of binge eating or overeating? (Mark all that apply) (choice=Exercised excessively (e.g., felt compelled to exercise, felt uneasy or distressed if unable to exercise)) | NA |
| **Maladaptive Exercise** | * Compulsive Exercise == ‘Yes’ OR Compensatory Exercise == ‘Yes’ | NA |

# Aim 1. Evaluate patterns of response across multiple exercise constructs, to identify the degree to which these constructs overlap in membership or capture distinct groups.

We hypothesize that those indicating that they have ‘exercise excessively’ more often in the initial screening item will also be likely to meet criteria for compulsive exercise, exercise addiction, and excessive exercise (high sensitivity), and moderately likely to meet criteria for compensatory exercise (moderate sensitivity; high negative predictive value). Specifically, we hypothesize sensitivity for compulsive exercise, exercise addiction, and excessive exercise based on Q1 will be > 80%. Sensitivity for compensatory exercise from Q1 will be > 60%, with > 80% negative predictive value. **Figure 1** presents the proportion of the full sample along with subsamples meeting criteria for each (sub)construct

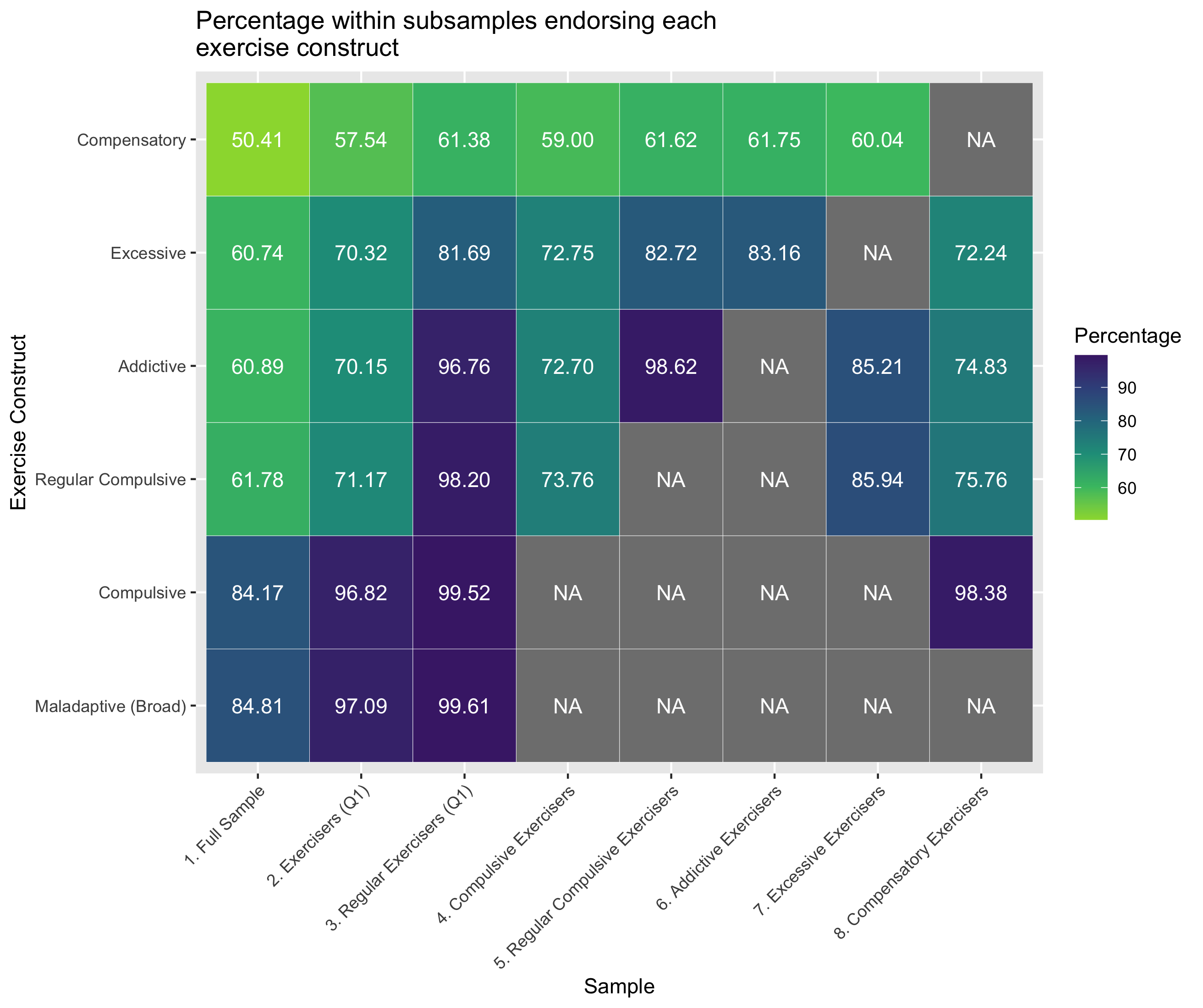


Figure 1. Heatmap with percentage of (sub)samples (horizontal axis) meeting criteria for each (sub)construct (vertical axis).

**Sensitivity of Q1 - Excessive Exercise.** Overall, there was high convergent validity for Q1 with Q2-Q6. Specifically, individuals eating disorders who endorse using exercise to intentionally control weight ‘more often’ are indeed highly likely to engage in this behavior for a substantive period of time (xx% of those reporting exercise to intentionally control weight ‘more often’ reported a duration of compulsive exercise > 3 months; a time period of equivalent to diagnostic levels of other intentional weight control behaviors), and to report symptoms consistent with a definition of both compulsive and addictive exercise. Regarding the sensitivity of Q1 to detect compulsive, addictive, and excessive exercise, xxxx (add confusion matrix statistics here). Overall, most individuals with eating disorders who reporting regular exercise for weight loss to control weight and shape report that this exercise was compulsive, and that they also experienced life interfering sequalae of this behavior. Regarding specific addictive exercise symptoms, the modal number of exercise interference items was all 3. Findings suggest high sensitivity of Q1 to additional follow-up questions regarding addictive and compulsive exercise, with slightly less sensitivity to excessive exercise (high frequency).

