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PERSONALITY AND MOTIVATION IN PHYSICAL ACTIVITY: A MEDIATING EFFECT OF EXERCISE REGULATION IN THE PERFECTIONISM-PHYSICAL ACTIVITY RELATIONSHIP

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Personality and Motivation in Physical Activity: A Mediating Effect of Exercise Regulation in The Perfectionism-Physical Activity Relationship

Doctoral Dissertation

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List of Abbreviation

α	Cronbach's internal reliability index
β	Standardized regression coefficient or parameter estimate
BMI	Body mass index
BREQ	The behavior regulation in exercise questionnaire third edition
$\chi^2=$	Chi square statistics
CFI	comparative fit index
CI	Confidence interval
d	Cohen's effect size measure
DSM-5	The diagnostic and statistical manual of mental disorders fifth edition
EAI	The Exercise Addiction Inventory
EDS	The Exercise Dependence Scale
EDQ	The Exercise Dependence Questionnaire
HBM	The health belief model
LPA	low-intensity physical activity
METs	Metabolic Equivalent Task
MLR	Maximum likelihood parameter estimates
MPA	moderate-intensity physical activity
MPS	The multidimensional perfectionism scale
MVPA	moderate to vigorous physical activity
N	number of participants
NGO	Non-governmental organization

OEQ	the Obligatory Exercise Questionnaire
OOP	The other-oriented perfectionism
p	p value
PA	Physical activity
r	Pearson's correlation index
RAI	Relative autonomy index
RMSEA	root mean square error of approximation
SCT	The social cognitive theory
SD	standard deviation
SDT	The self-determination theory
SMD	Standardized mean difference
SOP	The self-oriented perfectionism
SPP	The socially-prescribed perfectionism
SRMR	standardized root mean square residual
TLI	Tucker-Lewis Index
TPB	The theory of planned behavior
TRA	The theory of reasoned action
TTM	The trans-theoretical model theory
VPA	Vigorous-intensity physical activity
WHO	World Health Organization

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List of publications included in the dissertation

Publication's Title	Journal's impact factor	Highest Q-rating of the journal
Çakın, G., Juwono, I. D., Potenza, M. N., & Szabo, A. (2021). Exercise Addiction and Perfectionism: A Systematic Review of the Literature. Current Addiction Reports. https://doi.org/10.1007/s40429-021-00358-8		Scimago: Q1 (2021)
Juwono, I. D., Kun, B., Demetrovics, Z., & Szabo, A. (2020). Mothers' Physical Activity in the New Millennium: A Systematic Review of the Literature. Baltic Journal of Sport and Health Sciences, 4(119), 4–23. https://doi.org/10.33607/bjshs.v4i119.1015		
Juwono, I. D., Kun, B., Demetrovics, Z., & Urban, R. (2022). Healthy and Unhealthy Dimensions of Perfectionism : Perfectionism and Mental Health in Hungarian Adults. International Journal of Mental Health and Addiction. https://doi.org/10.1007/s11469-022-00771-8		Scimago: Q1 (2021)
Juwono, I. D., & Szabo, A. (2020). 100 Cases of Exercise Addiction : More Evidence for a Widely Researched but Rarely Identified Dysfunction. International Journal of Mental Health and Addiction. https://doi.org/https://doi.org/10.1007/s11469-020-00264-6		Scimago: Q2 (2020)
Juwono, I. D., & Szabo, A. (2020). The efficacy of Self Determination Theory-based interventions in increasing students ' physical activity : A systematic review. Physical Activity Review, 8. https://doi.org/10.16926/par.2020.08.10		Scimago: Q3 (2020)
Juwono, I. D., Tolnai, N., & Szabo, A. (2021). Exercise Addiction in Athletes: a Systematic Review of the Literature. International Journal of Mental Health and Addiction. https://doi.org/10.1007/s11469-021-00568-1		Scimago: Q1 (2021)

Executive Summary

To be physically active to optimize health is more crucial than ever as it is considered a protective factor against many non-communicable diseases and prevents premature death (World Health Organization (WHO), 2020). It is estimated that between 26 and 33 percent of adults worldwide reported undertaking no physical activity or exercise other than their regular employment in their daily living (Ainsworth & Ananian, 2020; Guthold et al., 2018; United States Department of Health and Human Services, 2018). Inactive people have a significantly higher risk of developing coronary health issues by 14%, stroke by 25%, and are considered at risk of premature death due to cardiovascular problems than active individuals (Kraus et al., 2019). The health and economic consequences of physically inactive lives necessitate immediate and coordinated communitywide measures to encourage the least active to embrace more physically active lifestyles. Public health experts have viewed physical inactivity as the most significant problem (Ainsworth & Ananian, 2020). Hence, government, academics, NGOs, and private sectors have promoted physical activity in all feasible ways.

Academics have agreed on the importance of the inter-relation among individuals and environmental factors (including social, physical, and policy) in understanding physical activity (Bauman et al., 2012; Biddle et al., 2015; Yuma-Guerrero et al., 2017). Engagement in physical activity results from the combined intraindividual factors (both psychological and biological), interpersonal variables, the presence of supporting policy, and the physical and social aspects of the environment (Bauman et al., 2012). Four psychological models were more often used in understanding physical activity engagement than other theories (Gourlan et al., 2016). The four

are the trans-theoretical model theory (TTM), the social cognitive theory (SCT), the theory of planned behavior (TPB), and the self-determination theory (SDT).

The TTM focuses on how to 'facilitate' change by creating a decisional balance leading to the intended behavior. The SCT stresses how the presence of a 'model' could facilitate the adoption of behavior, while the TPB focuses on intention, and SDT focuses on how the environment promotes or thwart the fulfillment of intrinsic needs. Despite the differences in their approach, the theories acknowledge the crucial interplay between individual and environment to determine behavior (e.g., social support identification or facilitative climate creation). The theories have been used in conjunction with physical activity promotion, and the results seemed promising.

Studies still show a global decline in physical activity levels despite growing efforts to promote physical activities (Ainsworth & Ananian, 2020; Guthold et al., 2018; United States Department of Health and Human Services, 2018). There are contrasting groups: the inactive individuals and the excessive exercisers. By comparing the inactive and excessively active individuals, I hoped to find the determinant of physical activity engagement. For this reason, chapters two and three will focus on the opposing groups. Among the inactive groups are mothers, who continue to be a concern due to lack of activity. On another side, some individuals are so preoccupied with the desire to exercise. The following two chapters will summarize studies on the two populations.

A recent review found a decline in physical activity often accompanied certain life events such as pregnancy, transition into parenthood, or transition in education (e.g., from kindergarten to primary school or from high school to university) (Gropper et al., 2020). Insufficient physical activity levels were often found in women (especially mothers), people living in rural areas, and

certain minority ethnicities (Ainsworth & Ananian, 2020). Of these populations, mothers' physical activity has been the most studied. There have been three systematic reviews on mothers' physical activity (Abbasi & van den Akker, 2015; Bellows-Riecken & Rhodes, 2008; Juwono et al., 2020). The three systematic reviews agreed that mothers had a higher chance of having physical activity level decline and that a number of factors (e.g., perceived barriers, social support) played a part in mothers' low physical activity levels.

While there have been populations that continue to show a low level of physical activity, there are individuals who lose control over their exercise behavior (Çakın et al., 2021; Juwono & Szabo, 2020a). Their urge to exercise often results in adverse effects (e.g., conflict with others, injury). These are known as exercise addiction. There have been studies investigating factors contributing to the emergence of exercise addiction. One of the most often studied variables of exercise addiction is perfectionism (Bircher et al., 2017; Çakın et al., 2021). Scholars have found that a specific type of perfectionism could be observed in those suffering from exercise addiction.

Physical inactivity (or low physical activity level) and exercise addiction could be opposites in the physical activity continuum. However, the two opposites have been investigated with different variables (i.e., low physical activity with perceived barriers, social support, self-esteem; exercise addiction with personality such as perfectionism) (Bauman et al., 2012). Hence, it is impossible to determine what differentiates active and inactive people. Studies have suggested that perfectionism could explain differences in exercise behavior (Box et al., 2019; Box & Petruzzello, 2020; Longbottom et al., 2010, 2012; Neilands et al., 2008). However, these studies are primarily conducted on regular exercisers, excluding the non-exerciser participants.

The dissertation intends to fill the gap by modeling how perfectionism could influence exercise behavior and differentiate exercisers and non-exercisers. The dissertation aims to answer the question, "Could perfectionism and exercise regulation explain the differences in physical activity levels?" Perfectionism and exercise regulation has been found to implicate engagement in exercise (Bircher et al., 2017; Box & Petruzzello, 2020; de la Vega et al., 2020; Duncan et al., 2010a; Feito et al., 2018; González-Hernández et al., 2021; Longbottom et al., 2012). Perfectionism and motivation could come from different sources (i.e., self-oriented vs. socially prescribed perfectionism; intrinsic vs. extrinsic motivation) (Box et al., 2019; Cox et al., 2002). Researchers have suggested that motivation could mediate a link between perfectionism and exercise, especially since motivation is often touted as the proximal determinant of exercise behavior (Box et al., 2019; Box & Petruzzello, 2020; Feito et al., 2018). For this reason, I assert that domains of perfectionism would predict certain exercise regulation motives, which later predict exercising behavior. The hypotheses are tested in studies described in chapter four.

I conducted two studies to test my hypotheses. 1365 adults (949 females and 416 males) participated in the first study. They were both regular exercisers and non-exercisers. The participants filled out instruments measuring perfectionism, exercise regulations, and exercising habits. My analysis showed that only self-oriented perfectionism had a small but significant negative correlation with exercise volume. Different exercise regulation types had substantial correlations with exercise volumes. However, there was a multicollinearity problem among the exercise regulation types. My analysis also revealed that the different domains of perfectionism's path to exercise volume was mediated by different exercise regulation. In my model, the SOP could predict exercise volume directly and indirectly through the mediating power of the identified. The SPP can only predict total exercising time when mediated by external regulation.

I also found that perfectionism and exercise regulation function differently in regular and non-exercisers. In non-exercising participants, the SOP can predict the exercise volume directly or when mediated by the identified regulation. The SPP can only predict introjected and external regulation, but not the total exercise time.

The second study intended to replicate study one findings with different participants. 645 regular exercisers participated in the second study (254 males and 391 females). My analysis showed that perfectionism has no association to exercise volumes in the regular exercisers. Exercise regulations had significant correlations to exercise volumes, but a similar multicollinearity problem also existed. My analysis revealed that exercise regulation mediated the relationship between perfectionism and exercise volume. Specifically, the identified regulation mediated the association between the SOP with exercise volume. The individual with a high score of SOP would have more increased identified regulation, which could lead to a higher probability of spending more time exercising. The identified regulation also mediated the association between the SPP and total exercise time differently. Individuals with high SPP would have lower identified regulation, leading to less time to exercise. The external regulation also mediated the interconnection between SPP and total exercise volume.

The second study also showed that gender might influence perfectionism and exercise regulation in an exercise setting. The analysis showed that identified regulation mediated the association between the SOP and exercise volume in both genders, but the mediating impact of identified regulation was more potent in men. I also found that external regulation mediates the association between the SPP and total exercise time, especially in women. A woman who felt she had to be perfect due to external pressures (i.e., high in SPP domain) would have high external regulated motives, which subsequently drop the exercise volume.

The two studies showed that by analyzing both perfectionism and exercise regulation motives, we could find differences between non-exercisers. The author also found gender could moderate the pathways of perfectionism and exercise regulation motives function in exercisers, which showed support from prior studies (Duncan et al., 2010a; Jennsen & Dillern, 2021; Luque-casado et al., 2021). The findings implied the importance of considering individual factors in understanding exercise engagement, including in interventions, especially the role of perfectionism and motivation (Engels et al., 2022; Rhodes & Smith, 2006). In an applied setting, the finding implies that a tailored intervention (i.e., adjusting intervention to individual uniqueness) is crucial to increase the effectiveness of the intervention.

The dissertation's findings should be interpreted with caution. The studies conducted in the dissertation were cross-sectional. The cross-sectional nature of the studies prevented a solid causal inference between the included variables. More research in the future should consider a longitudinal design to validate the finding of the current dissertation. The studies' participants were also limited to those who are internet savvy. Despite the limitations, the dissertation is perhaps the first to study the differences between regular and non-exercisers using perfectionism and exercise regulation in the same study.

Chapter 1: The global decline of physical activity

1. 1. Physical activity definition

Physical activity is bodily movements produced by skeletal muscles that result in energy expenditure (Caspersen et al., 1985; World Health Organization (WHO), 2018). We should not confuse physical activity with exercise. Exercise is a more specific form of physical activity done in a more structured and repetitive nature, intending to improve or maintain overall physical fitness (Caspersen et al., 1985). The physical activity covers a vast category, including occupational, household, and recreational activities. It encompasses activities such as commuting to and from the workplace, walking a pram or pet to a park, cleaning the house, dancing with friends, and many more.

Physical activity can be an integral part of one's work (e.g., carrying things from one place to another) and any obligatory activity as part of daily living. Physical activity could also serve as a means to serve recreational purposes (e.g., engaging in sports classes, dancing, walking) (World Health Organization (WHO), 2018). Despite the different nature of the activity (recreational versus obligatory activity), scientists have found that regularly active is beneficial (World Health Organization (WHO), 2018, 2020). Being physically active might improve physical and mental health well-being and reduce mortality risk. Furthermore, physical activity is one of the most crucial factors preventing non-communicable diseases like diabetes, cardiovascular and coronary diseases (Kraus et al., 2019).

Scientists have categorized physical activity into different forms based on the energy required to execute it. According to this classification, physical activity could be sedentary, light-

intensity physical activity (LPA), moderate-intensity physical activity (MPA), or vigorous-intensity physical activity (VPA). Sedentary behaviors require the least energy to engage (Ainsworth et al., 2011; Khoja et al., 2016). Sleeping, sitting (quietly), and watching TV are sedentary activities. Sedentary behavior also serves as the baseline from which the remaining categories emerge (Ainsworth et al., 2011; Hendelman et al., 2000; Jeon et al., 2007; Khoja et al., 2016; Shiroma et al., 2014). LPA are activities that require little energy to engage, including washing dishes, cleaning windows, folding laundry, and many others (Khoja et al., 2016). These activities can result in 1.5-2.9 times more energy expenditure than sedentary behaviors. MPA are activities that require between three to six times more energy expenditure than resting (Ainsworth et al., 2011; Jeon et al., 2007; Shiroma et al., 2014). Brisk walking, recreational swimming, and playing golf are moderate-intensity activities. VPA are activities that require at least six times the energy needed for resting (e.g., running, aerobic dancing, hiking) which are always accompanied by increased heart rate and sweating.

1. 2. The benefits of physical activity

Regularly engaging in physical activity can result in numerous health benefits, regardless of intensity. Even integrating light intensity physical activity can benefit older adults and those with moderate-severe illnesses such as cancer (Blair et al., 2014). Integrating standing (a form of LPA) in an 8-hour workday could also result in better blood pressure (Zeigler et al., 2016). One should note that LPA alone does not prevent or reduce the associated risk factors of mortality and cardiovascular diseases in a healthy population (Batacan et al., 2015). Studies have shown that to benefit from physical activity one must incorporate moderate-to-vigorous physical activity (MVPA) in their daily living. Research shows that incorporating MVPA could lower

mortality rates (Fishman et al., 2016; Hupin et al., 2015; Saint-Maurice et al., 2018) and prevent many non-communicable diseases (e.g., coronary heart disease, type 2 diabetes, cancer) (Lee et al., 2012; World Health Organization (WHO), 2018).

Regularly incorporating physical activity into one's daily life could also impact mental health. Studies suggest that being physically active could influence physical self-perception, which results in heightened self-esteem, reduced anxiety, and increased cognitive and academic performance, especially in adolescents and youth (Biddle & Asare, 2011; Lubans et al., 2016). Physical activity could also bring forth positive outcomes in individuals with mental health issues. A recent systematic review of meta-analytic studies showed that physical activity could alleviate symptoms of depression and anxiety and help overcome substance and alcohol abuse in the clinical and general adult population (Czosnek et al., 2019).

1. 3. The global decline of physical activity levels

Given the mounting evidence regarding the importance and benefits of physical activity, the World Health Organization (WHO) outlines recommendations for physical activity for different populations (World Health Organization (WHO), 2020). One should engage in at least 150-300 minutes of MPA spread throughout the week. The MPA could be done by doing five bouts of brisk walking for 30 minutes per session. One can also benefit from physical activity by engaging between 75-150 minutes of VPA, equal 5-time bouts of 15 minutes of running per week. Additional health benefit could be acquired if one increases the total time of MVPA and incorporate muscle-strengthening activities at least two times per week.

