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Towards Understanding Exercise Dependence

The Mediating Effect of Stress

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Abstract

Although physical activity is associated with general well-being and improved quality of life, compulsive exercise behaviour, such as exercise dependence, can be detrimental to an individual's physical and psychological health. Different models have been introduced to describe the phenomenon, though seldom tested. Based on the expanded interaction model of exercise addiction (Dinardi et al., 2021), the aim of the study was to investigate the mediating effect of stress on the relationship between exercise identity and exercise dependence as well as on the relationship between body dissatisfaction and exercise dependence. Variables were measured using the Exercise Dependence Scale-Revised (EDS-R), Exercise Identity Scale (EIS), Multidimensional Body-Self Relations Questionnaire's Appearance Evaluation and -Orientation subscales (MBSRQ-AE/AO) and Perceived Stress Scale (PSS). Participants were 99 regular exercisers (61 women, 38 men; M_{Age} = 33.37, *SD* = 10.24 years), and data was collected via an online questionnaire. 9.1% of the participants were classified as "at risk for exercise dependence". While the mediation analysis indicated no significant indirect effect of stress on both relationships, the present study found significant direct effects between exercise identity, body dissatisfaction, and exercise dependence. Additionally, it was found that stress predicts exercise dependence. This partly aligns with the pathways presented in the model. Future research should focus on further testing the model to investigate the role of stress and develop a universal assessment tool for measuring exercise dependence.

Keywords: exercise dependence, exercise identity, body dissatisfaction, stress

Sammanfattning

Även om fysisk aktivitet är förknippat med allmänt välbefinnande och förbättrad livskvalitet, kan tvångsmässigt träningsbeteende, såsom träningsberoende, vara skadligt för en individs fysiska och psykiska hälsa. Olika modeller har introducerats för att beskriva fenomenet, men de har sällan testats. Baserat på den ”expanded interaction model of exercise addiction” (Dinardi et al., 2021) var syftet med studien att undersöka den medierande effekten av stress på sambandet mellan träningsidentitet och träningsberoende samt på sambandet mellan kroppsmissnöje och träningsberoende. Variablerna mättes med hjälp av Exercise Dependence Scale-Revised (EDS-R), Exercise Identity Scale (EIS), Multidimensional Body-Self Relations Questionnaire's Appearance Evaluation and Orientation subskalorna (MBSRQ-AE/AO) och Perceived Stress Scale (PSS). Deltagarna var 99 regelbundna motionärer (61 kvinnor, 38 män; $M_{Ålder}$ = 33,37, *SD* = 10,24 år) och data samlades in via ett digitalt frågeformulär. 9,1% av deltagarna klassificerades som ”i risk för träningsberoende”. Medieringsanalysen visade ingen signifikant indirekt effekt av stress på båda relationerna, dock fann studien signifikanta direkta effekter mellan träningsidentitet, kroppsmissnöje och träningsberoende. Dessutom visade det sig att stress predicerar träningsberoende. Detta stämmer delvis överens med de samband som presenteras i modellen. Framtida forskning bör fokusera på att ytterligare testa modellen för att undersöka stressens roll samt att utveckla ett universellt mätinstrument för att mäta träningsberoende.

Nyckelord: träningsberoende, träningsidentitet, kroppsmissnöje, stress

> I started to realise that exercise controlled me, rather than me controlling exercise. That control quickly became an obsession… It's had a big impact on my work, my family - every aspect of my life. Over time, exercise became unhealthy. (Kelly, 2019, Introduction section)

In today's society, lifestyle choices individuals make have a significant effect on their health. Generally, research highlights that physical activity and exercise are known to support well-being, prevent heart and cardiovascular diseases, as well as reduce stress and anxiety (Garber et al., 2011; Loef & Walach, 2012; Lox et al., 2014). Nowadays, most people engage in sedentary behaviours and do not meet the recommended amount of daily exercise, making physical inactivity a public health problem rather than an individual one (Kljajević et al., 2022). In response, governments propose recommendations to challenge inactivity among different populations, and individuals aim to engage in healthy behaviour, like following a more nutritious diet and exercising, to achieve optimal well-being (Robinson et al., 2017). While these efforts are generally positive, pursuing health can also take a negative turn. As highlighted by the quotation at the beginning, aiming to pursue a healthy lifestyle and wanting to be more physically active can, in some individuals, lead to maladaptive behaviours such as obsessing over looks, disordered eating as well as exercise dependence (Malmborg et al., 2017; Oberle et al., 2018).

Exercise dependence concerns compulsive exercise behaviour, including vigorous and excessive exercise routines (Hausenblas & Symons Downs, 2002a). It is important to realise that exercise dependence is a behavioural pattern which can have detrimental effects on an individual's general well-being and quality of life (Back et al., 2021; Dinardi et al., 2021; Ganson et al., 2022; Symons Downs et al., 2019; Szabo et al., 2015). Factors such as exercise identity (Palermo & Rancourt, 2023), anxiety (e.g., Back et al., 2021; Palermo & Rancourt, 2023), body dissatisfaction (Freire et al., 2020), and eating disorders (Gori et al., 2021;

Oberle et al., 2018) have shown to be directly linked to exercise dependence and compulsive exercise patterns. Model such as the expanded interaction model (Dinardi et al., 2021) suggest that stress can be an underlying factor impacting the development of exercise dependence.

The Expanded Interactional Model of Exercise Addiction

Physical activity can be beneficial for an individual's mental as well as physical well-being and is, in some contexts, even described as therapeutic (Egorov & Szabo, 2013). However, certain factors can shift a healthy attitude towards exercise into an addictive behaviour. Identifying the latter can be difficult since such behaviour easily blends into the daily activities of individuals (Egorov & Szabo, 2013). Egorov and Szabo (2013) conceptualised the *interactional model of exercise addiction* to explain the interaction of individuals' personal, environmental as well as situational factors that impact their exercise behaviour. The interaction of these factors represents possible pathways that lead to exercise dependence. The model was revised and expanded by Dinardi et al. (2021), adding additional factors related to exercise dependence.