With regards to compensatory exercise, 61.38 % of individuals who reported maladaptive exercising ‘more often’ in Q1 also reported a history of compensatory exercise (sensitivity = ). Among the group reporting compensatory exercise, xx% reported exercising for weight loss at all in Q1, (NPV = ), and xx% reported exercising for weight loss ‘more often’ in Q1 (NPV = ). In sum, compensatory exercise was common, but somewhat less prevalent than other maladaptive exercise behaviors, and there was high sensitivity to detect compensatory exercise for those who reported any exercise for weight control in Q1.

**Aim 2. Evaluate Convergent and Discriminant Validity between history of *maladaptive* and c*ompulsive* exercise and: current compulsive exercise, perfectionism, and OCD sympotms**

H2a: Individuals who do not report *any* *history* of maladaptive and compulsive exercise will not report current compulsive exercise (high negative predictive value). *>90% negative predictive value of history to 1. Current compulsive exercise on the EDEQ, 2. Current compulsive exercise on the CET*

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Description automatically generatedH2b: Comparing those with and without history of compulsive exercise, those with history of compulsive exercise will report higher current compulsive exercise symptoms (all CET subscales) than those without. Those reporting current compulsive exercise will report the highest CET scores. *ANOVA comparing those with no compulsive exercise, history of compulsive exercise only, and current compulsive exercise on current CET, p < .05 for all subscales and global, and calculation of Cohen’s d effect sizes.*

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## **Perfectionism and OCD Symptoms.** H2c: Within diagnostic groups - those with vs. without history of maladaptive exercise will report higher Frost MPS and OCD symptoms. *t-tests within diagnostic groups comparing frost MPS and OCI-R/OCI-12 subscale scores, p < 0.05, and calculation of Cohen’s d effect sizes.*