In 2013, the WHO set a target to reduce the worldwide physical inactivity rate by 10% by 2015 (World Health Organization (WHO), 2018). To achieve this goal, the WHO encouraged

their member states to create active people, societies, environments, and systems by outlining policies, creating development plans, and initiatives that encourage people to be more active. Despite the existing guidelines outlined by the WHO, studies showed that people are failing to meet the recommended level of physical activity (Guthold et al., 2018; Hallal et al., 2012; World Health Organization (WHO), 2018). An analysis of data collected from 122 countries revealed that around one-third of adults (aged 15 years or older) did not meet the public health recommendation, with the highest prevalence of sedentary lifestyle being more profound in the eastern Mediterranean and America region (Hallal et al., 2012). Another study that compares the level of physical activity between 2001 and 2016 revealed that the number of people meeting the recommended level of physical activity remains the same (Guthold et al., 2018). The consistent rate of people failing to meet the recommended guideline occurs despite growing initiatives by the government worldwide to increase physical activity.

1. 4. Correlates of physical activity

The following sections outlines multiple factors that have been studied in conjunction with physical activity. Understanding the associated factors is crucial because it might suggest designing an effective intervention to reduce physical inactivity (Biddle et al., 2015). Correlates of physical activity could help us in two ways. First, a better understanding of modifiable factors of physical activity could be a target of intervention. By knowing how factors impact physical activity, interventions could be designed to these factors. In this regard, correlates are the mediator of change in physical activity. Second, by identifying unmodifiable correlates of physical activity, we could better identify populations prone to physical inactivity for whom intervention could be designed.

Scientists have long investigated why some people are active while others are sedentary. Early findings of the studies put a strong emphasis psychobiological model of exercise. In this model, participation and maintenance of exercise behavior are influenced by psychological and biological factors (Biddle & Mutrie, 2008). Scientists attributed differences between exercisers and non-exercisers to certain physiological features, such as muscle fiber, functional capacity, and body composition. For example, individuals with more body fat reported more discomfort during exercise, which led them to stop exercising later. The psychological factors differentiating between regular exercisers and non-exercisers include spousal support and perception of facility convenience. A few of these variables were subsequently integrated into more elaborated psychological theories of physical activity, which will be explained later this chapter.

1. 4. 1. The ecological model of physical activity

There was a shift in the way researchers studied physical activity as more researchers from various backgrounds delved into the topic. Inter-relation among individuals and environmental factors (including social, physical, and policy) has been added to the framework, resulting in an ecological approach to understanding physical activity (Bauman et al., 2012; Biddle et al., 2015; Yuma-Guerrero et al., 2017). The ecological model assumes that physical activity as a behavior is not only influenced by factors within the individuals (both psychological and biological), but it is also a result of interpersonal variables, the presence of supporting policy, and the physical and social aspects of the environment (Bauman et al., 2012).

All domains of the ecological models were necessary to understand the underlying mechanism of physical activity. For example, the impact of the socio-economic situation of

countries worldwide could determine the type of physical activity suitable for the country (Bauman et al., 2012). Since the most prevalent physical activity in developing countries is work-related or commuting, improving physical activity levels should concentrate on these areas. In contrast, in more developed countries, exercise in leisure time is more prominent. Therefore, physical activity promotion should focus on the utilization of leisure time. However, we need more studies as the factors in the ecological models are not equally studied. More studies concentrate on the intra- and interpersonal aspects, while the remaining domains are less investigated.

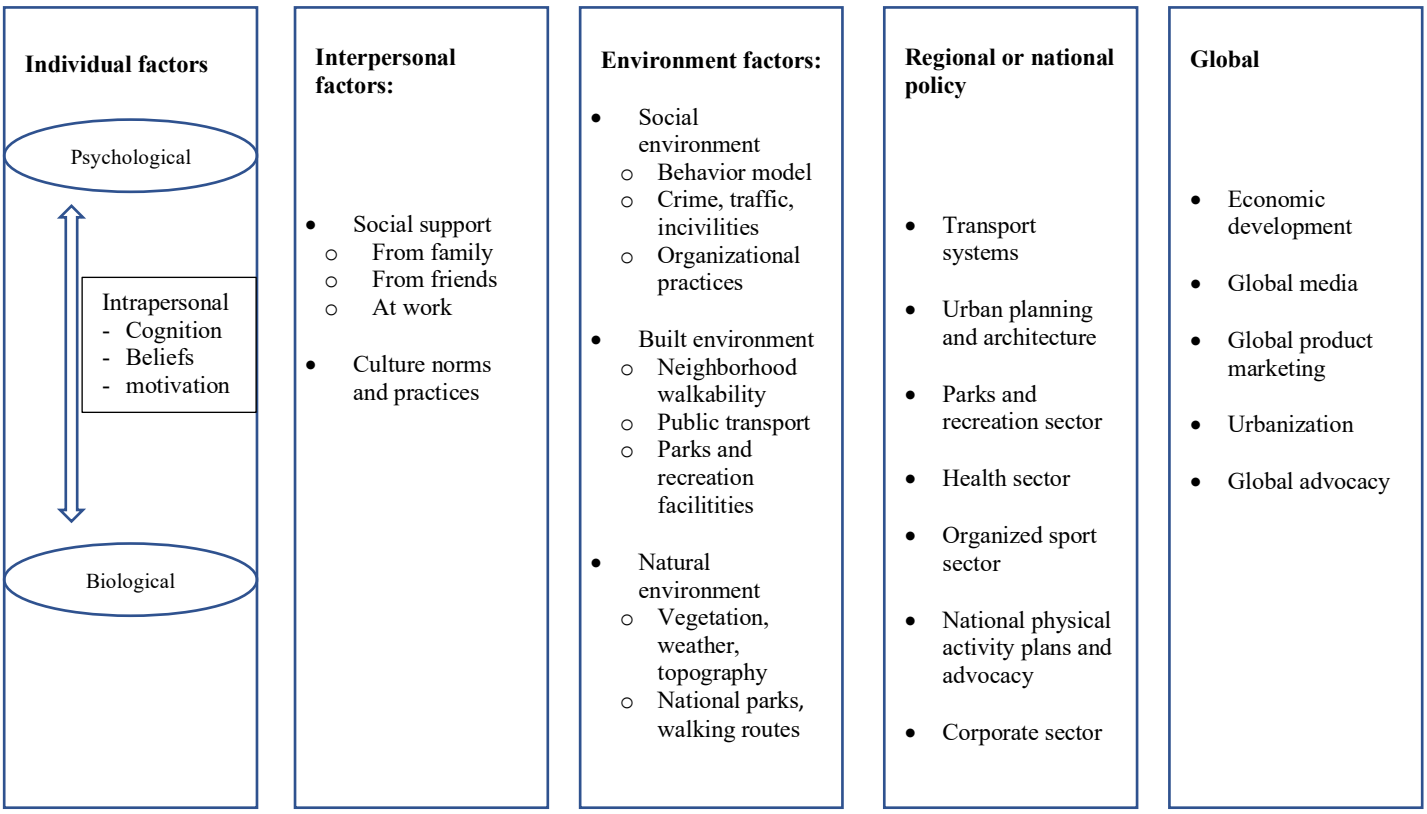
At the turn of the century, researchers tried to summarize the findings of studies of physical activity and its potential correlates (Trost et al., 2002). These scholars classified physical activity correlates into six categories: demographic and biological; psychological-cognitive-emotional; behavioral attributes and skills; social and cultural; physical environment; and physical characteristics in agreement with the ecological model. Demographic and biological factors include age, gender, socioeconomic status (including occupational status and highest education attained), and obesity status. Among these factors, gender is the most consistent factor, as women are less active than men.

The psychological-emotional-cognitive factors are wide-ranging intraindividual factors, including, among others, attitudes, perceived behavioral control, intentions, normative beliefs, self-efficacy, and perceived barriers (Trost et al., 2002). The most studied factors concerning physical activity are self-efficacy, perceived barriers, and social support. Scientists concluded that the three factors consistently contribute to physical activity. In contrast, scholars found less convincing evidence to support characteristics described in the theory of planned behavior or

theory of reasoned action (e.g., intentions, perceived behavioral control, normative behavior). Furthermore, these factors had no or minimal association with physical activity engagement.

Figure 1

Factors associated with physical activity based on ecological models



Note. Based on "Correlates of physical activity: why are some people physically active and others not?" by A.E. Baumann et al., 2012, *The Lancet*, *380*(9838), 258–271. Redrawn by the current author

The behavioral attributes and skills are behaviors (other than exercising) related to physical activity. Trost and colleagues (2002) found that past or current exercising habit is the

only consistent predictor of physical activity engagement. These researchers also concluded that dietary behavior had an inconsistent correlation with physical activity. Those who are active might not engage in a healthy diet or vice versa. Another behavioral attribute is smoking behavior. Smoking had an inverse relation with physical activity, in which smokers tend not to be sufficiently active, and those who regularly exercise care not to smoke.

The social and cultural factors include past family influence, physician influence, social support from friends, social support from spouse, and social support from instructor (Trost et al., 2002). There was enough evidence to conclude that social support was a significant correlate of physical activity among these factors. One study estimated women with high social support would have a higher probability of meeting the recommended physical activity guideline (Y. D. Miller et al., 2002). The percentage of friends who exercise was also a strong predictor of exercise engagement (Plotnikoff et al., 2004).

Physical and environmental factors might include access to facilities, traffic to facilities, neighborhood safety, the cost to facilities, and many others. Scientists argued these factors might impact physical activity (Trost et al., 2002). The assertion that biological and environmental factors contribute to physical activity shows that behavior adoption and maintenance of exercising is not occurring without context. One example is a study conducted in Australia which showed that access to quality public transport and perceived safety in the neighborhood contribute to increases in walking during free time (Cleland et al., 2008). Another study with 2750 participants found that social cohesion (social factor) could mediate perceived environmental safety (environmental element) and influence physical activity (Yuma-Guerrero et al., 2017). The result found that social cohesion did mediate perceived environmental safety, which led to improved physical activity. The two studies demonstrate the importance of

interrelation among different correlates to physical activity. Despite a growing awareness of the impact of physical, social, environmental, and policy factors on an active lifestyle, more studies are needed to ensure the effectiveness of these factors (Trost et al., 2002).

Early proponents of the ecological model of physical activity asserted that as the economic, education, and employment opportunities improve, awareness of the importance of being physically active should also increase, especially for the leisure time activity (Bauman et al., 2012). However, recent studies have shown the contrary. An increased rate of physical inactivity is more evident in high-income countries than in low-income countries (Guthold et al., 2018). One plausible explanation for this is that employment is more physically demanding in low-income countries. In contrast, in high-income countries, the advancement of technology available for work and increased use of motorized transportation modes all play a role in the incline of sedentary life and workstyle (i.e., spending more time in front of a computer and sitting) (Bauman et al., 2012; Guthold et al., 2018; Hallal et al., 2012).

1. 4. 2. Psychological theories of physical activity

Scientists have long utilized a more thorough approach to explaining specific health behavior's adoption, maintenance, and refusal. It goes back to the 1950s when scientists used the Health Belief Model (HBM) to guide tuberculosis research (Rejeski & Fanning, 2019). Since then, the type of health behavior has expanded, and so too have the theories. New theories have been developed to guide research in a health setting. A theory is a form of cumulative knowledge describing potential factors and mechanisms for behavior change, which could be applied in intervention studies (Dalgetty et al., 2019). A theory provides a standardized framework from which intervention could be developed and evaluated. For example,

intervention studies based on social cognitive theory should work on constructs such as self-efficacy or expectations outcomes. A self-determination theory-based intervention should work around the concept of autonomy, competence, and relatedness central to the theory.

Davis and his colleagues summarized the arguments for incorporating a theoretical framework in intervention studies (2015). First, a theory with its constructs can identify possible antecedents and their interrelations. These constructs could serve as guidelines in developing an intervention for the researchers to target. Second, theories often describe interrelations among constructs, thus providing possible causal links between the constructs and the behavioral outcome. Third, theory sums up the aggregate of knowledge of behavior change across different contexts (i.e., population, setting). And last, theory-based intervention allows the evaluation of the theory itself: whether a theory can explain the phenomenon under investigation. Researchers could determine if theory-based intervention is successful or not. In the context of physical activity, a theory could provide a more thorough explanation (antecedents, mechanism of change). Moreover, a theoretical framework can function as a guideline for intervention studies to confirm or reject the application of particular theories in physical activity.

In 2016, researchers scanned through databases and found 82 theories implemented in studies on different health behavior outcomes (Gourlan et al., 2016). Four of the most often used theory in health settings are the trans-theoretical theory, the social cognitive theory, the theory of planned behavior, and the self-determination theory. We will delve into these theories and how they have been implemented in studies of physical activity.

1. 4. 2. 1. The Trans-theoretical model

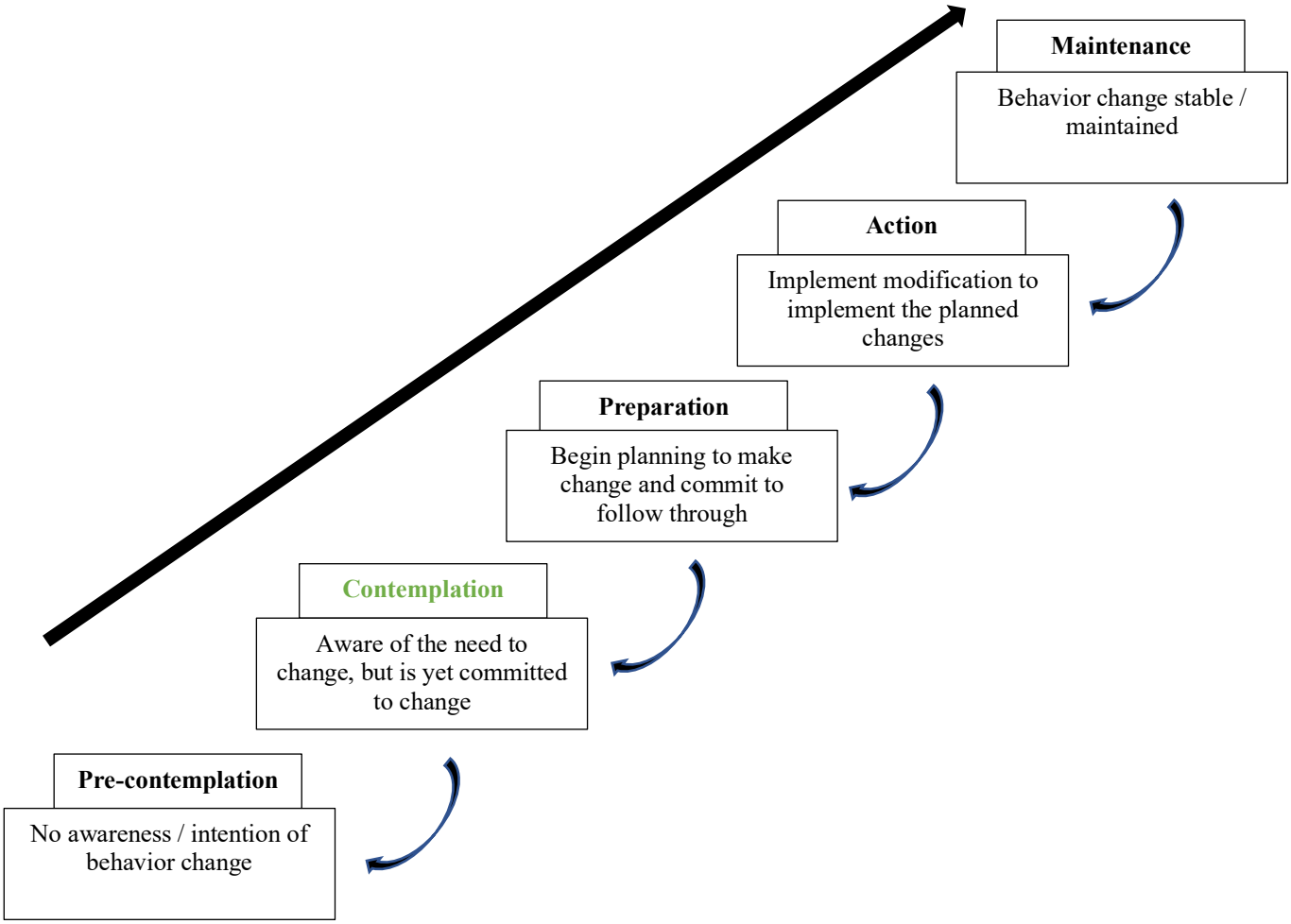
Trans-theoretical model (TTM) is the hallmark of Prochaska which states any successful behavior change happens in a series of stages (Biddle et al., 2015; Biddle & Mutrie, 2008; Velicer et al., 1998). The first stage is called 'precontemplation.' A person in this stage is not thinking or has no intention of changing at the time. In physical activity, it could mean that the person is not meeting the recommended level and is not considering changing it. The second stage is 'contemplation,' in which the person starts to think or have the intention to be more active. He 'wants' to be active but perhaps is not yet meeting the physical activity level. In the 'preparation' stage, the individual is likely to engage in physical activity, but not regularly. In the 'action' stage, the individuals exercise periodically but have just started incorporating it into their lifestyle. Hence, the behavior is lasting, but the individuals are prone to quit or revert to an inactive lifestyle. The last stage is 'maintenance,' where the behavior is stable.