As presented in Figure 1, the domain of personal factors consists of personality, needs and values, interests and goals, skills and abilities, as well as self-concept. It conceptualises the ideas and attitudes individuals have about themselves and their environment, who they are at their core and the identity they have or would like to assume having (Dinardi et al., 2021; Egorov & Szabo, 2013). The domain of situational factors consists of accessibility and costs, individual/group settings, social aspects, as well as social values. It is linked to the provided environmental conditions, which impact why an individual engages in exercise (Dinardi et al., 2021). Previously referred to as exercise motivation, incentives for exercise are linked to "the ways a person seeks to enhance their lived experience, their health, or physical ability, or appearance through participating in exercise" (Dinardi et al., 2021, p. 629). The domain

consists of eight factors: enjoyment, physical and psychological health, social and performance aspects, seeking a challenge, sensation seeking, and less common reasons, all representing motivational aspects towards engaging in exercise yet differ in significance for each individual.

Therapeutic and mastery orientation represent two distinct pathways regarding the "why" an individual may engage in physical activity and exercise. The first is linked to gaining or avoiding something through positive or negative reinforcement, such as gaining health (e.g., through running or strength training) and avoiding ill-health (e.g., obesity). The latter is associated with performance improvement and positive outcomes related to exercise (e.g., becoming a faster runner; Egorov & Szabo, 2013). Both orientations play a significant role in shaping exercise behaviours, which can ultimately lead to either healthy or unhealthy exercise patterns.

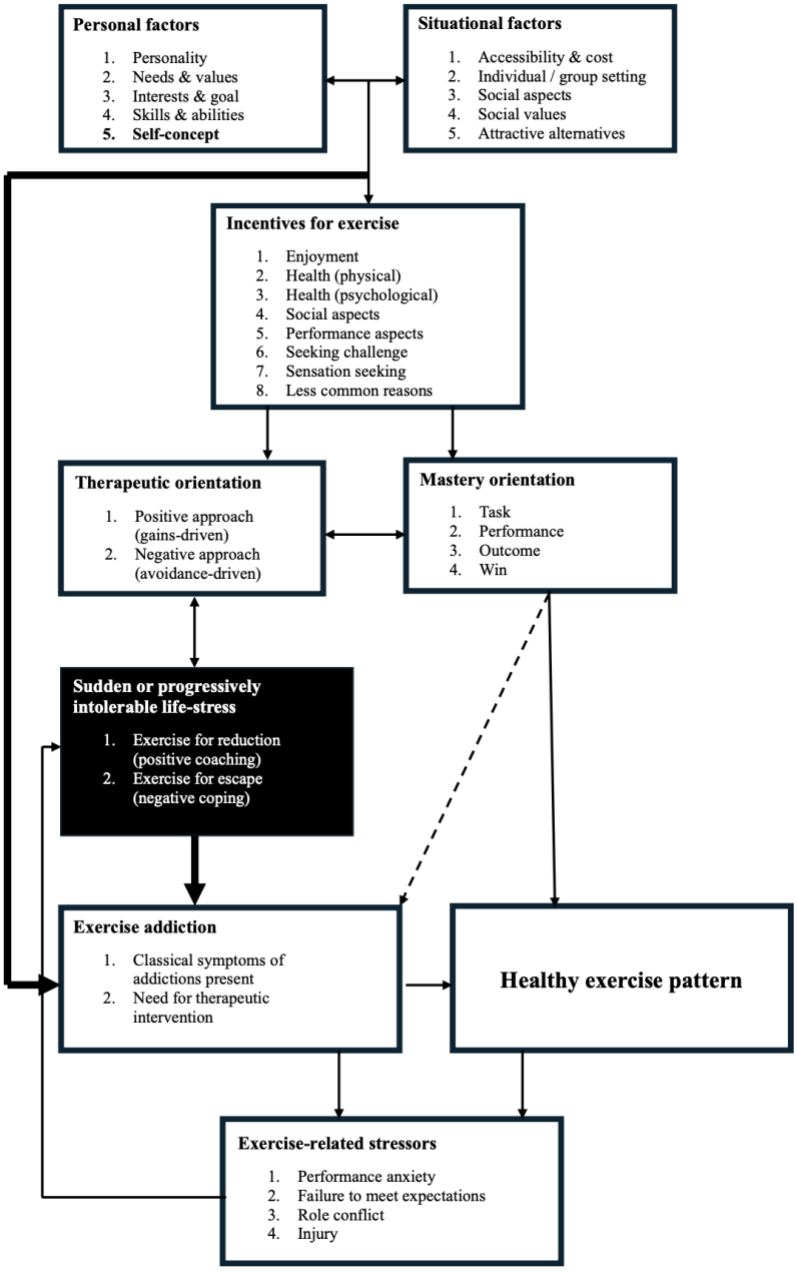
The black box, representing sudden or progressively intolerable life stress, makes up the central and most significant part of the model (Egorov & Szabo, 2013). It embodies the emerging intolerable interactions caused by personal or situational/environmental circumstances, which provoke unbearable and uncontrollable psychological distress. Consequently, individuals might turn towards using exercise as a coping strategy to be able to manage, reduce, escape, or eliminate difficult emotions and psychological distress. In case the strategy shows positive effects regarding a perceived decrease in stress, the individual will likely continue using it as a coping strategy. To elaborate, individuals could find themselves engaging, consciously as well as subconsciously, in unhealthy exercise behaviour patterns. The model highlights this relationship by directly linking stress to the domain of exercise addiction (Egorov & Szabo, 2013).