## H2d: Associations with the MPS and OCD measure will be weaker than with the CET. *Interpret patterns of ES. t-tests within diagnostic groups comparing frost MPS and OCI-R/OCI-12 subscale scores, p < 0.05, and calculation of Cohen’s d effect sizes*

**Aim 3. Demonstrate Prevalence of Maladaptive (Broad), Compulsive, Addictive, Excessive, and Compensatory Exercise across Diagnostic Groups**

H3a. Maladaptive exercise, compulsive exercise, and exercise addiction will be a common symptom across diagnoses. More common in AN and BN than BED. *Rates of maladaptive exercise, compulsive exercise, excessive exercise, and exercise addiction will all be > 50% in AN and BN presentations; > 20% in BED.*

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Description automatically generated*History of Compulsive Exercise was reported most frequently in the AN, AN-Mixed Diagnosis, and BN groups (see **Figure x**), with > 60% in each of these diagnostic groups reporting history of regular compulsive exercise, and almost 90% reporting any compulsive exercise. Regular compulsive exercise was also reported in half of those with BN-BED and a smaller portion of those with BED. *\*\*Add multinomial logistic tests across groups with AN as reference \*\*\**

H3b. Compensatory exercise will be more common among those with AN mixed and BN as compared to AN only . *Multinomial* *logistic regression with AN group as reference – BN groups will not differ but BED will*

**Discussion**

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| **Supplemental Table 1.** Exercise-related items on the ED100K | | | |
| **Measure** | **Variable name** | **Question** | **Response options** |
| ED100K | exercise | Exercised excessively (e.g. felt compelled to exercise, felt uneasy or distressed if unable to exercise) | 1=never; 2=a few times, but it never became a habit; 3=more often |
| ED100K | ex\_compel | Have you ever felt compelled to exercise-like you had to do it-to control your body shape or weight? | 1=Yes | 0=No | -9=Don't know |
| ED100K | ex\_distress | Have you ever felt uneasy or distressed if unable to exercise? | 1=Yes | 0=No | -9=Don't know |
| ED100K | ex\_friend | Have there been times when you declined opportunities to be with friends in order to exercise? | 1=Yes | 0=No | -9=Don't know |
| ED100K | ex\_ill | Have you exercised despite an injury or illness that would have prevented others from exercising? | 1=Yes | 0=No | -9=Don't know |
| ED100K | ex\_diet | Have there been times you modified your diet/eating habits if you were unable to exercise for any reason? | 1=Yes | 0=No | -9=Don't know |
| ED100K | ex\_age | How old were you when you first exercised to control your weight and shape AND felt either compelled to exercise or distressed if unable to exercise? | integer, Min:0, Max: 120 |
| ED100K | ex\_dur | For how long did you feel compelled to exercise or felt distressed if unable to exercise? | 1=Less than 1 month | 2=1 to 2 months | 3=3 to 5 months | 4=6-12 months | 5=More than 1 year | -9=Don't know |
| ED100K | ex\_freq | During these periods, how frequently did you exercise excessively in a week? | 1=Less than once a week | 2=At least once a week | 3=At least twice a week | 4=Every day/ nearly every day | -9=Don't know |
| ED100K | ex\_current | Do you currently exercise to control weight and shape AND feel compelled to exercise or distress if unable to exercise? | 1=Yes | 0=No |
| ED100K | ex\_age\_last | How old were you when you stopped exercising to control your weight and shape AND felt either compelled to exercise or distressed if unable to exercise? | integer, Min:0, Max: 120 |
| ED100K | Be\_icb\_5 | Have you ever used any of the following to compensate for episodes of binge eating or overeating? (Mark all that apply) (choice=Exercised excessively (e.g., felt compelled to exercise, felt uneasy or distressed if unable to exercise)) |  |
| ED100K | Icb\_lowt\_5 | Exercised excessively (e.g., felt compelled to exercise, felt uneasy or distressed if unable to exercise) |  |