The TTM stages occur in a cyclical rather than linear (Biddle et al., 2015; Biddle & Mutrie, 2008; Velicer et al., 1998). Although the stages appeared to be phased sequentially, (i.e. pre-contemplation→ contemplation → preparation → action → maintenance), TTM suggested that individuals may regress to earlier stages. An example of this would be if an individual is currently contemplating to start walking to lose some weight. At the same time the individual might have reservation about the benefit of walking in reducing weight, bringing the individual back to pre-contemplation. Figure 2 describe the proposed progression of change in the model.

The TTM proposes that changes in behavior result from a combination of cognitive, affective, and behavior strategies used along the stages over time (Biddle et al., 2015; Biddle & Mutrie, 2008; Velicer et al., 1998). The processes indicative of a change in TTM are decisional

Figure 2

Change in the transtheoretical model



Note. Based on "Psychology of Physical Activity: Determinants, Well-being, and Intervention (third edition)," by S. J. H. Biddle, N. Mutrie, and T. Gorely (2015). Redrawn by the current author

balance, self-efficacy, and the target behavior itself (Velicer et al., 1998). Decisional balance lists down the pros and cons of a target behavior and puts weight into each item. Self-efficacy in

TTM is adapted from the SCT, reflecting confidence to engage in targeted behavior without relapsing to the introductory level amidst challenging situations. In this regard, it is essential to measure both efficacy and situation temptation in TTM.

1. 4. 2. 1. 1. Behavior change techniques in TTM

A cognitive-affective-behavior intervention needs to elicit transition to a more advanced stage within TTM (Biddle et al., 2015; Biddle & Mutrie, 2008). Cognitive intervention could come in different forms. Educating the benefits of the behavior (e.g., improving the information on physical activity and its usefulness), increasing risk awareness, finding healthy alternatives, or caring about the consequences of not engaging in the behavior to others (e.g., family, friends). Intervention based on the TTM often encourages the clients to list down the advantage of the behavior and the disadvantage of not engaging in the behavior (e.g., the benefit of regularly exercising versus being sedentary). Other than cognitive intervention, the TTM also employs behavioral strategies to change behavior (Biddle et al., 2015; Biddle & Mutrie, 2008). Encouraging individuals to seek alternatives, list social support, and create a contingency plan that includes a self-reward system and a self-monitoring system are behavioral change techniques used in TTM.

1. 4. 2. 1. 2. Evidence from TTM-based interventions studies

The TTM was first employed in the effort to help individuals cease smoking but have since been applied to different health behavior, including physical activity (Marshall & Biddle, 2001; Velicer et al., 1998). A meta-analysis found 91 studies using TTM to improve physical activity (Marshall & Biddle, 2001). This study concluded that physical activity levels change as

individuals move through the stages. Of the four transitions between stages, an increase in physical activity accompanied three transitions. The researchers observed the biggest difference between the preparation stage and action (d = .85, 95% CI = .64 – 1.07). However, the same study also detected a change in physical activity level from pre-contemplation to contemplation (d = .34, 95% CI = .14 - .55), disproving the assumption that individuals in pre-contemplation and contemplation might share similar inactivity levels.

A more recent review of 34 interventions studies to increase physical activity claiming to use TTM offered a striking conclusion (Hutchison et al., 2009). The researchers observed that TTM was thoroughly used only in 7 studies. Only the seven studies reported proper use of cognitive and behavioral strategies and measuring the stage changes. Of the seven, six studies reported a significant impact of TTM-based intervention. The studies concluded that the researchers often failed to operationalize the TTM thoroughly in the intervention studies.

Critics of the TTM pointed to at least three more reasons (Biddle et al., 2015; Biddle & Mutrie, 2008; Marshall & Biddle, 2001). The first is that the reported TTM-based intervention often came from cross-sectional and not experimental studies. A cross-sectional study prevents causal relationships from being tested, unlike experimental designs. The second critique revolves around the unstandardized measurement used in the studies, especially for measuring efficacy and situational temptations. And the last comment points to the unclear mechanism underlying the change. In some studies, the phases-like processes could not be verified. In intervention studies to improve physical activity, the TTM is criticized for not explaining the changes due to factors not integrated into the model (Hutchison et al., 2009). Moreover, physical activity might be a more complex than other health behavior in which TTM has been proven useful (e.g., smoking cessation) (Hutchison et al., 2009; Marshall & Biddle, 2001).

1. 4. 2. 2. The social cognitive theory

The social cognitive theory (SCT) is a theory based on the seminal work of Albert Bandura (Biddle et al., 2015; Stacey et al., 2015; Young et al., 2014). The central premise of the SCT is that human behavior is acquired through interaction between personal, behavioral, and environmental factors. The SCT evolves from behaviorism which stresses the importance of environmental influence on individual learning. In the SCT, the individual is not a passive recipient of environmental effects but can also influence the environment and behavior. The three influence each other, known as 'reciprocal determinism.' (see figure 2)

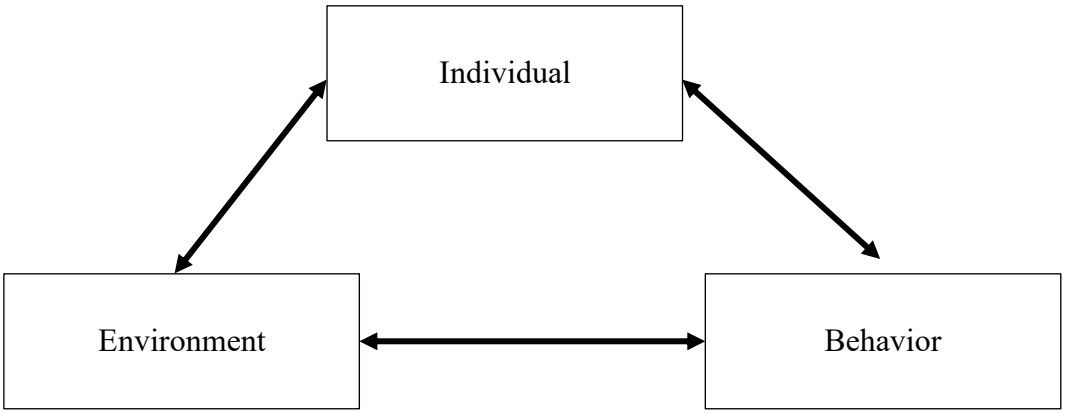
In the SCT, the individual is active in that our thinking plays a significant role. Human's ability to think about, observe and anticipate future courses of action are central to SCT (Biddle et al., 2015; Biddle & Mutrie, 2008). To learn a behavior, one need not experience it firsthand but can observe the experience of others and then reflect on the observed consequences. We will 'model' behavior when we see others being reinforced for doing so, and we value the consequences positively (Stacey et al., 2015; Young et al., 2014). Conversely, if the model receives a devalued result, we will not engage in the behavior. Someone could follow others to exercise after observing that others who regularly engage in physical activity have improved fitness and weight loss, which might be valuable for the observer.

Two interrelated terms need to be described here: self-efficacy and outcome expectancies. Self-efficacy, sometimes mentioned as 'efficacy expectancies,' can be defined as one's judgment of their capabilities to execute several actions to reach specific goals (Biddle et al., 2015; Stacey et al., 2015; Young et al., 2014). Self-efficacy is more a reflection if one believes they can do the intended behavior with their skills as it is. Proponents of SCT view self-

efficacy as a powerful behavior determinant across different settings and is often used as part of the intervention in health settings.

Figure 3

Reciprocal determinism in the social cognitive theory



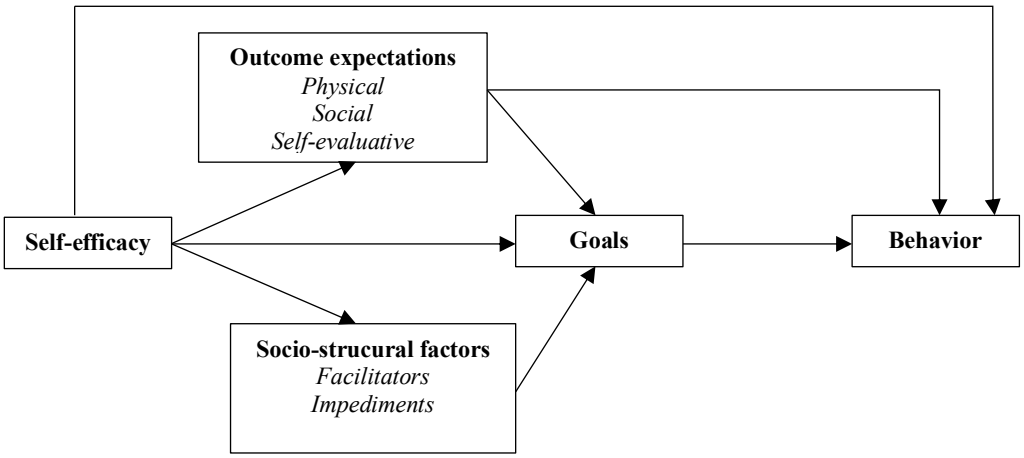
Note. Based on "Psychology of Physical Activity: Determinants, Well-being, and Intervention (third edition)," by S. J. H. Biddle, N. Mutrie, and T. Gorely (2015). Redrawn by the current author

The second factor is outcome expectancies, the expected thought of possible consequences when engaging in a behavior (Biddle et al., 2015; Stacey et al., 2015; Young et al., 2014). For example, if we expect walking 10,000 steps daily to help lose weight and losing weight is vital to our self-esteem, we would likely adopt walking and maintain it. Conversely, if we anticipate that walking daily to 10,000 steps would tire us and cost us time from doing other things, the likelihood of us engaging in the behavior is low. In the health setting, SCT proposes that outcome expectancies could be physical (i.e., body sensations), social (i.e., the

approval/disapproval of others), or self-evaluative (i.e., how one would feel about themselves for performing specific behavior) (Young et al., 2014).

Figure 4

Proposed mechanism of change in the social cognitive theory



Note. Based on "Social cognitive theory and physical activity: A systematic review and meta-analysis," by M. D. Young, R. C. Plotnikoff, C. E. Collins, R. Callister, and P. J. Morgan, 2014, *Obesity Reviews*, 15(12), p. 984. Redrawn by the current author

Besides outcome expectancies and self-efficacy, behavioral goals and socio-cultural factors are crucial in SCT (Young et al., 2014). Goals give guidance and inform the individuals about the intended target. In physical activity, an example of goals could be reducing waist circumference, improving overall health, and many others. It is crucial to have regulatory skills (goal-setting, self-monitoring, and contingencies for progress) to attain the goals. And lastly, a behavior could also be influenced by socio-cultural factors, which include factors outside the individual which are thought to exert influence on the intended behavior. The hypothesized

relation between self-efficacy, outcome expectancies, goals, socio-cultural factors, and intended behavior is depicted in figure 4.

1. 4. 2. 2. 1. Behavior change techniques in SCT

There are several change techniques associated with the SCT. Knowledge provision is among the chief change technique employed in SCT-based interventions (Stacey et al., 2015). Intervention can provide information on the positive and negative consequences of the behavior to the individuals. By explaining the benefits and negative impacts of behavior, the individual is asked to set a behavioral goal to be achieved. Knowledge provision can also target improved self-efficacy, especially if the interventions provide instructions or models on how to do the intended behavior for individuals lacking the knowledge to do the target behavior.

Academics have used other strategies to improve self-efficacy to do the intended behavior (Stacey et al., 2015). Among these are prompting self-monitoring and behavior practice for the individuals. Once the individuals know how to execute the behavior, they should be taught how to record their progress and failures. They also need to be enabled to analyze what contributes to their success or shortcomings. They also need to be taught how the analysis is taken in the following action sequence. All actions should help improve self-efficacy and manage realistic goals and expectations.

Other change techniques in SCT-based interventions include barrier identification and problem-solving (Stacey et al., 2015). Intervention might include activities to help individuals reflect on obstacles preventing them to do the targeted behavior. Problem-solving interventions often follows the barrier identification. Problem solving intervention might include restructuring the environment, finding cues in the environment to initiate the behavior, anticipating regret/

failure, and identifying social support. These actions could result in realistic goals and expectation management.

1. 4. 2. 2. 2. Evidence from SCT-based interventions studies

SCT is a helpful framework to explain physical activity levels, with one meta-analysis study estimating random effect accounting for 31% of the variance in physical activity (Young et al., 2014). However, SCT-based intervention studies often focus only on self-efficacy and excluding the other factors (Conn et al., 2011; Young et al., 2014). Scholars argued that even though self-efficacy had a direct influence on specific health behavior, its connection to behavior is also believed to be mediated by outcome expectations, goals, and socio-cultural factors.

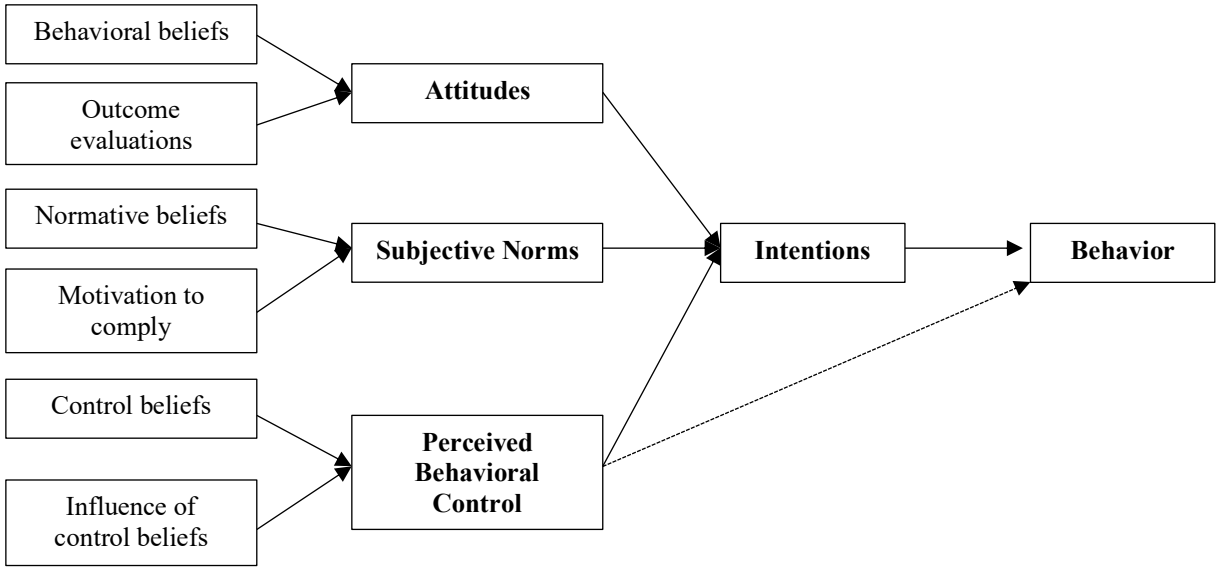
The efficacy of SCT-based interventions is promising in different setting within the health behavior. In a systematic review of SCT-based intervention with cancer patients, the interventions could yield a small-to-medium effect size in patients' physical activity (standardized mean difference (SMD) = .33; $p < .01$) (Stacey et al., 2015). Another meta-analytic study evaluated SCT-based interventions to increase the physical activity level of healthy adults (Young et al., 2014). The study also supports SCT value eliciting an increased physical activity level, albeit with a smaller estimated effect size (mean effect size $d = .12$).

1. 4. 2. 3. The theory of planned behavior

The theory of planned behavior (TPB) is the hallmark work of Ajzen and Fishbein (Ajzen, 2011; Biddle et al., 2015; Prestwich et al., 2013; Sniehotta et al., 2005, 2014). The TPB has been used as the foundation of numerous research (Ajzen, 2011; Francis et al., 2004). The TPB focuses on untangling the underlying cause of a specific volitional behavior.

Figure 5

Theory of planned behavior



Note. Based on "Psychology of Physical Activity: Determinants, Well-being, and Intervention (third edition)," by S. J. H. Biddle, N. Mutrie, and T. Gorely (2015). Redrawn by the current author

The TPB assumes that behavior is volitional, deliberate, and executed after specific cognitive and affective related processes (Biddle et al., 2015). A central tenet in TPB is that behavior must have a compatible attitude, evaluating the degree of favorableness of a specific behavior (Ajzen, 2011). Attitude is an evaluation process regarding the conduct that encompasses cognitive (e.g., belief about the potential benefit) and affective (e.g., belief in the significant other's evaluation of the behavior). TPB proposes that each behavior must have a corresponding attitude. A specific behavior could result from beliefs (behavioral beliefs, normative beliefs, and control beliefs) held over that behavior (Biddle et al., 2015; Biddle &

Mutrie, 2008). An individual is more likely to engage in regular physical activity if she has a positive attitude toward physical activity.

The TPB proposes that we could expect a specific behavior could with a particular attitude, subjective norms, and perceived behavioral control (Ajzen, 2011; Biddle et al., 2015; Prestwich et al., 2013; Sniehotta et al., 2005, 2014). The three factors would influence the intention to engage in the behavior, the closest predictor of the behavior. Attitude is an evaluation of behavior. This evaluation has two components: the cognitive assessment of the possible consequences of engaging or not engaging in the intended behavior (referred to as the behavioral beliefs) and the judgment about each consequence (referred to as outcome evaluation).