Exercise-related stressors were added to the expanded model by Dinardi et al. (2021) and consist of factors related to stressors due to engagement in exercise and physical activity.

This includes factors such as performance anxiety, failure to meet expectations, role conflicts and injury. While it primarily interacts with the domain of sudden or progressively intolerable life-stress, it is not limited to only affecting individuals with addictive behaviour. According to Dinardi et al. (2021), this domain has an antithetical aspect regarding the fact that individuals might exercise to reduce or avoid stress but, by that, create more, descending into a potentially harmful behavioural pattern.

Figure 1

The Expanded Interaction Model of Exercise Addiction



Note. Modified expanded interaction model of exercise dependence, highlighting the investigated pathways in bold. Adapted from "The expanded interaction model of exercise addiction", by J. S. Dinardi, A. Y. Egorov, and A. Szabo, 2021, *Journal of Behavioral Addictions, 10*(3), p. 627 (http://dx.doi.org/10.1556/2006.2021.00061). Used under CC BY 4.0 https://creativecommons.org/licenses/by/4.0/

Exercise Dependence

So far, research investigating exercise dependence has been unclear due to a plethora of terms used to describe the phenomenon of exercise dependence, making it difficult to give a precise definition. Most commonly, the terms exercise addiction (Gori et al., 2021; Lichtenstein et al., 2014; Szabo et al., 2015), exercise dependence (Back et al., 2021; Cook & Hausenblas, 2008; Hausenblas & Symons Downs, 2002a; Murray et al., 2013) and compulsive exercise (Bell et al., 2016; Palermo & Rancourt, 2023) are used, often interchangeably. For instance, reviews such as Weinstein and Szabo (2023) or Szabo et al. (2015) refer to studies using either exercise addiction or -dependence to explain the same phenomenon. Szabo et al. (2015) found that exercise dependence is still the most used term. Therefore, the authors of this study will refer to exercise dependence when relating to the phenomenon.

In general, exercise dependence is a complex phenomenon characterised by persistent engagement in unhealthy or maladaptive exercise behaviours (Hausenblas & Symons Downs, 2002a). The seven symptoms of exercise dependence include (1) the tolerance to engage for longer in exercise or the need to increase its amount; (2) the occurrence of withdrawal symptoms (e.g., anxiety); (3) amount of exercise exceeds initial intention; (4) losing control over exercise behaviour; (5) time spent is much related to exercise and activities including exercise; (6) exercise impacts social, occupational, or recreational activities in a way that those are being cancelled, neglected, given up or reduced; and (7) continuance of exercise habits despite knowledge of the adverse psychological and physiological effects (e.g., recurring injuries; De Coverley Veale, 1987). If the individual meets three or more criteria, they are seen to be *at risk for exercise dependence* (Hausenblas & Symons Downs, 2002a, 2002b). Research has further investigated the phenomenon, and different factors have been identified as posing a potential risk for developing exercise dependence (e.g., Back et al.,

2021; Gori et al., 2021; Wågan et al., 2021).

Prevalence

Prevalence rates of exercise dependence differ substantially and are inconsistent across studies, primarily due to the mentioned plethora of terms as well as the variety of assessment tools used (Egorov & Szabo, 2013; Weinstein & Szabo, 2023). The variability in assessment tools makes it especially challenging to estimate accurately the number of individuals affected by exercise dependence (Weinstein & Szabo, 2023). Most commonly, prevalence has been measured with the Exercise Dependence Scale (EDS), its revised version, the Exercise Addiction Inventory (EAI) or the revised version of the EAI. Results generated by these scales are comparable; for instance, Szabo et al. (2019) reported a concurrent validity of .87, while Mónok et al. (2012) reported a correlation of .79. However, these tools assess the prevalence of being "at risk" for exercise dependence rather than definite diagnoses, therefore not presenting definite cases of exercise dependence (Szabo et al., 2015). Systematic reviews, such as Marques et al. (2019), indicate that the prevalence of exercise dependence ranges from 1.9% to 10.2% among regular exercisers. Szabo et al. (2019) found that prevalence rates among regular exercisers for being at risk for exercise dependence ranged from 9% (measured with EDS-R) to 11.5% (measured with EAI).

Risk Factors for Exercise Dependence

Stress

While stress is a phenomenon experienced by most individuals at some point in their lives, there is, up to now, no universally accepted definition (Stults-Kolehmainen & Sinha, 2014). The present study follows the definition by Cohen et al. (1983). According to them, stress shows effects when "(a) the situation is appraised as threatening or otherwise demanding and (b) in-sufficient resources are available to cope with the situation" (Cohen et al., 1983, p. 386). A key aspect of this perspective is that the response to a situation is shaped

by its intensity as well as personal and contextual factors (Cohen et al., 1983). In the context of exercise dependence, this means that the compulsion to exercise excessively may not arise solely from the physical demands or rewards of the activity itself but is also influenced by other factors, such as personal identities as well as exercise-related stressors (Cohen et al., 1983; Egorov & Szabo, 2013). For example, Hassanbeigi et al. (2013) and Wågan et al. (2021) explain that stress can lead to an increase in unhealthy behaviours, such as alcohol, drug, and exercise abuse, to cope with stress.

Stress is a popular topic in health psychology, where exercise is recommended to reduce symptoms and prevent illness outcomes. While many studies have focused on the benefits of physical activity on stress, there is a lack of studies looking at the opposite effect. However, those few existing studies emphasise that stress can both decrease and increase physical activity and exercise behaviour (Pinto et al., 2019; Stults-Kolehmainen & Sinha, 2014; Wågan et al., 2021). A study by Wågan et al. (2021) explains that behaviours reducing stress yield relief and can become problematic for some individuals (e.g. people with low self-esteem and/or those who experience higher stress levels) and that exercise may be a coping strategy in an attempt to reduce stress (Egorov & Szabo, 2013; Stults-Kolehmainen & Sinha, 2014). Additionally, Walter and Bodner (2024) found that exercise is used to regulate emotions in people at risk of exercise dependence, with stress playing a central role in driving that motivation. Furthermore, studies by Pinto et al. (2019) and Wågan et al. (2021) reported a significant relationship between perceived stress and exercise dependence. This suggests that individuals experiencing greater stress are more likely to adopt intensive exercise patterns that may result in exercise dependence, especially if the exercise becomes a developing stressor due to sudden life-stress experienced by personal or situational circumstances (Dinardi et al., 2021).

Exercise Identity

Exercise identity is grounded in identity theory, which refers to meanings that describe who a person is in a social context or role (Anderson & Cychosz, 1994; Stryker & Burke, 2000). In addition, identities are formed by norms and encourage self-regulatory actions to provide behaviours that align with the expectations of that specific role (Porter et al., 2024; Rhodes et al., 2016). This explains that identities not only define who someone is but also direct how someone behaves to maintain this identity (Murray et al., 2013; Strachan et al., 2013). Also, individuals who perceive themselves as aligned with their identity experience a positive effect that strengthens their identity. However, a lack of congruence produces a negative effect that motivates behaviours to prevent this disturbance (Murray et al., 2013; Rhodes et al., 2016; Stryker & Burke, 2000). Actions for this mismatch include behavioural modifications that result in the identity being verified (Strachan et al., 2011). The study by Anderson and Cychosz (1994) expands on these foundations and explains that identity is a central part of the self-concept and serves as a guide for past and future behaviours. Dinardi et al. (2021) further illustrate that self-concept includes identity elements, such as “I am an exerciser”. Similarly, Strachan et al. (2013) highlight that individuals who identify themselves as exercisers aim to establish congruency between their identity as exercisers and their exercising behaviour.

Studies have shown that exercise identity increases an individual’s volume of physical activity (Palermo et al., 2021; Rhodes et al., 2016) and can be connected to both adaptive and compulsive exercise (Palermo & Rancourt, 2023), as well as exercise dependence (Murray et al., 2013). A study by Palermo and Rancourt (2023) sought to clarify whether exercise identity had a relation to adaptive or compulsive exercise. The results indicated that a strong exercise identity is a predictor for both. However, compulsive exercise is especially encouraged by it, along with anxiety and body dissatisfaction. Another study by Cook et al.

(2015) found a significant interaction effect between exercise identity and exercise dependence with social physique anxiety (i.e., anxiety related to how others perceive the body) as a moderator. Therefore, exercise identity appears to be associated with exercise dependence under the influence of other factors.

Body Dissatisfaction

During the last two decades, research interest in body image has increased (Grogan, 2017). The field explores how body dissatisfaction influences behaviours such as unhealthy dieting, drug abuse, weight loss or muscle gain (Freire et al., 2020; Quittkat et al., 2019), as well as compulsive training (Homan, 2010; Williams et al., 2023) and addiction to exercise (Freire et al., 2020). Body image is defined as a "person's perceptions, thoughts, and feelings about his or her body" (Grogan, 2017, p. 4), including "behaviors and attitudes about their body and appearance" (Burychka et al., 2021, p. 249). It is a complex phenomenon that can affect an individual's physical and psychological characteristics, as well as the sociocultural context (Burychka et al., 2021). Furthermore, the construct consists of both negative and positive aspects of the body (Grogan, 2017). While body satisfaction refers to the positive feelings and attitudes about one's own body, body dissatisfaction refers to the negative ones, such as a negative view of one´s body in terms of size, weight, muscularity, and shape. This often includes a perceived discrepancy between a person's body image and ideal body (Aniulis et al., 2021; Freire et al., 2020; Grogan, 2017). Quittkat et al. (2019) highlight that body dissatisfaction is considered the most significant indicator of stress associated with the body. Furthermore, research by Castellano et al. (2021) indicates that stress can mediate the relationship between body dissatisfaction and eating disorder symptoms. Gori et al. (2021) also found that body image concern significantly mediated the relationship between body dissatisfaction and exercise dependence. Drawing on these results, unhealthy coping strategies such as excessive exercise could be used to reduce negative feelings and emotions

related to the body (Freire et al., 2020; Gualdi-Russo et al., 2022). As presented in the model of Dinardi et al. (2021), self-concept includes not only identity elements, as already mentioned, but also self-perception, such as “I am not in shape” (Dinardi et al., 2021). This perception of oneself seems to impact both an individual's positive (adaptive or healthy exercise) and negative exercise behaviours (maladaptive exercise or exercise dependence; Dinardi et al., 2021; Palermo & Rancourt, 2023).

Purpose of the Present Study

Despite having been cited over a hundred times (Dinardi et al., 2021), the expanded interaction model of exercise has only scarcely been used as a theoretical framework (Walter & Bodner, 2024; Wågan et al., 2021). Sudden or progressively intolerable life-stress as a central part of the model remains unclear due to the lack of research that tests it. This leaves room to explore whether stress is the significant factor contributing to exercise dependence, as suggested by Dinardi et al. (2021). Additionally, scholars like Cook et al. (2015) and Pinto et al. (2019) inquired further research regarding risk factors, the effect of stress, and a better understanding of body-focused variables concerning exercise dependence. Furthermore, since previous research has shown that exercise identity and body dissatisfaction directly correlate with exercise dependence, this study attempts to provide a more detailed understanding of these relationships. By examining whether stress functions as a mediator, this study could clarify how stress may contribute to exercise dependence. It would give empirical evidence on the role of stress within the existing theory, helping to understand and refine the model and its pathway between personal factors and exercise dependence.

Therefore, this study aims to investigate whether stress mediates the relationships between exercise identity and exercise dependence as well as between body dissatisfaction and exercise dependence.