The second factor is the subjective norms, which is a subjective estimation of the individual regarding the social pressure one feel to perform the target behavior (Ajzen, 2011; Biddle et al., 2015; Prestwich et al., 2013; Sniehotta et al., 2005, 2014). Subjective norms represent beliefs about significant others' thinking (the normative belief) and the evaluation toward that belief (the motivation to comply). An example of this will be if a person feels that the spouse would be happier if one is exercising regularly (normative belief), that person feels the urge to comply (motivation to comply).

The third factor is whether the behavior could be done or if one owns total control of the behavior (Ajzen, 2011; Biddle et al., 2015; Prestwich et al., 2013; Sniehotta et al., 2005, 2014). This is known as perceived behavioral control. The perceived behavioral control is an addition to the previous two factors in the theory, which differentiate TPB and the prior theory of reasoned action (TRA) (Biddle et al., 2015; Sniehotta et al., 2005, 2014). The perceived behavioral control consists of two components: how much power a person has over the behavior (control

beliefs) and how confident a person feels about being able to do or not conduct the behavior (influence of control beliefs) (Ajzen, 2011; Biddle et al., 2015; Prestwich et al., 2013; Sniehotta et al., 2005, 2014). Suppose a person expresses that exercising is challenging due to uncontrollable factors (e.g., lack of time due to work, lack of the knowledge to do it) (showing low level of control over the behavior). In this situation, it is more likely that the individual will not engage in regular exercise.

The attitude toward behavior, subjective norms and perceived behavior control all predict the intention, which is the proximal determinant of behavior in TPB (Ajzen, 2011; Biddle et al., 2015; Prestwich et al., 2013; Sniehotta et al., 2005, 2014). However, perceived behavioral control is thought to directly exert influence on the behavior without the mediating factor of intention (Francis et al., 2004). Figure 3 describes the behavior adoption and maintenance mechanism from a TPB perspective.

1. 4. 2. 3. 1. Behavior change techniques in TPB-based intervention

There are a variety of change techniques associated with TPB (Senkowski et al., 2019; Steinmetz et al., 2016). One of which is persuasion, or the act of arguing against self-doubts and asserting that the individual can succeed in changing the behavior. Another method is providing information objectively. Improving skills to do the intended behavior is also part of the behavior change method in TPB. Whether it is demonstrating how to do the behavior, giving suggestions to improve the behavior, or prompting rehearsal of the behavior are essential to help the individuals feel that they have control over the behavior. Other change techniques include planning, finding social support, setting reinforcement contingencies, and social support.

A systematic review of 123 TPB-based interventions not limited to physical activity showed that most studies employed either one specific strategy or a mix of two approaches to change the intended behavior (Steinmetz et al., 2016). The review also found that the three most often used strategies are providing information, skill enhancement, and persuasion. The review also suggests that the differential method employed in the interventions had a different effect on the TPB variables. For example, improving skills was most beneficial in altering attitudes, but it was unexpectedly ineffective in modifying perceived behavioral control. Persuasion has the most influence on perceived behavioral control and intention.

In the context of physical activity, the perceived behavioral control is the construct most often targeted (Senkowski et al., 2019). Behavioral intentions and attitude are second and third behind the perceived behavioral control. To elicit changes in the perceived behavioral control, scientists often relied on goal setting, barrier identification, and action planning. Researchers expect increased perceived behavioral control by helping participants set goals, identify barriers, and action plan to overcome the obstacles, leading to increased physical activity. Another possible avenue of change often implemented in intervention studies involves using credible sources (Senkowski et al., 2019). This strategy was the third most used behavior change technique in the included articles. Providing written or verbal information (e.g., by a personal coach, celebrities, physicians, or ministers) could impact physical activity, possibly due to a change in attitude toward behavior and intention to engage in physical activity.

1. 4. 2. 3. 2. Evidence from TPB-based interventions studies

The TPB has been used in many studies within health settings. The result from the studies seemed varied, but they indicate the value of integrating the TPB in studies of physical activity.

A 12-week-long observation of 94 participants supported the theory (Armitage, 2005). Regression analysis for behavioral intention showed that attitude, subjective norm, and perceived behavioral control accounted for almost half of the variability of intent to exercise. The study also found that perceived behavioral control was a significant predictor of the actual behavior of exercising.

Another study also showed that perceived behavioral control is the most powerful predictor of physical activity. In a study of 104 overweight individuals, it was observed that perceived behavioral control had the highest contribution to the variance in intention to exercise and behavior (18.2%), followed by attitude (15.7%), and subjective norm (9.6%) (Cheng et al., 2019). The study, however, showed that perceived behavioral control has no direct effect on physical activity but only an indirect effect through the mediation of intention.

TPB has also been used as the foundation of experimental research on various health behaviors (Senkowski et al., 2019; Steinmetz et al., 2016). A recent meta-analysis of 123 TPB-based interventions found that intervention significantly affects the target behavior, with an average effect size of .50 (Steinmetz et al., 2016). Moreover, the study found that the intervention significantly impacted the different TPB constructs to a varying degree (weighted average effect size for attitude .24; subjective norm .14; perceived behavioral control .26, and

The use of TPB depends on the specificity of the target behavior. Scientists suggest that the target behavior needs to be highly specific (Biddle et al., 2015; Biddle & Mutrie, 2008; Francis et al., 2004). Instead of a general "regular exercise," scientists would incorporate a more specific target which includes target and action, context, and time like "I want to run three times a week in the next six months." Past research supports that different health behaviors result from different attitudes, subjective norms, and perceived behavioral control. A study of 164

individuals tested TPB for different exercise intensity (Rebar et al., 2016). After accounting for the between-person effect, the researchers concluded that intention–behavior relations were stronger for vigorous physical activity than for moderate physical activity or walking. These effects were present after accounting for significant between-person effects in intention–behavior relations. These finding led the scholars to argue that PA promotion targeting intention is better suited for promotion of VPA and not MPA or walking.

Although TPB has garnered much attention in the academic world, it has been highly criticized (Ajzen, 2011; Sniehotta et al., 2014). Chief among the criticism is the overly emphasis on rationality of the TPB (Sniehotta et al., 2014). TPB's reliance on beliefs seems to put aside unconscious determinants of behavior and play down the role of emotion. Another criticism pointed toward the inability of TPB to explain individuals who had solid intentions but failed to act accordingly (Biddle et al., 2015; Sniehotta et al., 2014).

Moreover, mounting evidence rejected the TPB proposition (Sniehotta et al., 2014). In TPB, belief does not predict change in actual behavior directly but through the mediation of intention. Behavioral belief (which makes up attitude toward a behavior), normative belief (which makes up subjective norm), and control belief (which makes up perceived behavioral control) all determine behavior through intention. Some studies showed the contrary, that belief is sufficient to predict actual behavior.

TPB has also been criticized for its claim that TPB constructs fully mediate external factors such as demographic and environmental variables impacting health behavior (Sniehotta et al., 2014). Studies have shown the opposite is true (Sniehotta et al., 2013). Demographic variables (e.g., age, socioeconomic status) and environmental features may predict physical activity when TPB constructs are held constant.

1. 4. 2. 4. The self-determination theory

Self-determination theory is the hallmark of Richard Ryan and Edward Deci. The SDT is a macro theory that explains human behavior by dissecting their psychological level, especially the motivational facets (Ryan & Deci, 2017). In SDT, human is seen as having the propensity to grow intrinsically. This intrinsic motivation might stem from basic psychological needs of autonomy, competence, and relatedness). Autonomy refers to how many behaviors are freely initiated and self-driven. At the same time, competence reflects the sense of mastery in one's circumstances, ability to overcome challenging assignments (physical and mental), and capacity to perform tasks (Ryan & Deci, 2017; Teixeira et al., 2020). Relatedness is the need to feel accepted and respected or have a mutual concern with significant others (Teixeira et al., 2020).

SDT argues that psychological needs are innate and critical for growth and well-being (Ryan & Deci, 2017). In the SDT view it is crucial to have an environment that facilitates the satisfaction of these basic needs to ensure they grow and becomes intrinsically motivated. The environmental factors can be facilitatory, which results in the sense of more autonomy, competence, and relatedness. However, the environmental factors can also thwart individuals' striving to meet their basic needs, leading them to be externally driven to do things.

The SDT, however, also acknowledge that many of the social regulation we live under is not intrinsically motivating (Ryan & Deci, 2017). Yet, people try and strive to assimilate these social regulations. How one assimilates extrinsically controlled behavior is the focus of the organismic integration theory, one of the SDT approach. We can also consider SDT as a motivation theory as it also focuses on different types of motivation along a continuum from controlled to autonomous. External factors impose controlled behavior, while internal motivation

drives autonomous behavior. However, in the SDT view, controlled and autonomous is not binary but rather a continuous variable.

In the SDT view, the individual could internalize the externally imposed behaviors, taking the values and beliefs of external behavior regulations and transforming them into one's own beliefs. This process occurs through socialization (Ryan & Deci, 2017). Internalization is a process from which a previously extrinsic behavior becomes a crucial part of people's thinking and motivation. It should be noted that internalization happens in all individuals, but some would experience internalization more effectively than others. The result is that different people would show different degrees of internalization, reflecting different perceived locus of control in regulating specific behavior.

The first type is external regulation. An externally regulated person engages in a behavior dependent upon external consequences (reward or punishment) (Ryan & Deci, 2017). This individual performs when there is an expected contingency in effect. In this regard, the perceived cause of enacting a behavior is outside the individual. An example of this in physical activity is exercising because one is promised to get a gift.

The second type is introjection. In introjection, a behavior is no longer dependent on external reward or punishment (Ryan & Deci, 2017). However, internalization involves taking in partially the values of the behavior. An example of this will be if one starts to exercise because she thinks it would please her partner or mean acceptance from her peers. There are no apparent external contingencies in this situation, but it was in the actor's mind. In introjected regulation, behavior results from partly integrating the demand of the external world (e.g., "I should exercise because it would please my wife," "I must exercise or I would worry that others would mock me."). In this regard, an introjected behavior is not externally caused by external regulation but is

also not internally controlled. Introjection often involves affection (i.e., feeling good when doing or bad when not doing a behavior), impacting self-esteem.

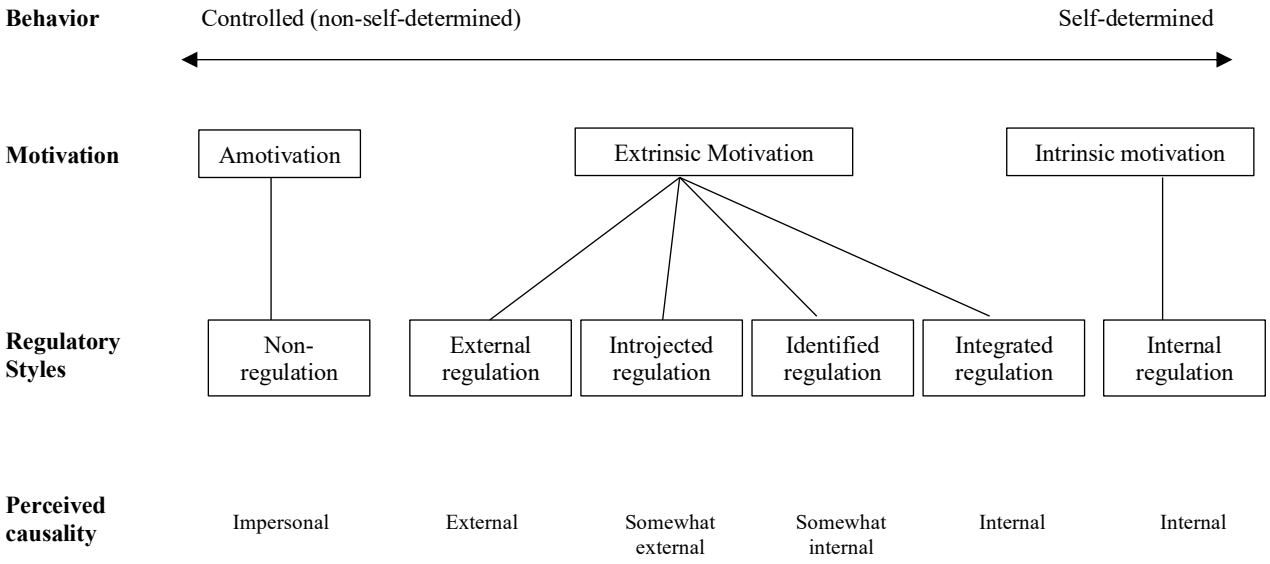
While introjection behavior is enacted because of self-demand, which stems from partly internalized pressure, in identified regulation, the person has fully internalized the importance of a behavior (Ryan & Deci, 2017). The perceived cause of engaging in behavior lies within oneself and not external factors. An example of this would be a mother who participates in regular exercise because she believes exercise will bring health and fitness.

The last type of internalization is the integrated regulation in which individuals accepts the benefit and values of the behavior, and he/she also acknowledges how this behavior is congruent to other aspects of his/her lives (Ryan & Deci, 2017). An example of this would be a mother who exercises because she believes exercise is beneficial for her, and this is in line with her aspiration to be a good role model for her children. The external, introjected, identified, and integrated, along with amotivation and intrinsic motivation, can be considered different points in a continuum. This continuum reflects the degree of autonomy (from externally imposed to truly internally imposed) and perceived causality (external to internal) (Ryan & Deci, 2017).

Scientists have argued that the SDT can be applied in varied settings, including the adoption and maintenance of health-related behaviors (Fortier et al., 2012; Gillison et al., 2019; Ng et al., 2012; Teixeira et al., 2012, 2015, 2020; Vieira et al., 2009), especially physical activity. For example, SDT-based treatments had a favorable effect on physical activity in elementary, secondary, and university settings, according to a recent review of 14 intervention studies in education settings (Juwono & Szabo, 2020b).

Figure 6

Continuum of exercise regulatory motives according to the organismic integration theory



Note. Based on "Self-determination theory: Basic psychological needs in motivation, development, and wellness," by R. M. Ryan and E. L. Deci (2017). Redrawn by the current author

In the SDT view, the adoption and maintenance of behavior depend on predominant exercise regulation (autonomous or controlled) (Fortier et al., 2012; Gillison et al., 2019; Ng et al., 2012; Teixeira et al., 2012, 2015, 2020; Vieira et al., 2009). If a more autonomous form of motivation and regulation is dominant, the individual will likely engage in and maintain exercise behavior, while controlled regulation will predict the absence of behavior (Fortier et al., 2012; Ng et al., 2012; Teixeira et al., 2012, 2020). It is, therefore, crucial for the scientist to target increment in the autonomous form of regulation of health-related behavior (Fortier et al., 2012).

1. 4. 2. 4. 1. Behavior change techniques in SDT-based intervention

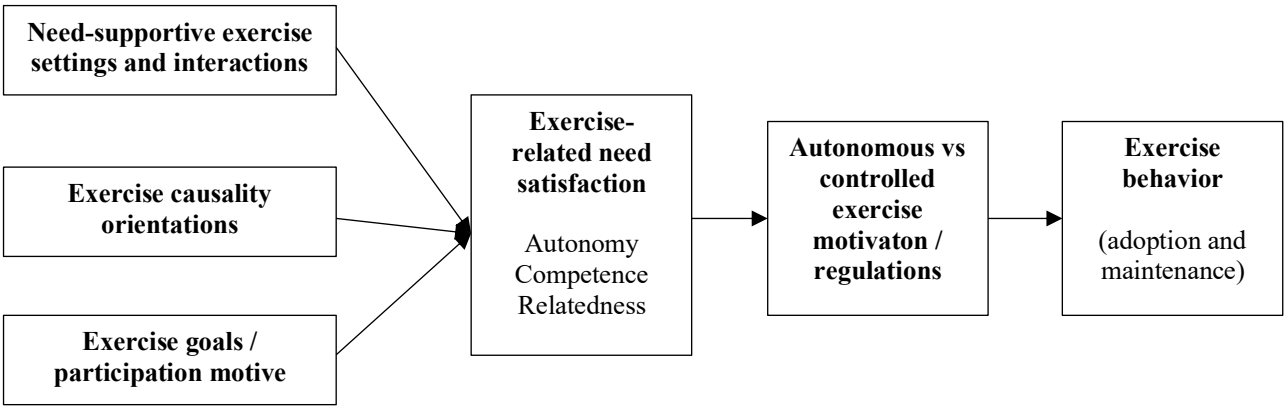
To elicit increased autonomous regulation, the individual needs to satisfy their basic needs (autonomy, competence, and relatedness) concerning a specific behavior (Fortier et al., 2012; Ng et al., 2012; Teixeira et al., 2012, 2020). There are three possible avenues to achieve this. The first is to ensure the therapist or instructor creates a supportive interaction and climate that facilitates change. The second possible avenue is to modify the perceived causality of the behavior. And the last one is to intervene in the underlying motive of exercising. The overall schema of possible changes in health behavior in the SDT view can be seen in figure 7.