Hypotheses

Based on previous research (Pinto et al., 2019; Walter & Bodner, 2024; Wågan et al., 2021) and the expanded interaction model (Dinardi et al., 2021), it was hypothesised that stress in the first model (see Figure 2), would have a significant indirect effect on the relationship between exercise identity and exercise dependence. It was also hypothesised that stress, in the second model (see Figure 3), would have a significant indirect effect on the relationship between body dissatisfaction and exercise dependence.

Figure 2

Hypothetical Mediation Model Involving the Relationship Between Exercise Identity and Exercise Dependence Through Stress

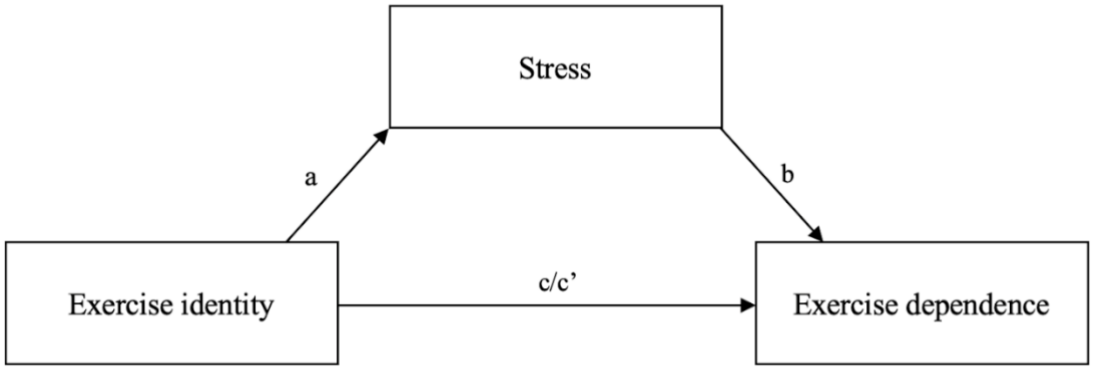
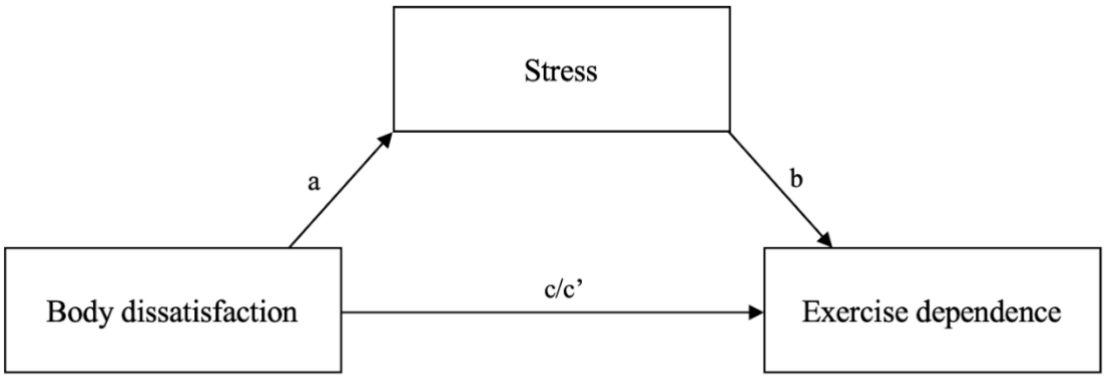


Figure 3

Hypothetical Mediation Model Involving the Relationship Between Body Dissatisfaction and Exercise Dependence Through Stress



Method

Participants and Procedure

A total of 111 participants took part in this study. Participants who did not meet the inclusion criteria of being regular exercisers (n=3) or who did not answer all questions of the questionnaire (n=9) were excluded from the analysis. This resulted in a final sample size of 99 participants, of which 61 were women and 38 were men. The participants were between 20 and 63 years old (M_{Age} = 33.37, *SD* = 10.24), and 13 were English-speaking ($n_{European}$ = 11, $n_{Non\text{-}European}$ = 2). Additionally, information on participants' primary form of exercise was collected, and participants were asked to choose the category that resonated with their form of exercise the most. The participants' main exercises included strength training (*n* = 35), high-intensity training (*n* = 44), cardio (*n* = 13), team sports (*n* = 4), and other (*n* = 3).

This study followed a cross-sectional design. Participants were recruited by reaching out to gyms and students at a local university in Sweden, as well as by sharing the survey on social media with the data-gathering occurring during November 2024 using an online questionnaire. Participants did not receive any compensation for their participation. The information letter was included at the beginning of the survey before participants could

complete the questionnaire. The letter informed the participants about the aims of the study and the confidentiality of their data. Furthermore, they had to consent to participation before being able to proceed with the study.

Measures

Physical Exercise

Physical exercise was assessed using the Godin Leisure Time Exercise Questionnaire (GLTEQ; Godin & Shephard, 1985). It is a 4-item questionnaire which measures the frequency of strenuous, moderate, and mild physical activity performed for at least 15 minutes during a seven-day period during one's free time. To compute a total score, the reported strenuous and moderate exercise frequencies are multiplied by 9 and 5, respectively, and then added together. The sum is referred to as units. Individuals obtaining units of 24 or more are classified as being active. Individuals with units between 14 and 23 are classified as moderately active, and units below 14 are equal to being insufficiently active (Godin, 2011).

Exercise Dependence

The Exercise Dependence Scale-Revised (EDS-R) is a multidimensional 21-item measurement instrument with a 6-point Likert scale ranging from 1 ("Never") to 6 ("Always"). It includes seven subscales related to the criteria, i.e., tolerance, withdrawal, intention effects, lack of control, time, reduction in other activities, and continuance (Hausenblas & Symons Downs, 2002b; Symons Downs et al., 2004). Individuals will be classified into three different categories: "at risk for exercise dependence", "nondependent-symptomatic", and "nondependent-asymptomatic" (Hausenblas & Symons Downs, 2002b; Symons Downs et al., 2004). Participants who score between 5 and 6 on the Likert scale in at least three of the seven criteria will be classified as being at risk. Individuals scoring between 3 and 4 in at least three criteria are classified as non-dependent symptomatic. Participants will also be classified as non-dependent symptomatic if they count a combination of at-risk and

non-dependent symptomatic scores in at least three criteria. If scores range between 1 and 2 on the Likert scale, individuals will be classified as non-dependent asymptomatic (Symons Downs et al., 2004). In previous studies, the questionnaire has shown good Cronbach's alpha scores in six of the seven subscales (Cronbach's alpha > .8; Murray et al., 2013). A validated Swedish version exists (Lindwall & Palmeira, 2009). For this study, Cronbach's alpha for the total scale was .91.

Stress

The Perceived Stress Scale (PSS; Cohen et al., 1983) is a short self-assessment questionnaire and one of the most well-known tools for measuring psychological stress (Lee, 2012). The PSS evaluates stress broadly rather than focusing on a specific situation (Cohen & Williamson, 1988). The PSS was shortened to 10 items (PSS-10), of which six are negative (items 1,2,3,6,9 and 10), and four are positive (items 4,5,7 and 8; Lee, 2012; Reis et al., 2010). Each item includes a 5-point Likert scale ranging from 0 ("Never") to 4 ("Very often"), and scores are reversed on the positively stated items (Cohen & Williamson, 1988). A total score, ranging from 0 to 40, is generated by summing up all items, with a higher score indicating higher levels of stress (Nordin & Nordin, 2013). In the current study, Cronbach's alpha for the PSS was .81.

Exercise Identity

The Exercise Identity Scale (EIS; Anderson & Cychosz, 1994) was used to assess exercise identity among participants. The EIS measures the extent to which exercise is described as part of an individual's self-concept (Anderson & Cychosz, 1994). However, more recent analyses suggest a superior statistically significant two-factor measurement model, including the factors "exercise beliefs" (items 3,4,5,7,8 and 9) and "exercise identity role" (items 1,2 and 6; Vlachopoulos et al., 2011; Wilson & Muon, 2008). Participants responded on a 7-point Likert scale from 1 ("Strongly disagree") to 7 ("Strongly agree").

Anderson and Cychosz (1994) reported internal consistency of α = .94. Subsequent studies support these findings, with Vlachopoulos et al. (2011) reporting good internal reliability with α = .87 for exercise role identity and α = .90 for exercise beliefs, while Murray et al. (2013) found similar values. The current study did not follow the two-factor model but used the total scale to assess exercise identity. For the total scale, Cronbach's alpha for EIS was .90.

Body Dissatisfaction

To assess body dissatisfaction, the Multidimensional Body-Self Relations Questionnaire's (MBSRQ) subscales were used, i.e., the appearance evaluation (MBSRQ-AE) and orientation (MBSRQ-AO) subscales. Responses are measured by using a 5-point Likert scale ranging from 1 (”Strongly disagree”) to 5 (”Strongly agree”; Brown et al., 1990). The appearance evaluation subscale is a 7-item scale which measures the individual's feelings regarding their physical (un-)attractiveness and (dis-)satisfaction with their own looks (Brown et al., 1990; Cash, 2000). The appearance orientation subscale consists of 12 items, measuring participants' investment in physical appearance (Brown et al., 1990; Cash, 2000). Brown et al. (1990) reported internal consistencies between α = .84 and .88 for both subscales. Subsequent studies support these findings. For instance, Back et al. (2021) reported an internal consistency of α = .86 for the orientation subscale. In line with previous research, Cronbach's alpha of the MBSRQ-AE and MBSRQ-AO was .91 and .89, respectively. In this study, the subscales were combined to create a total scale to assess all dimensions of body dissatisfaction. The total scale of the MBSRQ-AO and MBSRQ-AE generated an internal consistency of α = .80.

Data Analysis

Data was analysed using JASP. Descriptive statistics were generated for all variables following a Pearson's r correlation analysis to investigate the relationships between the

variables. Following Symons Downs et al. (2004), participants were classified as (I) at risk for exercise dependence, (II) nondependent–symptomatic, or (III) nondependent–asymptomatic for the EDS-R. For the EDS-R, MBSRQ-AE/AO, and EIS, the mean and the standard deviation were generated based on the Likert scale in each questionnaire. The mean and standard deviation for the PSS is based on the sum of the total scale. Mediation analyses were conducted to test the study's hypotheses using JASP. According to Preacher and Hayes (2008), mediation hypotheses are growing in behavioural sciences as they offer the possibility of understanding causal effects between two variables to a greater extent. Mediation analysis can demonstrate how an independent variable (X) has an indirect effect on a dependent variable (Y) through an intervening or mediator variable (M). In mediation, the indirect effect is presented through a 95% CI-value (confidence interval). If the interval for the indirect effect includes zero, the variable M cannot be considered a mediator in the relationship between variables X and Y (Preacher & Hayes, 2008). In the present study, the effect of exercise identity (X) on exercise dependence (Y) through stress (M) as a mediator was analysed (see Figure 2), as well as the effect of body dissatisfaction (X) on exercise dependence (Y) through stress (M; see Figure 3). The mediation analyses examine the direct effect of the two independent variables, exercise identity and body dissatisfaction, on the mediator stress (path a in both models), the relationship between stress and the dependent variable exercise dependence (path b), the indirect effect of the independent variables on the dependent through the mediator (path c'), as well as the relationship between the independent variables and exercise dependence (path c).

Result

Descriptive statistics for physical activity, exercise identity, body dissatisfaction, stress, and exercise dependence are presented in Table 1. According to Godin (2011), the participants can be considered active. Following the classification by Symons Downs et al.