Academics have outlined possible change techniques for creating a supportive climate and interaction (Gillison et al., 2019; Teixeira et al., 2020). The instructor or the researcher could do several things to ensure the participants feel more autonomy. First, the researchers could take time to understand participants' perspectives while identifying possible sources of pressure. Then, they must ensure they use non-controlling language during the interactions, including providing a rationale for engaging in the intended activity. It is essential to explore participants' life aspirations and values in harmony with the intended goal. Integrating aspirations and values could serve as the intrinsic motivation resource for behavior adoption in the participants. The last change technique provides choice because, in SDT, the researchers would like the participants to take ownership of the change.

Practitioners/ researchers could also target change by intervening in the need for competence through several change techniques (Gillison et al., 2019; Teixeira et al., 2020). This could be done by addressing the perceived difficulties of engaging in the desired behavior. Once the barriers have been identified, the practitioner could provide general encouragement and support to deal with the obstacles, including providing information related to the challenges.

Figure 7

Proposed mechanism of change under the self-determination theory



Note. Based on "Exercise, physical activity, and self-determination theory: A systematic review," by P. J. Teixeira, E. V. Carraça, D. Markland, M. N. Silva, and R. M. Ryan, 2012, *International Journal of Behavioral Nutrition and Physical Activity*, 9. Redrawn by the current author

Then, the practitioner can help the client by providing an optimal challenge. An optimal challenge is challenging enough but realistic and achievable. Then the client needs to be given constructive and relevant feedback in a non-controlling language. This is conducted while the practitioner should ensure that participant is not always dependent upon their feedback. Self-monitoring needs to be gradually introduced for the participant to take responsibility for their progress.

To increase relatedness, scientists suggest practitioners help clients identify possible social support and encourage cooperation with others (Gillison et al., 2019; Teixeira et al., 2020). Practitioners also need to show their care and interest in the client's improvement.

Acknowledging clients' emotions in relation to their success, hardship, worries, and others is crucial for the client to feel they are accepted. The use of active listening is essential for this phase.

1. 4. 2. 4. 1. Evidence from SDT-based intervention studies

A meta-analysis of SDT-based intervention for health-related behavior (not only for physical activity) supported the suggested mechanism in figure 7. A meta-analytic study in 2012 in general health-related behavior tested the model in figure 7 to explain the SDT mechanism in the adoption and maintenance of health behavior (Ng et al., 2012). Though the researcher did not include causality orientations and exercise goals, their finding supported the use of the model due to a good fit. Hence, intervention based on SDT should at least create a supportive interaction as the medium to increase needs satisfaction. When individuals feel their needs being satisfied, the more likely they will adopt and maintain the intended health behavior.

A more recent meta-analytic study also showed that by incorporating supportive communication techniques, interventions resulted in higher satisfaction of autonomy, competence, and relatedness. (Gillison et al., 2019) The increased autonomy, competence, and relatedness led to more autonomous regulation and changes in the behavior The study suggested that the use of non-controlling language to be the most significant for enhancing autonomy satisfaction compared to other strategies such as providing options or giving rationale. A non-controlling language used by the practitioner not only enhance autonomy satisfaction, but also for promoting autonomous regulation of the behavior.

1. 5. Summary

Physical activity level continues to decline throughout the world. The decline in physical activity causes many health problems (e.g., increased obesity, increased cardiovascular diseases, diabetes, and an increased number of premature death). The problems caused by physical inactivity could also bring an economic burden, as individuals have to pay extra for medication or suffer from loss of income due to illness. Academics have attempted to understand the potential causes of the decline in physical activity levels and reverse the decline in physical activity levels.

Academics found a mixture of intra-, inter-personal, environmental, policy, and global factors played roles in the decline of physical activity levels. For example, the changing nature of work requiring more sitting behind desks could also increase the sedentary time. Another example would be the emergence of technological advancement that also contributed to a sedentary lifestyle. It is easy for us to do anything through the smartphone (e.g., grocery shopping, ordering food) without moving from our home or office, reducing our physical movement. Even though the interplay of different correlates has been recognized, research on physical activity levels still primarily focuses on individual factors. Most research in physical activity focuses on individual factors, which could also include the use of psychological theories in research.

Four of the most widely used psychological theories that have been used to understand physical activity are TTM, the SCT, the TPB, and the SDT. The TTM focuses on how to 'facilitate' change by creating a decisional balance leading to the intended behavior. The SCT stresses how the presence of a 'model' could facilitate the adoption of behavior, while the TPB

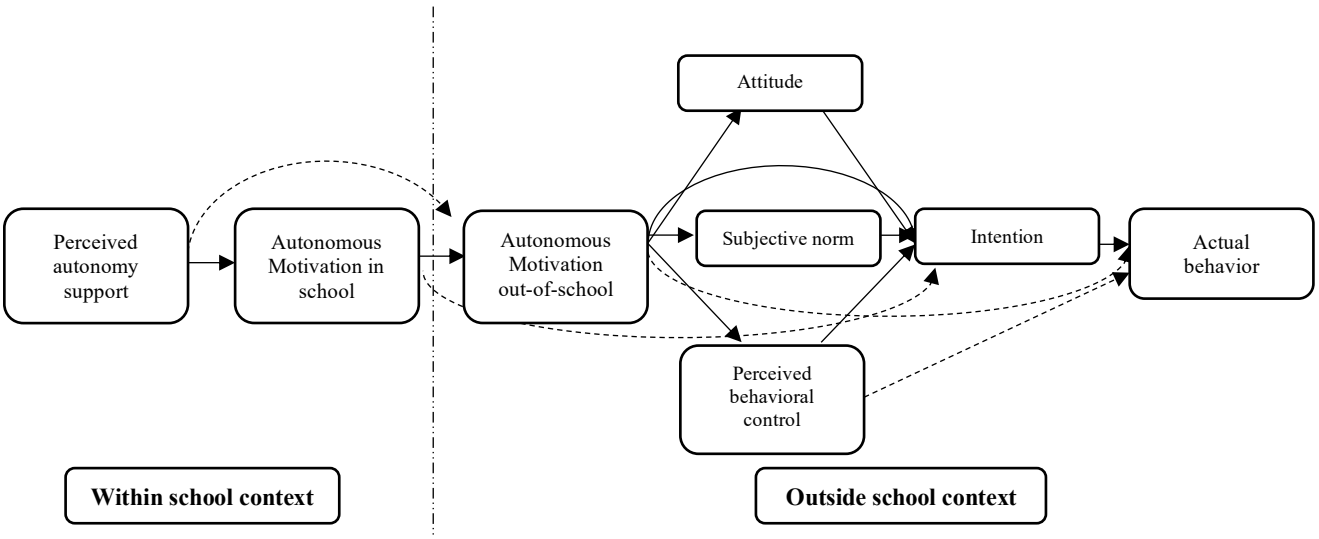
focuses on intention, and SDT focuses on how the environment promotes or thwart the fulfillment of intrinsic needs.

Recently, academics have attempted to combine tenets from different theories to complement the strengths of each paradigm, with the goal of improving knowledge of the trans-contextual effect. That is, how process in educational setting can be transferred into non-curricular or leisure time activities. Hagger and Chatzisarantis proposed the trans-contextual model, which blended concepts from the self-determination theory and the planned behavior theory (Hagger et al., 2005; Hagger et al., 2003; Hagger & Chatzisarantis, 2012, 2016). The Trans Contextual Model (TCM) outlines that autonomous motivation toward certain activities in one setting, may be transferred to different setting.

Hagger and Chatzisarantis argued that there are three basic proposition of transfer behavior in one setting (i.e. physical education in school) to different setting (i.e. physical education in leisure time) (Hagger et al., 2005; Hagger et al., 2003; Hagger & Chatzisarantis, 2012, 2016). The first proposition is that perceived autonomous support felt in physical education in school predicts autonomous motivation in school context. The second proposition in the model states that the autonomous motivation for educational activities predicts autonomous motivation toward similar activities outside of school. That is, autonomous motivation in school setting will predict autonomous motivation to exercise in leisure time. Consequently, the autonomous motivation to exercise in school setting mediates the relationship of perceived autonomy support in physical education classes and autonomous motivation in out-of-school context. The first and second proposition of the TCM are align with tenets of the SDT.

Figure 8

The hypothesized model of the Trans-contextual model theory



Note. Based on "The Trans-Contextual Model of Autonomous Motivation in Education: Conceptual and Empirical Issues and Meta-Analysis" by M.S. Hagger and N. Chatzisarantis, 2016, *Review of Educational Research*, *86*(2), 364. Redrawn by the current author

The last proposition of the TCM states that autonomous motive in out-of-school setting predicts future intention and actual behavior engagement through process outlined by the TPB (Hagger et al., 2005; Hagger et al., 2003; Hagger & Chatzisarantis, 2012, 2016). According to the TCM, exercise engagement in the future is a function of intentions. Intentions itself is determined by three sets of belief-based variables on future behavior: attitudes, subjective norms, and perceived behavioral control. The model predicts that autonomous motivation in an out-of-school context predicts intentions, which later predicts behavior. The hypothesized model of TCM can be seen in the figure 8.

Despite the differences in their approach, the theories acknowledge the crucial interplay between individual and environment to determine behavior (e.g., social support identification or facilitative climate creation). The theories have been used in conjunction with physical activity promotion, and the results seem promising.

Studies still show a global decline in physical activity levels despite growing efforts to promote physical activities. There are contrasting groups: the inactive individuals and the excessive exercisers. Among the inactive groups are mothers, who continue to be a concern due to lack of activity. On another side, some individuals are so preoccupied with the desire to exercise. The following two chapters will summarize studies on the two populations. I will begin by outlining the physical activity trends in mothers and associated correlations in chapter two and follow it up with exercise addiction in chapter three. The two different populations will be used as an example to be contrasted with the hope that it would result in a better understanding of the differences between exercisers and non-exercisers.

Chapter 2: Mothers' physical (in)activity

One specific group that continues to garner physical activity researchers' attention is the mother population. Having children is one of major life events during adulthood that has been tipped to alter physical activity levels (Gropper et al., 2020). Although the presence of children impacts parents of all genders, mothers tend to have less physical activity than fathers (Bellows-Riecken & Rhodes, 2008). Women with dependent children in their household were found to have a lower physical activity level when compared to women who are married but have no children in the household (Rhodes et al., 2014). Mothers are more likely to be inactive than their non-mother counterparts (W. J. Brown & Trost, 2003). This finding highlights the potential adverse effect of motherhood on physical activity.

Becoming parents require individuals to devote time and attention to caregiving, which implicates resources to PA (i.e., energy, time) (Gropper et al., 2020; Nomaguchi & Bianchi, 2004; Rhodes et al., 2014). A review of 31 studies comparing adults with children and without children in their household documented a moderate to a large effect size of parenthood on physical activity level (Bellows-Riecken & Rhodes, 2008). Moreover, physical inactivity is more prevalent in mothers than fathers. One study showed that mothers of young children, on average, spend 86 fewer minutes engaging in leisure-time physical activity than fathers (Nomaguchi & Bianchi, 2004).

One study analyzed the changes in mothers' physical activity between 1965 and 2010 (Archer et al., 2013). The study found a significant decrease in the physical activity level of mothers during the span accompanied by increased sedentary time. The decline was more

pronounced in mothers of young children (< 5 years old) showed a remarkable decline in physical activity level. The fall was 13.9 hours/week for these mothers. The study also mothers of older children (5-18 years old) have a lesser decline (11.1 hours per week).

2. 1. Physical activity benefits for pregnant and postpartum mothers

Scientist have argued that pregnant women could benefit from regularly exercising (Bull et al., 2020; Nascimento et al., 2012). To gain the benefit of exercising, experts recommend that pregnant mothers regularly incorporate 150 minutes of MPA in a week, barring any medical condition that prevents them from being active (Nascimento et al., 2012; United States Department of Health and Human Services, 2018). Activities such as walking or yoga that increases heart rate but not to an extreme level (as in sprinting) are among the recommended activities for mothers (Bull et al., 2020). Regularly exercising could result in better maternal weight control, maintenance of fitness level for labor, prevention of gestational diabetes, and help to manage emotional wellbeing during pregnancy and lactation period (W. J. Brown, 2002; Bull et al., 2020; Domingues et al., 2012; United States Department of Health and Human Services, 2018). Experts also observed a reduced risk of preterm labor when pregnant mothers regularly exercise (Bull et al., 2020; Domingues et al., 2012).

For postpartum mothers, scientists suggested to slowly return to exercise (Bull et al., 2020; Nascimento et al., 2012). Mothers can gradually resume their exercise six weeks after delivery (W. J. Brown, 2002; Doran & Davis, 2011; U.S. Department of Health and Human Services, 2018; Wilkinson et al., 2004). There is no detrimental effect of exercising during lactation period. On the contrary, studies have found that exercising during lactation period does not negatively impair milk production (Nguyen et al., 2019; Su et al., 2007).

2. 2. Patterns of the decline in physical activity throughout motherhood

Pregnant and postpartum mothers' continues to fail to meet the recommended activity level despite that the transition to motherhood provides a chance to become more active. There were negative trajectories of physical activity levels from pregnancy to motherhood, showing that more women become less active as mothers than those who become more active (Gropper et al., 2020). (Bellows-Riecken & Rhodes, 2008; Gaston et al., 2014; Hartman et al., 2011; Lloyd et al., 2016; Mailey & McAuley, 2014a; McGannon & Schinke, 2013; Mcquillan et al., 2010). A recent systematic review of mothers' physical activity found that past studies seemed to agree that mothers tend to not meet the recommended level of physical activity for pregnant and post-partum mothers, regardless of the age of the dependent children (Juwono et al., 2020). For example, mothers of infants (< 12 months old) do not engage in enough physical activity (Albright et al., 2005, 2009, 2012; Mailey & Hsu, 2017). Similarly, mothers of pre-school-aged children were physically inactive (Carver et al., 2020; Hesketh et al., 2014; Jiryaee et al., 2015; Sallis et al., 2001; Suzuki et al., 2017). Similar observation can be found in mothers of school-aged children; they do not meet the recommended physical activity guideline (Alhassan et al., 2018; Dearth-Wesley et al., 2012; Gierc et al., 2016; Mansfield et al., 2012; Mascarenhas et al., 2018; Olvera et al., 2011).

The decline in physical activity in women could start during their pregnancy period. Pregnancy was shown to be associated with decreases in physical activity, with more women lowered their physical activity levels during pregnancy than those who increased it (Gropper et al., 2020). The finding replicates the conclusion of a systematic review of 24 studies (Abbasi & van den Akker, 2015). Unfortunately, the decline which started early during pregnancy term does not

always return to pre-pregnancy or increase after delivery. A study of postpartum women revealed a decrease in VPA and MPA before pregnancy, during pregnancy, and after delivery (Downs & Hausenblas, 2004). According to the study, the highest physical activity was in the pre-pregnancy period. Another study of 471 mothers showed a pattern in which a decline in exercise during pregnancy rebounded only slightly after delivery (Borodulin et al., 2009).

The declining amount of physical activity might be related to the fact that mothers often assume the primary caregiver for children in the family (Bellows-Riecken & Rhodes, 2008; Gaston et al., 2014; Hartman et al., 2011; Lloyd et al., 2016; Mailey & McAuley, 2014a; McGannon & Schinke, 2013; Mcquillan et al., 2010). As a primary caregiver for children mothers find difficulties to incorporate exercise among other responsibilities in their routine. Exercising is much more problematic for women who worked full-time, adding to their already extensive list of duties (Mailey & McAuley, 2014b; McGannon & Schinke, 2013).

Studies also suggested that the number of children in the household affects mothers' physical activity levels (P. R. Brown et al., 2001; W. J. Brown & Trost, 2003). One study suggests that having more than two children decreases the likelihood of mothers engaging insufficient physical activity (W. J. Brown & Trost, 2003). This argument is especially valid for those having children below five years old, where no structural support from the school is available to help them (Nomaguchi & Bianchi, 2004). However, other researchers found the contrary: the number of children and their age did not impact physical activity engagement (Sallis et al., 2001). Given the inconclusive argument, more investigation is needed to analyze the impact of the number of children in a household and their age on the mothers' physical activity level.

2. 3. Factors associated with mothers' physical activity

Although mothers' physical inactivity has been investigated with various constructs, three factors have received a large percentage of attention: perceived barriers, self-efficacy, and social support (Bellows-Riecken & Rhodes, 2008; Juwono et al., 2020; Y. D. Miller et al., 2002). Below, we will explain each of the factors in greater detail.

2. 3. 1. Perceived barriers

One factor that is often identified as a risk factor for mothers' physical inactivity is the perceived barriers (Trost et al., 2002). Parents' most frequently cited barriers to exercise are lack of time and energy, fatigue, childcare, and obligations to other roles (Abbasi & van den Akker, 2015; Juwono et al., 2020). Mothers often reported lack of time as the primary barrier for mothers to engaging in exercise (Adachi-Mejia et al., 2010; Evenson et al., 2009; Mailey et al., 2016; Saligheh et al., 2016; Schluter et al., 2011). The lack of time might be the impact mothers' responsibilities at home (i.e., childcare, house chores).