(2004), 9 participants (9.1%) were classified as being at risk for exercise dependence, 52 participants (52.5%) were classified as being nondependent-symptomatic, and 38 participants (38.4%) were classified as being nondependent-asymptomatic.

Table 1

Means and Standard Deviations for Study Variables

Variable	*n*	*M*	*SD*
GLTEQ	99	40.535	22.404
Exercise identity	99	5.557	1.224
Body dissatisfaction	99	3.274	.535
Stress	99	17.051	6.107
Exercise Dependence	99	2.881	.862

Correlation Analysis

Table 2

Correlation Matrix of the Examined Variables

Variable	1.	2.	3.	4.
1. Exercise identity	-	.317**	.030	.565**
2. Body dissatisfaction		-	-.078	.176
3. Stress			-	.233*
4. Exercise Dependence				-

*$p < .05$, **$p < .01$.

Mediation Analysis

Results (see Table 3) showed no significant indirect effect of exercise identity on exercise dependence through stress (*ab* = .005, 95%(CI) = -.030, .040). Findings show a significant direct effect of exercise identity on exercise dependence with and without the mediator, as well as a significant effect of stress on exercise dependence. No significant direct effect of exercise identity on stress could be found. The results suggest that stress does not mediate the relationship between exercise identity and exercise dependence.

Table 3

Regression Results from Mediation Analysis of the Effect of Exercise Identity on Exercise Dependence Through Stress

Model	Value	*SE*	*p*	CI(lower)	CI(upper)
Model without mediator					
EIS EDS-R	.456	.065	< .001		
Model with mediator					
EIS PSS	.025	.082	.762		
PSS EDS-R	.261	.080	.007		
EIS EDS-R	.462	.068	< .001		
Indirect effect	.005	.018	.763	-.030	.040
R^2-y	.366				
R^2-m	.001				

Note. EIS = Exercise Identity, EDS-R = Exercise Dependence, PSS = Stress, y = EDS-R, m = PSS.

Results (see Table 4) showed no significant indirect effect of body dissatisfaction on exercise dependence through stress (*ab* = -.037, 95%(CI) = -.132, .059). Results indicate a significant direct effect of body dissatisfaction on exercise dependence without the mediator and a significant effect of stress on exercise dependence. However, there was no significant

effect of body dissatisfaction on exercise dependence with a mediator, and no significant effect of body dissatisfaction on stress could be found. The results suggest that stress does not mediate the relationship between body dissatisfaction and exercise dependence.

Table 4

Regression Results from Mediation Analysis of the Effect of Body Dissatisfaction on Exercise Dependence Through Stress

Model	Value	*SE*	*p*	CI(lower)	CI(upper)
Model without mediator					
MBSRQ_AE/AO EDS-R	.367	.180	.041		
Model with mediator					
MBSRQ_AE/AO PSS	-.147	.187	.434		
PSS EDS-R	.249	.096	.010		
MBSRQ_AE/AO EDS-R	.330	.185	.074		
Indirect effect	-.037	.049	.454	-.132	.059
R^2-y	.093				
R^2-m	.006				

Note. MBSRQ_AE/AO = Body Dissatisfaction, EDS-R = Exercise Dependence, PSS = Stress, y = EDS-R, m = PSS.

Discussion

Rooted in the expanded interaction model (Dinardi et al., 2021), this study aimed to investigate whether stress mediates the relationship between exercise identity and exercise dependence as well as the relationship between body dissatisfaction and exercise dependence. Overall, the study's key findings indicated no significant indirect effect of stress, i.e., mediating effect, on both relationships. Yet, stress did predict exercise dependence in both models. Additionally, results showed that both exercise identity and body dissatisfaction have a significant direct effect on exercise dependence.

Based on the understanding that individuals turn towards a therapeutic orientation regarding their exercise behaviour to reduce, escape or eliminate difficult emotions and psychological distress, it was hypothesised that stress would mediate the relationships between exercise identity and exercise dependence as well as between body dissatisfaction and exercise dependence. However, neither mediation model showed significant indirect effects of stress. These findings suggest that stress does not play the central explanatory role in exercise dependence as proposed by the expanded interaction model. Instead, exercise identity and body dissatisfaction appear to have a significant relationship with exercise dependence, independently of stress. Therefore, the model's assumption regarding the role of stress and exercise dependence cannot be confirmed. This incongruence between the model's assumptions and the study's findings suggests that other psychological or behavioural factors may underlie these relationships. For instance, Lu et al. (2012) found that "have to" exercise commitment – the feeling of obligation regarding the continuation of exercise – partially mediated the relationship between exercise identity and exercise dependence. So, individuals with a strong exercise identity may feel compelled to sustain high physical activity to verify and reinforce their identity, regardless of stress. Similarly, individuals who experience a discrepancy between their own and ideal body may exercise to align their appearance with an ideal, potentially leading individuals to engage in rigorous exercise routines. Gori et al. (2021) found that body image concern positively mediated the relationship between body dissatisfaction and exercise addiction, suggesting that being dissatisfied with one's physical appearance may induce concerns regarding the latter, which in turn could foster exercise as a coping mechanism (Gori et al., 2021). Whether other factors may mediate these relationships remains unclear due to a lack of research. Additionally, the characteristics of the sample may have contributed to the lack of significant findings. In this study, participants were highly active, as indicated by their GLTEQ-scores, while the mean PSS scores were not

exceptionally high. This suggests that the population was not notably stressed. As argued by Egorov and Szabo (2013), this could be explained by the population's use of exercise as a coping mechanism for stress. The availability of exercise and physical activity could likely have contributed to reducing negative feelings and minimised the individuals' vulnerability to stress, resulting in a possibly less stressed sample.