Speculation as to why the commitment to provide childcare obstructs mothers' engagement in physical activity is two-fold. First, mothers feel pressured to fulfill their task as primary caregivers, leading to difficulty in schedule arrangements that incorporate physical activity (Dlugonski & Motl, 2016; Evenson et al., 2009; Hamilton & White, 2010a; Mailey et al., 2014). Second, mothers could perceive that they prioritized their own needs before their children's needs (Lloyd et al., 2016; Mailey et al., 2014; McGannon & Schinke, 2013). Mothers would feel bad for 'over-prioritizing' their health and well-being before their children's needs.

2. 3. 2. Self-efficacy

Another factor often associated with increased physical activity is self-efficacy or the belief that one can be physically active. Researchers have argued that self-efficacy is one of the most dominant underlying factors between physically active and inactive women (Miller et al., 2002; Trost et al., 2002). Self-efficacy is central to social cognitive theories. Self-efficacy facilitates self-regulatory actions in varying obstacles and is closely linked to the perceived barrier discussed earlier (Gierc et al., 2016; Jung & Brawley, 2011). An individual with high self-efficacy to exercise will strive to integrate exercising, despite many hurdles in day-to-day situations (Jung & Brawley, 2011). Mothers' reported lack of time to exercise might also underline the self-perception of mothers regarding their ability to exercise in the face of hurdles and demands; in other words, their self-efficacy to exercise (Mailey & Hsu, 2017). Two studies validated the argument (Jung & Brawley, 2011, 2013). The researchers found that active mothers have higher self-efficacy related to exercising than those inactive ones.

Some researchers suggested that self-efficacy is not the antecedent factor determining an active or inactive lifestyle but rather a mediating variable that leads to higher physical activity levels (Bellows-Riecken & Rhodes, 2008; Greaves et al., 2011; Mailey & Hsu, 2017). Hence, interventions studies, both for the general population or mothers, often target problem-solving skills which subsequently impact self-efficacy and later impact the physical activity of the participants (Albright et al., 2009; Brownson et al., 2019; Jiryaee et al., 2015; Lombard et al., 2009; Mailey & Hsu, 2017).

Intervention studies to increase the physical activity level of mothers are often comprising multiple sessions aimed at providing information regarding material activity recommendations and self-regulatory skills (problem-identification, setting individual goals, self-

monitoring, and feedback sessions) (Albright et al., 2009; Jiryaee et al., 2015; Lombard et al., 2009; Mailey & Hsu, 2017; Mailey & McAuley, 2014b). When the intervention is conducted interactively, the result seemed to be promising where the physical activity increased, accompanied by an increase in self-efficacy. One study recorded a very significant increase in MVPA of sedentary mothers from a mean of 3±14 minutes per week at baseline to 85.5±76.4 minutes per week after the intervention (Albright et al., 2009). Another study of 254 mothers of young children showed a similar result, in which a post-intervention increase in physical activity was evident (Lombard et al., 2009). Other studies even reported that the impact of increased physical activity and self-efficacy lasted for six months after the intervention was terminated (Mailey et al., 2014; Mailey & Hsu, 2017; Miller et al., 2002). These studies above show that by helping mothers solve and overcome their hurdles, they would be empowered and have better self-efficacy, leading to increased activity levels.

2. 3. 3. Social support

Social support is another psychological variable tightly linked with physical activity. Researchers even implied that social support is the most critical factor in overcoming barriers to physical activity for mothers (Bellows-Riecken & Rhodes, 2008). Social support is the individual's action to facilitate another person's process of adopting or maintaining a specific behavior (Belanger & Patrick, 2017; Hamilton & White, 2010b). Social support occurs between two parties, which involves the interpersonal transaction of giving and taking. In mothers' physical activity, social support can be seen as the help mothers receive from their significant others (e.g., spouse and other family members) that can help them overcome inhibiting factors for exercising. Researchers suggested that for intervention to increase physical activity levels to

succeed, it is essential to identify possible social support sources (Greaves et al., 2011; Hamilton & White, 2010b; Mansfield et al., 2012).

Social support can have different forms (Belanger & Patrick, 2017; Hamilton & White, 2010b). In emotional support, significant others express their trust and affection for the individual. The second type is instrumental support, in which the help comes in a concrete aid (e.g., providing the tools or equipment) and service (e.g., providing the necessary tools or equipment) and service. The third form is informational support that might involve information or advice on how to get things done. Finally, the appraisal support comes in constructive feedback and affirmation.

In a qualitative study that included 21 mothers, it was found that different forms of social support played a role in physical activity. These mothers reported the importance of instrumental social support in having another childcare provider or someone helping with the household responsibilities. They also considered encouragement from a partner or companionship to exercise as crucial emotional support they would like to have. Moreover, they also need information on how to initiate exercise. Another study with 42 social-economically disadvantaged mothers concluded that other social support impacted mothers' exercise decisions (Mansfield et al., 2012).

Despite the relatively consistent finding, the impact of social support is perplexing. While it is almost always true that mothers who exercise regularly have social permission from their surroundings, not all mothers who have supportive spouses, friends, and environments are active enough (P. R. Brown et al., 2001). In one study, nearly two-thirds of the participating 543 mothers reported being encouraged by their partners to exercise. However, only half of them said getting help with sharing childcare, and only one-third were offered help with chores by their partner. Hence the study concluded that some form of social support is more potent in impacting mothers' physical activity. Even if mothers get the necessary support, it does not always lead to physical

activity, especially if mothers are so committed to childcare and experience guilt when opting for exercise instead of taking care of their children (Mansfield et al., 2012; McGannon & Schinke, 2013).

2. 4. Summary

Throughout the chapter, mothers' insufficient physical activity level has been explained. Insufficient physical activity level continues to be a potential health hazard for women with children. The decline might start from the early pregnancy term, despite the recommended guide to remain active during pregnancy. More studies reported that women became less active starting from pregnancy, which continued after labor, than those reported that pregnant and new mothers became more active. Low physical activity levels are noted in mothers of newborns, infants, and school-aged children.

The three most studied the known covariates of mothers' physical activity are perceived barriers, self-efficacy, and social support. Mothers often assume the role of primary childcare provider in the household. This role might create hurdles for mothers to be physically active, even feeling guilty when exercising (prioritizing exercise over childcare). Childcare responsibility also leads to tiredness and a lack of energy to exercise. Scheduling becomes another issue, that becomes worse if mothers are also working. Mothers' physical activity is also associated with their perception of the ability to exercise in the face of demanding roles (i.e., household and childcare provider). Mothers reported a lack of support, especially from their spouses, to ease their burdens, affecting their engagement in exercise.

A systematic review of 19 intervention studies to improve mothers' physical activity found that these studies often targeted problem-solving skills, self-efficacy, goal-setting, and provision of social support (Juwono et al., 2020). The review suggested that the interventions were more efficacious compared to interventions that merely target mothers' knowledge about PA's health benefits. However, the efficacy of the intervention might be moderated by the intervention delivery methods. Individually tailored intervention seemed to work better than a uniform intervention. Intervention in groups could also be more effective, especially for providing the necessary social support to be active for mothers. The same review also suggested that most intervention to promote physical activity do not involve partner or spouse as social support to exercise.

A group of people exercise compulsively, a direct opposite of mothers. The level of exercise of these individuals is disturbing other facets of their living. Where mothers often find difficulties to incorporate exercise, these individuals often have difficulties to stay out of exercise. They often sacrifice other activities (e.g., missing social gathering, skipping resting period) for exercise and have difficulties to stop exercise. The next chapter will delve into this population and known correlates.

Chapter 3: When exercise becomes toxic to life: exercise addiction

While many people rarely engage in regular exercise, a group of people exercise excessively, exercising to an extent that annoys their functioning in other aspects of their living (e.g., social life, work). Researchers began to acknowledge that exercise, aside from the benefits, could have a negative impact on an individual (Lichtenstein et al., 2017). Researchers originally wondered if running might be addictive and if the addiction was 'positive.' Since then, increased research has shown that exercise and sports may be carried to extremes, with negative implications such as injuries, health damage, and strained interpersonal connections. (Berczik et al., 2012; Lichtenstein et al., 2017). Various terms have been employed to describe these people. “Exercise dependent,” “compulsive exercisers,” “obligatory exerciser,” and “exercise addict” are some of the terms that have been used in the past that refer to these people (Berczik et al., 2012; Juwono et al., 2021; Lichtenstein et al., 2017; Szabo et al., 2015).

Exercise dependence is a constant desire for recreational physical activity that leads to uncontrollable excessive exercise behavior and brings forth negative physiological and/or psychological consequences. (Hagan & Hausenblas, 2003). Other academics have referred to the same definition as compulsive exercise, stressing the uncontrollable nature of the urge to exercise (Lichtenstein et al., 2017). Academics observed that exercise addiction signifies six symptoms of other behavioral addictions like gambling addiction (i.e., salience, mood modification, tolerance, withdrawal, conflict, and relapse). For this reason, the term exercise addiction is the best fitting term, as it incorporates both the compulsive nature and dependence to exercise (Schreiber & Hausenblas, 2015; Szabo et al., 2015).

3. 1. Symptoms of exercise addiction

Exercise addiction could be viewed as a recurring pattern of exercising beyond what is "normal" level (Schreiber & Hausenblas, 2015). The urge to exercise excessively could alter the mood. When the craving is satisfied, the individual might experience psychological relief, but it could also create psychological stress and anxiety when the individual cannot meet the urge. Even when the drive to exercise is satisfied, it might result in a need to do it over again at an increased level. The continued drive to exercise becomes too difficult to control that it presents itself in the face of injury and obstructs personal, professional, and social aspects of the individuals.

People with exercise addiction feel that exercise is the most essential thing in their lives, making them preoccupied with negative thinking if they miss a schedule (Berczik et al., 2012; Griffiths, 2005). Exercise is the single most salient thing in their life. They associate exercise with changes in their mood (i.e., the experience of an improved mood after a session or lowered mental health when skipping a session). The need to increase the time for exercise (tolerance) is something they often feel. They might start with merely a few minutes of exercise and later on to hours per day in the gym or other sporting facilities to feel sufficient. When they cannot meet the perceived need for exercise, they would show symptoms of irritability (withdrawal symptom). The ritual of exaggerating exercise intrudes on their lives, resulting in conflict with other people or other responsibilities. They might even risk injuring themselves. And when these people try to cut the behavior, they only return to the same level or even worse (relapse).

The symptoms mentioned earlier (salience, mood modification, tolerance, withdrawal, relapse, and conflict) often indicate behavioral addiction based on the components model of

addictions (Griffiths, 2005), akin to problematic internet use, gambling addiction, and many others. For this reason, I agree with the suggestion that the term exercise addiction is the best-fitting term to describe the phenomenon as it underlies the compulsion and dependence aspect of the behavior (Szabo et al., 2015). People with exercise addiction frequently continue to exercise despite negative consequences (e.g., injury, conflict with others) to ease some internal discomfort (e.g., anxiety, stress) and are often characterized by recurrent failure to regulate the behavior (Berczik et al., 2012). Hence, exercise addiction is a maladaptive exercise pattern that leads to clinically significant disturbances in daily functioning and distress (Lichtenstein et al., 2017).

From the previous description, it should be clear that exercise addiction is not similar to those who exercise very often. Exercise frequency itself is not sufficient to indicate exercise addiction (Lichtenstein et al., 2017; Szabo et al., 2015; Torstveit et al., 2019). For example, athletes who train regularly with high intensity could not be categorized as having exercise addiction. To be identified as an exercise addict, one's participation in exercise should adversely impact one's health and functioning (Dinardi et al., 2021).

Researchers have suggested two types of exercise addiction: primary and secondary (Berczik et al., 2012; Çakın et al., 2021; Dumitru et al., 2018; Lichtenstein et al., 2017; Szabo et al., 2015). Primary exercise addiction occurs when symptoms of exercise addiction are present without any eating disorders. In contrast, the existence of eating disorders like anorexia nervosa, orthorexia, and others joins the secondary exercise addiction. In secondary exercise addiction, the urge to always exercise occurs due to motives like the drive for thinness found in eating disorders. These people overly exercise because they are not satisfied with their bodies and would like to be thinner. Hence the exercise is a product of these drives. It was estimated that between 39 and 48% of people suffering from eating disorders also develop symptoms of

exercise addiction (Lichtenstein et al., 2017). On the contrary, primary exercise addiction occurs in the absence of these other disorders. Those with primary exercise addiction might be more driven by better performance; hence, they might not limit energy intake significantly as those with eating disorders.

3. 2. Estimated prevalence of exercise addiction

Studies showed that around .3 -.5% of the population generally might show symptoms of exercise addiction (Mónok et al., 2012). This number might increase for regular exercisers (1.9 – 3.2%). But there have been reports of even higher probabilities of exercise addiction. For example, a recent study indicated that the prevalence of exercise addiction was 8.1% in regular exercisers (95% CI 1.5%-34.2%), 5% in amateur athletes (95% CI 1.3%-17.3%), and 5.5% in university students (95% CI 1.4%-19.1%) (Trott et al., 2020). A study even reported a prevalence of 42% in regular fitness center users (Lejoyeux et al., 2012).

A recent systematic review suggested that younger people are more prone to exercise addiction than older individuals (González-Hernández et al., 2021). Regarding gender differences, research is yet to conclude. Studies suggest that women are more prone than men to develop exercise addiction (Dumitru et al., 2018; Youngman & Simpson, 2014). The finding that women have a higher likelihood of developing exercise addiction symptoms might be related to internalized social pressure that perpetuates the strive for “perfect appearance” (Corazza et al., 2019; González-Hernández et al., 2021; Lichtenstein & Jensen, 2016; Wilson et al., 2004). However, there have been studies to suggest the contrary; men have a higher likelihood of developing exercise addiction symptoms (González-Hernández et al., 2021).

Another systematic review concentrated on the athletes' population (Juwono et al., 2021). It is assumed that athletes must follow a strict training regimen, making them susceptible to developing exercise addiction. Eleven of the included studies reported the prevalence of exercise addiction in the athletes' population. The average reported prevalence was 16.5%, with a wide range. It was as low as 2.7% (Zeulner et al., 2016), but could reach 42%, especially in competitive male runners (Smith et al., 2010). However, since the included studies relied only on self-report measures without any observation from professionals, the high prevalence might reflect how athletes interpret the exercise addiction measurement employed in the studies.

The athletes' high scores in the studies might not indicate exercise addiction, but perhaps other things such as passion or drive to excel in the specific exercise. The review found early evidence that exercise addiction in athletes might be linked to passion (Juwono et al., 2021). However, it was based only on one study. The study found that the risk of exercise addiction is positively correlated to two different passions: obsessive and harmonious passion (Akehurst & Oliver, 2014). Obsessive passion is defined as the controlled integration of activity in one's identity, which causes the internal pressure to engage in the activity that the individual enjoys. Harmonious passion is an independent internalization that causes people to choose to engage in activities they like. The study found that addiction to dance was connected to both types of passion, although the link was stronger to obsessive passion. The same review also found conflicting evidence of potential gender differences in exercise addiction in athletes (Juwono et al., 2021). While most of the included studies in the review found no difference between the sexes, two studies indicated gender differences in exercise addiction prevalence (McNamara & McCabe, 2012; Szabo et al., 2013). One of the studies indicated male athletes were more prone

to exercise addiction (Szabo et al., 2013), while the other stated the contrary (McNamara & McCabe, 2012).

The inconclusive nature of exercise addiction prevalence and gender differences in exercise addiction could reflect a few methodological issues. First, the instruments are different in different studies leading to a different proportion of people at risk of exercise addiction (Cunningham et al., 2016; Szabo et al., 2015; Trott et al., 2020). These instruments were developed using different theoretical backgrounds, leading to different results (Dumitru et al., 2018; Szabo et al., 2015). A recent review showed that the prevalence of people at risk of developing exercise addiction differs when measured by four instruments (Trott et al., 2020). People assessed using the Obligatory Exercise Questionnaire (OEQ), and Exercise Dependence Questionnaire (EDQ) resulted in a more significant proportion of people at risk of exercise addiction than in studies that employed the Exercise Addiction Inventory (EAI) or Exercise Dependence Scale (EDS). Hence, these instruments are better perceived as screening tools instead of diagnostics (Dumitru et al., 2018; Szabo et al., 2015).

The second concern is related to the characteristics of the samples included in the studies. Most studies on exercise addiction have university students, regular exercisers, and amateur athletes, and some studies use high-performance athletes (Dumitru et al., 2018; Szabo et al., 2015). The different groups in which the studies were conducted would yield different patterns of exercise addiction, including potential gender differences (Trott et al., 2020).

Exercise addiction is not listed in the Diagnostic and Statistical Manual of Mental Disorders (American Psychiatric Association, 2013). Lacking scientific evidence and inconclusive nature are why exercise addiction is not listed as behavioral addiction (Szabo et al., 2015). The inconclusive nature could be illustrated by the different instruments used in exercise

addiction studies (Cunningham et al., 2016; Szabo et al., 2015; Trott et al., 2020). Most studies on exercise addiction rely on self-report questionnaires. Only a few case studies on exercise addiction have been published in a scientific report (for example, Schreiber & Hausenblas, 2015). These case studies provided a detailed description of the symptoms, which were often unavailable in self-report questionnaires studies. Despite limited case studies of exercise addiction and its absence from DSM-5, exercise addiction is a real concern.