Despite not finding a mediating effect, the study's results indicated that stress predicts exercise dependence unrelated to exercise identity or body dissatisfaction. Walter and Bodner (2024) represent some of the few studies that have incorporated the expanded model as part of their study's framework to examine the role of stress concerning exercise dependence. In their mixed method study, Walter and Bodner (2024) supported the idea that stress functions as a catalyst for an increase in exercise to cope with challenging and stressful circumstances. Therefore, exercise was used to compensate for and regulate difficult emotions caused by sudden stress (Walter & Bodner, 2024). In a sample of Israeli army reserves, Pinto et al. (2019) also found that stress is a predictor for exercise addiction. Consequently, individuals potentially turn to exercise for coping reasons, which could explain the direct effect of stress on exercise dependence. As suggested by these studies, there appears to be a relationship between stress and exercise dependence.

Additionally, significant direct effects were found between exercise identity and exercise dependence, as well as between body dissatisfaction and exercise dependence, aligning with the pathways by the interaction model. These findings are consistent with previous research. For instance, Cook et al. (2015) identified a significant relationship between exercise identity and dependence. Similarly, Murray et al. (2013), using the two-factor model of the EIS, found that the factor of exercise beliefs was significantly associated with exercise dependence. Regarding body dissatisfaction, Freire et al. (2020) identified it as

a potential risk factor for exercise dependence. These findings closely align with those of the present study, strengthening the consistency of results
across research and further supporting the interaction model's link between personal factors and exercise dependence.

The present study also indicated that 9.1% of the participants were at risk for exercise dependence, aligning with findings in previous research. For instance, Wågan et al. (2021) found that 9.9% of participants in their study were classified as being at risk. Szabo et al. (2019) reported a similar prevalence among regular exercisers. In their study, 9% were classified as being "at risk for exercise dependence" based on the EDS-R. A possible explanation for the study's relatively low prevalence, based on the model, could be that participants exercise for health benefits, enjoyment, or mastery orientation, as these are also associated with healthy exercise patterns (Dinardi et al., 2021; Egorov & Szabo, 2013).

Limitations

The study results must be interpreted cautiously as several limitations must be considered. The present study used a cross-sectional design, only allowing the identification of associations between variables but limiting the authors' ability to draw causal conclusions (Mitchell & Jolley, 2013). Self-report measures were used to investigate the mediating effect of stress in the relationship between exercise identity, body dissatisfaction and exercise dependence. Given the use of self-report measures and convenience sampling, there is a risk of social desirability bias. As described by Podsakoff et al. (2003), social desirability refers to participants' tendency to appear in a more desired manner. In this study, individuals who were easily accessible to the authors and matched the inclusion criteria were invited to participate. Consequently, the potential for participants to present their exercise behaviour as more balanced rather than dependent may have affected the results. It, therefore, could be viewed as a limitation of the study, as it could affect the accuracy of the results regarding

exercise dependence. Additionally, it could be likely that due to participation being voluntary, individuals with unhealthy behaviours were less likely to participate. By assuring anonymity, explaining how the information would be processed, and explaining the motivation for conducting the study, the authors aimed to minimise the effect. Through anonymity, the impact of social desirability can be reduced as participants feel more assured that their answers cannot be distinguished from others. Therefore, they answer more authentic to their feelings (Mitchell & Jolley, 2013).

In general, the questionnaires in this study showed good internal reliability, with values being above .80, which is considered satisfactory (Howitt & Cramer, 2024). Although this study adopted a convenience sample, it produced a relatively heterogeneous group of active individuals varying in age, gender, and forms of exercise. Convenience sampling is widely used in psychological research due to its practicality, accessibility, and cost-effectiveness (Howitt & Cramer, 2024). Importantly, the heterogeneity of the sample increases the generalisability of the findings to the broader population of active individuals, which could be viewed as another strength.

Implications and Future Research

This study provides insights into the expanded interaction model of exercise addiction (Dinardi et al., 2021). To the authors' knowledge, it is one of the first to examine the mediating role of stress regarding the development of exercise dependence, based on the framework proposed by Dinardi et al. (2021). Even though no mediating effect of stress was found, the study identified significant relationships between exercise identity, body dissatisfaction, stress, and exercise dependence. These results contribute to a more nuanced understanding of how these factors interact and influence exercise dependence. Although the study could not confirm stress as a key mechanism within the interaction

model, it highlights the complexity of the pathways leading to exercise dependence. It underscores the need for further research to explore alternative explanations.

Future research should continue testing the applicability of the expanded interaction model to further enhance the understanding of its various pathways, particularly the role of stress as its relationship to exercise dependence, which seems to be different from the model's proposal. This includes identifying suitable samples to explore whether stress may mediate other relationships among the variables in the model. Additionally, since this study followed a cross-sectional design, longitudinal studies would be valuable in establishing causal relationships. By tracking a population of regular exercisers over time, a longitudinal design would allow to rule out alternative explanations for influencing exercise dependence and provide a clearer picture of how changes in stress levels influence exercise dependence.

Conclusion

According to the expanded interaction model, personal factors and stress can potentially play a crucial role in developing exercise dependence (Dinardi et al., 2021; Egorov & Szabo, 2013). The study's result showed no significant indirect effect of stress on the relationship between exercise identity and exercise dependence or between body dissatisfaction and exercise dependence. Hence, the study could not confirm that stress functions as an underlying mechanism for exercise dependence, as the expanded interaction model suggested. Still, significant direct effects were found between exercise identity, body dissatisfaction and exercise dependence. Additionally, it was found that stress predicts exercise dependence, leading to the conclusion that exercise identity, body dissatisfaction and stress can be considered risk factors regarding exercise dependence among regular exercisers. This is also partly in line with the expanded interaction model, supporting its applicability. Still, studies regarding the interaction model are scarce, and more research is needed to test

the model's applicability further.

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