I conducted a search of exercise addiction cases through Google search and found at least 100 individuals reporting symptoms of exercise addiction (Juwono & Szabo, 2020). Summary of the cases can be found in table 1. Although this number is not exhaustive, it shows that the exercise addiction problem is genuine and affects many people. I found that more women (81 cases) shared their experience of exercise addiction than men, which illustrated gender discrepancies in exercise addiction. A significant proportion of the identified instances reported showing four or more symptoms of the Components Model of Addiction. They also reported a multitude of negative consequences, be it physical (e.g., injury, low body weight, etc.), psychological (e.g., difficulty concentrating on other tasks, depression, etc.), or social (e.g., withdrawal from social gatherings). My analysis showed that most of the included cases did exercise of different forms, although running, cycling, and bodybuilding are the most often reported exercises.

Table 1

Summary of 100 cases of "potential exercise addiction" found on the internet[1]

M = Male **F =** Female **n.d.** = no date **NR** = not reported **S** = salience **W** = withdrawal **T** = tolerance **M** = mood modification **C** = conflict **R** = relapse **Ijr =** Injury **Dys =** internal organ dysfunction **Imm** = immune problems **Uw** = underweight **Ame** = amenorrhea **Ax** = anxiety **Dep** = depression **Gui** = guilty feeling **Ina =** inability to concentrate **LoC =** loss of control **LoSR** = loss of social relationship **LoJ** = Loss of Job **SR** = self reported case **Oth** = case reported by others

					Symptoms						**Physical Damage**					**Psychological Consequences**					**Social Consequences**		
Case	**Date**	**Age**	**Sex**	**Type of Exercise**	**S**	**W**	**T**	**M**	**C**	**R**	**Ijr**	**Dys**	**Imm**	**Uw**	**Ame**	**Ax**	**Dep**	**Gui**	**Ina**	**LoC**	**LoSR**	**LoJ**	**Report**
1	2002	NR	M	Swimming, cycling	✓	✓	✓	✓		✓				✓		✓			✓				SR
2	2007	NR	M	Body building, cardio exercises	✓	✓		✓								✓		✓					Oth
3	2007	30	M	Body building	✓		✓	✓									✓						Oth
4	2007	NR	M	Running, mixed martial art	✓	✓	✓	✓								✓				✓			Oth
5	2007	59	M	Karate, jumping rope, body building, cycling	✓	✓	✓	✓	✓		✓						✓						Oth
6	2009	NR	F	Body building	✓				✓		✓	✓	✓	✓	✓	✓					✓		Oth
7	2011	46	M	Triathlon	✓	✓	✓	✓	✓												✓		Oth
8	2011	NR	M	Running	✓	✓	✓		✓												✓		Oth
9	2011	NR	F	Cycling, body building, running, yoga	✓	✓	✓	✓										✓					SR

(Continued on the next page)

[1] Based on "100 cases of exercise addiction" by I.D. Juwono and A. Szabo, 2021, *RInternational Journal of Mental Health and Addiction*, *vol. 19*), 1802-1805. Adjusted by the current author

					Symptoms						Physical Damage					Psychological Consequences					Social Consequences		
Case	Date	Age	Sex	Type of Exercise	S	W	T	M	C	R	Ijr	Dys	Imm	Uw	Ame	Ax	Dep	Gui	Ina	LoC	LoSR	LoJ	Report
(continuation from the previous page)																							
10	2012	46	F	Body building, jumping rope, kickboxing, triathlon	✓	✓	✓	✓	✓							✓				✓	✓	✓	Oth
11	2012	NR	F	Body building, running, swimming, crossfit, cycling	✓	✓	✓	✓		✓	✓	✓	✓			✓							SR
12	2013	NR	F	Body building, running	✓	✓	✓	✓						✓						✓	✓		SR
13	2013	46	F	Running	✓			✓	✓					✓									Oth
14	2014	24	F	Running	✓	✓	✓	✓	✓				✓	✓		✓		✓				✓	Oth
15	2014	NR	M	Body	✓	✓		✓		✓	✓					✓							Oth
16	2014	33	F	Elliptical machine	✓	✓	✓		✓	✓	✓			✓		✓	✓				✓	✓	Oth
17	2014	27	F	Running, triahtlon	✓	✓	✓	✓					✓								✓		Oth
18	2014	29	F	Body building, cycling, pilates, dance class	✓	✓	✓	✓											✓		✓		Oth
19	2014	NR	F	Running	✓	✓	✓	✓	✓		✓			✓		✓	✓			✓	✓		Oth

(continued on the next page)

					Symptoms						Physical Damage					Psychological Consequences					Social Consequences		
Case	Date	Age	Sex	Type of Exercise	S	W	T	M	C	R	Ijr	Dys	Imm	Uw	Ame	Ax	Dep	Gui	Ina	LoC	LoSR	LoJ	Report
(continuation from the previous page)																							
20	2014	27	F	Body building, High-Intensity interval training (HIIT)	✓	✓	✓	✓			✓					✓		✓					Oth
21	2014	24	F	Swimming, Triathlon	✓		✓	✓	✓					✓									Oth
22	2014	NR	F	Running, body building	✓	✓	✓	✓									✓				✓		SR
23	2014	NR	M	Running, hiking	✓			✓	✓											✓	✓		SR
24	2014	NR	F	Body building	✓	✓	✓	✓	✓		✓					✓	✓			✓	✓		SR
25	2015	NR	F	Running, body building, tae bo	✓	✓	✓	✓	✓	✓		✓	✓			✓		✓					SR
26	2015	NR	F	Running body building	✓	✓	✓	✓		✓	✓							✓					SR
27	2015	NR	F	Running, Cycling, Swimming	✓		✓	✓	✓									✓		✓	✓		SR
28	2015	39	F	Running	✓	✓	✓	✓					✓			✓	✓						Oth
29	2015	42	F	Running, body building	✓	✓	✓	✓	✓		✓		✓							✓			SR
30	2015	NR	F	Body building	✓	✓	✓	✓	✓												✓		SR
31	2015	NR	M	Running, Cycling	✓		✓	✓	✓										✓				SR
32	2015	NR	F	Running	✓	✓	✓	✓			✓					✓		✓		✓			SR

(continued on the next page)

					Symptoms						Physical Damage					Psychological Consequences					Social Consequences		
Case	Date	Age	Sex	Type of Exercise	S	W	T	M	C	R	Ijr	Dys	Imm	Uw	Ame	Ax	Dep	Gui	Ina	LoC	LoSR	LoJ	Report
(continuation from the previous page)																							
33	2016	36	F	body building, running	✓	✓	✓	✓	✓		✓		✓			✓		✓			✓		SR
34	2016	NR	F	Running, pilates, body building	✓	✓	✓	✓	✓		✓	✓				✓		✓		✓	✓		SR
35	2016	35	F	Body building, cycling	✓	✓	✓		✓		✓				✓	✓							Oth
36	2016	24	M	Body building, cycling, triathlon	✓		✓	✓	✓					✓		✓				✓			Oth
37	2016	35	F	Body building, yoga, zumba, crossfit, biking	✓	✓	✓	✓			✓					✓				✓			Oth
38	2016	NR	F	Body building	✓			✓	✓												✓		SR
39	2016	NR	F	Crossfit, running	✓		✓		✓											✓			Oth
40	2016	NR	M	Body building, cycling	✓		✓									✓							Oth
41	2016	NR	F	Body building, crossfit	✓	✓	✓	✓								✓			✓				SR
42	2016	NR	F	Swimming, running, circuit training	✓	✓	✓	✓								✓				✓	✓		SR
43	2016	NR	M	Cycling, running	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓				✓			SR

(continued on the next page)

					Symptoms						Physical Damage					Psychological Consequences					Social Consequences		
Case	Date	Age	Sex	Type of Exercise	S	W	T	M	C	R	Ijr	Dys	Imm	Uw	Ame	Ax	Dep	Gui	Ina	LoC	LoSR	LoJ	Report
(continuation from the previous page)																							
44	2016	NR	M	Running, body building, rock climbing	✓	✓	✓	✓	✓	✓	✓		✓				✓						SR
45	2016	NR	F	Body building	✓	✓		✓								✓							SR
46	2016	NR	F	Body building	✓	✓	✓	✓	✓							✓		✓				✓	Oth
47	2017	25	F	Cardio	✓	✓		✓			✓							✓	✓				Oth
48	2017	25	F	Running	✓	✓	✓	✓	✓	✓	✓						✓		✓		✓		Oth
49	2017	25	F	Body building, pole dancing	✓	✓	✓	✓	✓					✓				✓					Oth
50	2017	35	F	NR	✓	✓	✓	✓						✓		✓							Oth
51	2017	NR	F	running	✓	✓	✓	✓	✓	✓	✓					✓		✓			✓		Oth
52	2017	39	F	NR	✓	✓	✓	✓								✓	✓	✓			✓		Oth
53	2017	33	F	Dancing	✓			✓		✓		✓			✓			✓					SR
54	2017	NR	F	Running	✓			✓			✓					✓				✓			SR
55	2017	NR	M	Running	✓	✓	✓	✓	✓				✓										SR
56	2017	NR	F	Running	✓	✓	✓	✓	✓							✓		✓					Oth
57	2017	NR	F	Gymnastic, body building, cardio exercises	✓	✓	✓	✓	✓	✓	✓					✓		✓			✓		Oth
58	2017	NR	F	Cycling	✓	✓	✓	✓	✓				✓										SR
59	2017	34	F	Body building	✓		✓	✓			✓						✓	✓					Oth

(continued on the next page)

					Symptoms						Physical Damage					Psychological Consequences					Social Consequences		
Case	Date	Age	Sex	Type of Exercise	S	W	T	M	C	R	Ijr	Dys	Imm	Uw	Ame	Ax	Dep	Gui	Ina	LoC	LoSR	LoJ	Report
(continuation from the previous page)																							
60	2017	NR	F	Body building, running	✓		✓												✓				SR
61	2017	NR	F	Body building, running, yoga	✓	✓	✓	✓								✓	✓			✓			SR
62	2017	NR	NR	Elliptical machine	✓	✓	✓	✓	✓							✓				✓		✓	SR
66	2018	NR	F	running	✓	✓	✓	✓			✓	✓		✓	✓			✓					Oth
67	2018	34	M	body building, fasted cardio (HIIT)	✓	✓	✓	✓								✓					✓		Oth
68	2018	NR	F	body building	✓							✓		✓									
69	2018	29	F	running, body building, yoga	✓	✓	✓	✓	✓												✓		Oth
70	2018	NR	F	Body building	✓	✓	✓	✓	✓					✓		✓			✓	✓			Oth
71	2018	33	F	Rowing	✓				✓		✓										✓		Oth
72	2018	NR	F	Running, kickboxing	✓	✓		✓	✓		✓									✓			SR
73	2018	NR	F	Boxing, running, pilates, yoga	✓	✓	✓	✓	✓							✓				✓			SR
74	2018	NR	F	Body building, High-Intensity interval training (HIIT)	✓	✓	✓	✓	✓							✓		✓		✓	✓		SR

(continued on the next page)

					Symptoms						Physical Damage					Psychological Consequences					Social Consequences		
Case	Date	Age	Sex	Type of Exercise	S	W	T	M	C	R	Ijr	Dys	Imm	Uw	Ame	Ax	Dep	Gui	Ina	LoC	LoSR	LoJ	Report
(continuation from the previous page)																							
75	2018	NR	F	NR	✓	✓	✓				✓	✓		✓	✓					✓	✓		Oth
76	2018	NR	F	Dancing, tennis, basketball, cardio machine	✓	✓	✓	✓	✓							✓		✓		✓			Oth
77	2018	40	F	Running, boxing, bodybuilding, fasted cardio (HIIT)	✓	✓	✓	✓	✓	✓	✓									✓			SR
78	2018	NR	M	Cycling	✓	✓	✓	✓			✓							✓		✓			SR
79	2018	NR	F	Body building, yoga	✓	✓	✓	✓	✓		✓	✓		✓	✓	✓							SR
80	2018	NR	F	Body building	✓	✓	✓	✓			✓	✓		✓	✓	✓		✓					SR
81	2019	32	F	body building, boxing				✓						✓				✓					Oth
82	2019	NR	F	running	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓		✓	✓	✓	Oth
83	2019	NR	F	Running	✓	✓	✓	✓	✓	✓	✓					✓	✓			✓	✓		SR
84	2019	NR	F	Swimming, weight lifting	✓		✓	✓	✓	✓	✓	✓									✓		SR
85	2019	NR	F	Running	✓		✓		✓	✓	✓	✓		✓		✓	✓				✓		SR
86	2019	NR	F	Body building, running	✓			✓	✓	✓	✓	✓						✓			✓		SR

(continued on the next page)

Case	Date	Age	Sex	Type of Exercise	Symptoms						Physical Damage					Psychological Consequences					Social Consequences		Report
					S	W	T	M	C	R	Ijr	Dys	Imm	Uw	Ame	Ax	Dep	Gui	Ina	LoC	LoSR	LoJ	
(continuation from the previous page)																							
87	2019	NR	F	Running, stairmaster, body building, swim	✓	✓	✓	✓	✓		✓					✓		✓			✓		SR
89	2019	56	F	Running, Cycling, body building	✓	✓	✓		✓											✓			Oth
90	2019	NR	F	Swimming, cross country	✓	✓	✓	✓								✓							Oth
91	2019	54	F	Body building	✓	✓	✓	✓	✓		✓					✓				✓	✓		Oth
92	2019	NR	M	Running	✓	✓	✓	✓	✓		✓		✓			✓		✓			✓		Oth
93	2019	NR	F	Body building	✓	✓	✓	✓	✓		✓				✓					✓			Oth
94	2019	27	F	Elliptical machine, cycling, running	✓	✓		✓						✓		✓		✓					SR
95	2019	NR	F	Running, body building	✓	✓	✓				✓			✓						✓			SR
96	2019	NR	F	Yoga, running, boxing, HIIT, body building	✓	✓	✓	✓	✓		✓	✓	✓			✓	✓						SR
97	n.d.	NR	F	Running, body building	✓	✓	✓		✓									✓		✓			Oth

(continued on the next page)

Case	Date	Age	Sex	Type of Exercise	Symptoms	Physical Damage	Psychological Consequences	Social Consequences	Report

					S	W	T	M	C	R	Ijr	Dys	Imm	Uw	Ame	Ax	Dep	Gui	Ina	LoC	LoSR	LoJ	
(continuation from the previous page)																							
98	n.d.	NR	F	NR	✓	✓	✓	✓								✓		✓					SR
99	n.d.	31	F	Body building, cardio exercises	✓		✓	✓					✓										Oth
100	n.d.	31	F	Crossfit	✓		✓	✓								✓				✓			Oth

3. 3. Personality correlates of exercise addiction

Exercise addiction has been investigated in conjunction with some personality traits (González-Hernández et al., 2021; Juwono et al., 2021; Szabo et al., 2015). These studies were conducted to identify individuals who were more susceptible to exercise addiction. Scientists hope that better identification and prevention programs can be designed by understanding these correlations.

3. 3. 1. Perfectionism

Perfectionism stood out among the most studied correlates (Bircher et al., 2017; Çakın et al., 2021; Szabo et al., 2015). Perfectionism is a personality trait characterized by a persistent quest for a very high standard or faultless performance which is frequently coupled with excessive worry about how others perceive one's behavior (Frost et al., 1990; Hewitt et al., 1991). Studies suggest that perfectionism is multidimensional, and each dimension could impact mental health positively and negatively. Perfectionism can have an adaptive and maladaptive function, depending on how the domains of perfectionism function. For example, individuals with high self-oriented perfectionism (those striving to achieve the exorbitant standard for an intrinsic motive) might positively associate self-esteem and wellbeing (Birch et al., 2019). On the other hand, socially prescribed perfectionism negatively correlates with self-esteem and well-being (Bieling et al., 2004; Juwono et al., 2022; Stoeber, 2015). Individuals who constantly feel pressure from their surroundings to perform at the highest level would have lower self-esteem and well-being. Self-oriented perfectionism and socially prescribed perfectionism were found to correlate with anxiety positively.

Studies with regular exercisers have found that self-oriented perfectionism and socially prescribed perfectionism is not directly associated with exercise behavior (Longbottom et al., 2012). However, there was indirect association between the two which was mediated by autonomous exercise regulations. A recent review showed that perfectionism correlates with an increased risk of exercise addiction; however, the strength of the association is weak to moderate (Çakın et al., 2021; González-Hernández et al., 2021). A recent review of the link between perfectionism and the risk of exercise addiction pointed out that perfectionism might be a mediating variable that promotes exercise addiction formation (González-Hernández et al., 2021). Another systematic review of 22 studies found a positive correlation between exercise addiction associates and self-oriented perfectionism and socially prescribed perfectionism (Çakın et al., 2021). However, the relationships between these domains and exercise addiction may be moderated by gender, indicating that perfectionism might function differently in men and women to develop exercise addiction.

Perfectionism, scientists argued, could affect individuals by having less tolerance over flaws in exercise, subsequently leading to a never-ending quest to achieve 'perfect' exercise performance (Lichtenstein et al., 2017). The never-ending strive would then lead to emotional distress whenever the 'perfect standard' is not achieved and becomes number one priority. When exercise is prioritized over friends and family, interpersonal relationships can suffer and lead to social isolation.

3. 3. 2. Narcissism

Another psychological trait often associated with perfectionism is narcissism. Narcissism tends to evaluate oneself positively compared to others (Leckelt et al., 2017; Stoeber, 2015).

Specifically, a narcissist tends to enhance oneself (e.g., showing dominance, self-assurance) driven by admiration toward oneself. A narcissist could also show antagonistic aspects (e.g., selfishness, arrogance), usually motivated by self-defense against a rival. Narcissists often have over-focus on themselves.

Researchers have found a positive correlation between narcissism and the risk of exercise addiction (K. J. Miller & Mesagno, 2014). These researchers discovered a link between the likelihood of exercise addiction and narcissism. They found that the probability of exercise addiction is associated with narcissism. Their findings imply that narcissistic people frequently focus on exterior features of their appearance to garner acceptance from others. This urge to meet expectations may lead to exercise. Then, exercise morphs into an addiction for some people because they need to preserve their self-esteem.

A review of studies linking exercise addiction and narcissism echoes the above finding. The three included articles in the review found that narcissism is positively associated with exercise frequency and risk of exercise addiction (Bircher et al., 2017). However, the predictive power of narcissism to exercise addiction is more substantial when combined with other factors. The combination of narcissism and self-esteem or narcissism and perfectionism would better predict exercise addiction than narcissism alone.

3. 3. 3. Self-esteem

Another personality trait that has been linked with the risk of exercise addiction is self-esteem. Self-esteem is a global appraisal of the self (Moroz & Dunkley, 2015). Four studies conducted between 1995 and 2016 revealed a concurrent theme that self-esteem is a crucial aspect to consider while dealing with exercise addiction. Self-esteem may mediate between exercise addiction and other characteristics, mainly when training aims to improve physical

performance (Bircher et al., 2017). Obsession with physical perfection has resulted in the emergence of exercise addiction and other appearance-related disorders (Corazza et al., 2019). A recent cross-sectional study conducted in four European countries revealed that as the risk of exercise addiction increases, the anxiety over one's appearance also increases.

3. 4. Summary

Exercise can have an addiction potency. Exercise addiction is a constant desire for recreational physical activity that leads to uncontrollable excessive exercise behavior and brings forth negative physiological and/or psychological consequences. Various terms have been employed to describe these people. Still, exercise addiction is perhaps the most fitting as it underlies components of behavioral addiction (salience, mood modification, tolerance, withdrawal, relapse, and conflict).

Academics have tried to estimate the prevalence of exercise addiction. The results varied, ranging from below 1 percent to 42% in regular fitness center users. A study to identify cases of exercise addiction in the public media (not scholarly journals) identified 100 cases (Juwono & Szabo, 2020a). These cases were based on the reported symptoms and consequences. The 100 cases found in the study might indicate that exercise addiction is a genuine concern, despite its absence in the *Diagnostics and Statistical Manual of Mental Disorder* (DSM-5).

Personality factors have been studied to predict those at higher risk of becoming exercise addicts. Among the personality factors, perfectionism stood out as the most studied covariate. Perfectionism could affect individuals by striving to achieve an unreasonable standard in exercise and become overly committed to achieving the standard. This might subsequently lead

to emotional distress whenever the 'perfect standard' is not achieved and becomes the number one priority, overshadowing other aspects of their living.

This chapter has described perfectionism as a personality trait that can explain exercise behavior. Perfectionism has been used in studies of exercise addiction and those who regularly exercise, but rarely in the non-exercising population like mothers. Studies to promote mothers' physical activity levels have stressed the importance of considering personal characteristics in the intervention, but seldom incorporate personality factors like perfectionism. For example, mothers' physical activity is most often studied in conjunction with perceived barriers, self-efficacy, and social support.

Mothers and exercise addicts are representative of two polarizing populations: the ones who do not exercise and those who exercise excessively. However, mothers and potentially exercise addicts have been studied using different personal-psychological constructs. The potential exercise addicted individuals, on the other hand, are often studied with the personality trait of perfectionism, narcissism, self-esteem, or body image. The differing psychological construct makes it challenging to analyze the differences between regularly exercising and those who are not. For this reason, I designed a study in which differences between regularly exercising and non-exercising individuals could be analyzed.

Personality factor could perhaps explain the differences between regularly- and non-exercising individuals. I argue that perfectionism might be able to explain the differences between exercising and non-exercising individuals. For this reason, I hypothesize that perfectionism would predict exercise behavior and that different exercise regulations would mediate the link between perfectionism and exercise. The following chapter will describe the

author's attempt to test the hypothesized arguments. The author will incorporate perfectionism and motivation as factors to explain the differences between exercisers and non-exercisers.

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Chapter 4: Perfectionism and physical activity relationship: the mediating role of exercise regulation

In the previous chapters, we have summarized the decline in physical activity thoroughly. Despite the observed decrease, some individuals engage in exercise to a pathological level. A question emerges: what could differentiate those who are active and those who are not. Unfortunately, research on those who are not regularly exercising (mothers) and those who regularly exercise (those with risk of exercise addiction) has not been conducted comparably. Studies of individual factors in mothers and those with potential exercise addiction have been undertaken on different personality constructs. This chapter aims to answer the question: what mechanism could explain the differences in physical activity.

As discussed in the preceding chapters, researchers have put effort into unfolding the underlying factors and mechanisms of why some people are physically active while others are not and concluded that individual environmental and policy factors played a role (Bauman et al., 2012). Efforts have also focused on applying the knowledge of known antecedents from psychological theories to improve the level of physical activity and help individuals adhere to it (Box et al., 2019; Dalgetty et al., 2019).

4. 1. Introduction

Two intrapersonal factors studied in conjunction with exercise were personality and motivation. Researchers have suggested that certain personality traits have bidirectional relation

to exercising behaviors (M. S. Allen & Laborde, 2014; Bircher et al., 2017; Çakın et al., 2021; Corazza et al., 2019; Courneya & Hellsten, 1998; de la Vega et al., 2020). For example, a recent study suggested that a particular personality type predicted engagement in high-intensity exercises (Box & Petruzzello, 2020). The study observed that differences in motivation and personality factors could explain the 18.6% variability of frequency of engaging in high-intensity exercises (e.g., cross-fit, resistance training). However, the study was limited to those who exercised regularly.

Other researchers have tried to model the interplay of personal and situational factors in exercising. Some argue that personal factors (e.g., personality, values, self-concept) and situational factors (e.g., social value, accessibility) jointly impact motivation to exercise (Dinardi et al., 2021; Egorov & Szabo, 2013). Together, these factors could influence exercise behavior. For example, if a person considers herself athletic and is brought up in an environment where exercise is highly appraised, she would likely have higher motivation to exercise, which increases the likelihood of exercising. On the contrary, if another person considers that she has limited knowledge and the exercising would be too much to bear, she would likely have a lower motivation to exercise and seldom make time for it.

Perfectionism is a crucial personality trait related to exercising behavior (Vicent et al., 2021). Although mainly studied in risk of exercise addiction, perfectionism has also been found to impact exercise frequency, duration, and intensity in the general population (Bircher et al., 2017; Box & Petruzzello, 2020; de la Vega et al., 2020; Feito et al., 2018; González-Hernández et al., 2021; Longbottom et al., 2012). Perfectionism is a multidimensional personality construct characterized by a constant striving for excessively high standards or flawless performance and is often accompanied by exaggerated concern about evaluations of the behavior (Frost et al.,

1990; Hewitt et al., 1991). Perfectionism has different intrapersonal and interpersonal orientations that indicate the individual's beliefs about his behavior and attitudes toward the behavior of others (Hewitt et al., 1991; Hill, 2016).

One model of perfectionism outlines three different types of perfectionism (Cox et al., 2002; Hewitt et al., 1991). The first one, self-oriented perfectionism (SOP), is characterized by the tendency to set unrealistic standards for themselves. The second type of perfectionism is other-oriented perfectionism (OOP), marked by a strong tendency to expect unrealistically high standards from others. The third is socially prescribed perfectionism (SPP), reflecting the affected individuals' belief others expect them to be perfect. Despite the apparent differences between the three categories of perfectionism, their unique relationship to various measures was seldom studied separately. Still, they collapsed under the umbrella factor of general perfectionism.

A study of 254 university students found that a 41% variance in exercise behavior could be explained by a different aspect of perfectionism (Longbottom et al., 2012). The researchers found that perfectionism could predict exercise behavior by a mediating autonomous motivation. They concluded that both SOP and SPP played a part in predicting exercise behavior, but the SOP had a more robust association with more autonomous forms of exercise regulation. Hence, another variable should be integrated into the framework: motivation.

Motivation was often cited as having an influential impact in determining exercise behavior (Courneya & Hellsten, 1998; Duncan et al., 2010a). Motivation was thought of as the proximal predictor of exercising behavior (van Lankveld et al., 2021). Recent studies revealed that motivation factors could impact the frequency of exercising (Duncan et al., 2010a; Feito et al., 2018).

I used the SDT framework to test a model here since SDT has been used in motivation research, including motivation in exercise (Edmunds et al., 2006b). The SDT is a macro theory about motivation that classifies human behavior as intrinsically or externally motivated (Ryan & Deci, 2017). Intrinsically motivating behaviors originate from within oneself. They are freely initiated because the behavior is enjoyable and meaningful. In contrast, extrinsic motivation is the drive to perform a behavior due to perceived or actual external pressures. SDT emphasizes how individual and environmental factors influence behavior (Dinardi et al., 2021; Ryan & Deci, 2017; Vieira et al., 2009).

One SDT approach is organismic-integration theory (Ryan & Deci, 2017; Sebire et al., 2016), according to which intrinsic or extrinsic motivation is dependent upon the internalization of the activity, which is the result of an interplay between environment and internal needs) (Cid et al., 2018; Deci & Ryan, 2000; Ryan & Deci, 2017; Sebire et al., 2016). The idea is concerned with the process through which externally motivated behaviors become integrated via social and cultural interactions. It underpins the crossing to satisfy basic psychological needs (autonomy, competence, and relatedness) and social environment, which may encourage or prevent behavior internalization or integration. Accordingly, six different behavior regulations signify different type of motivation and perceived locus of control of the behavior. An individual can be not motivated to act (amotivation), externally or internally motivated. The external or extrinsic forms of motivation have four categories. The most controlled form is the *external regulation* characterized by exercise due to external contingencies of rewards or punishment for a targeted behavior. Another slightly less controlled form is the *introjected regulation*, manifested in exercise to obtain social consent or avoid internal pressure such as guilt. The third form is *identified regulation*, motivating the person to exercise because of the known benefits of the

behavior. The fourth and the most autonomous form is *integrated regulation*, exemplified by exercise that aligns with other aspects of the self. The six regulations are believed to reflect individuals' current values about exercise behavior (Cid et al., 2018; Edmunds et al., 2006b; Ryan & Deci, 2017).

4. 2. Study 1: Could perfectionism and different motive regulation explain differences in exercise patterns?

The study's goal is to test the link between the domains of perfectionism, exercise motives, and exercise behavior. Researchers suggested that different domains of perfectionism were antecedent factors that influence individuals' use of various exercise regulation motives, which later impacted their exercise behavior (Longbottom et al., 2010, 2012). However, the studies exclusively recruited university students who regularly exercise or took sports science as their major. So, the conclusion does not apply to a broader spectrum of the population. Moreover, these studies used motivation regulation as an aggregate indication of autonomy level (i.e., Relative Autonomy Index/ RAI); instead of specific different possible behavior regulations (i.e., amotivation, external, introjected, identified, integrated regulation, and intrinsic motivation). Hence, the aim was to test individual regulation motives that link perfectionism and exercise behavior.

Another goal of the study is to identify possible differences between exercisers and non-exercisers as the studies by Longbottom and colleagues did not identify differences between exercising and non-exercising individuals (2010, 2012). By identifying possible differences between exercising and non-exercising individuals, we might improve the understanding of exercise behavior to foster physical activity

4. 2. 1. Hypotheses

Scholars observed that personality could explain differences in exercise preference and volume in exercisers (Box et al., 2019; Box & Petruzzello, 2020). Another research found that both self-oriented perfectionism and socially prescribed perfectionism had a small but significant correlation with exercise behavior (Longbottom et al., 2012). Based on the conclusion of past research, I hypothesize that both self-oriented perfectionism and socially prescribed perfectionism would significantly affect with exercise behavior, as past study suggested.

Longbottom and colleagues (2012) also found that the association between perfectionism and exercise behavior is mediated by self-determined motivation differently. The self-oriented perfectionism as part of adaptive perfectionism would increase self-determined motivation and lead to increased exercise. On the contrary the socially prescribed perfectionism as part of maladaptive perfectionism would negatively affect the self-determined motivation and later predict less exercise behavior. For this reason, the second hypothesis would be that different domains of perfectionism predict different exercise regulation which later affect exercise behavior. That is, exercise regulation would mediate perfectionism and exercise behavior.

Prior research that investigated personality and self-determination in relation to exercise were conducted in regularly exercising samples (Box et al., 2019; Box & Petruzzello, 2020). Hence, their generalization of their findings are limited to exercising samples. In the current study, I have recruited non-exercising individuals to see if exercisers and non-exercisers have different perfectionism and exercise regulation patterns. Thus, the third hypothesis is: the linkage between perfectionism, exercise regulation, and exercise volume would be different in exercisers and non-exercisers.

4. 2. 2. Methods

4. 2. 2. 1. Participants and sampling procedure

After obtaining the university's institutional review board approval, the author distributed a call for participation on the university's bulletin boards. The author also distributed the invitation to participate through social media for broader coverage.

Adults (≥ 18 years old) of any exercising status were eligible to participate in the study. The study was conducted in an online survey platform of Qualtrics. Two thousand seventy-eight individuals responded to the invitation. However, only 1365 responses were used for analysis (416 males and 949 females), as the remaining did not complete the questionnaires. Of the total samples, 57.1% indicated that they exercise regularly (i.e., engage in exercise at least twice a week for 30 minutes per session). The detailed demographic characteristic of the participant is listed in table 2.

4. 2. 2. 2. Instruments

4. 2. 2. 2. 1. Exercise Regulation. We used the revised Behavioral Regulation in Exercise Questionnaire (BREQ-3) to measure participants' exercise motives. The BREQ-3 is constructed based on the organismic approach of SDT and has 24 items (Cid et al., 2018; Divine et al., 2019; Markland & Tobin, 2004; Sevil et al., 2018; Wilson et al., 2002). These items reflect six possible motivations to exercise on the continuum of the SDT proposed by Deci and Ryan: amotivation, external regulation, introjected regulation, identified regulation, integrated regulation, and intrinsic motivation.

Table 2

Study 1 participants' demographic data

	Regularly exercising (n = 785)		Non-exercisers (N = 580)	
	Male (n = 293)	Female (n = 492)	Male (n = 123)	Female (n = 457)
Age	26.5 ± 10.4	25.3 ± 8.6	20.9 ± 4.5	19.9 ± 2.5
Height	171.4 ± 5.7 cm	159.6 ± 5.7	171 ± 5.8 cm	159.5 ± 5.6 cm
Weight	69.8 ± 13.8 kg	56.33 ± 10.3	70.36 ± 17.0 kg	55.3 ± 11.2 kg
BMI	23.7 ± 4.3	22.5 ± 10.7	24.0 ± 5.3	21.7 ± 3.9
Education				
High school or lower	53.2%	52.6%	80.5%	89.1%
Vocational college	3.1%	6.3%	1.6%	2.8%
Bachelor	28.3%	28.3%	15.4%	7.7%
Postgraduate	15.4%	12.8%	2.4%	0.4%
Employment				
Fulltime	23.2%	23.%	8.9%	2.6%
Part-time	4.8%	5.7%	5.7%	3.3%
Unemployed and looking for one	3.1%	3.7%	0.8%	2.8%
Unemployed and not looking for one	0.7%	1.2%	0.0%	0.2%
Retired	0.3%	0.8%	0.8%	0.0%
Student	56.3%	59.1%	81.3%	89.7%
Entrepreneur	11.6%	6.5%	2.4%	1.3%

Participants must respond to each of the 24 items on a Likert scale ranging from one (strongly disagree) to five (strongly agree) (Markland & Tobin, 2004; Sevil et al., 2018). A profile of six individual scores was obtained by summing the scores of each item within a motivational type. The instrument's internal consistency of the scale in this study was acceptable (Cronbach's α for amotivation = 0.82; external regulation = 0.79; introjected regulation = 0.87; identified regulation = 0.83; integrated regulation = 0.90; and intrinsic motivation = 0.91, that was in accordance to the original values reported for the scale (α ranging from 0.76-0.90) (Mullan & Markland, 1997).

4. 2. 2. 2. 2. Perfectionism. I employed the short version of the Multidimensional Perfectionism Scale (MPS) to measure perfectionism. The questionnaire has 15 items, five for each SOP, SPP, and OOP (Cox et al., 2002, 2009; Mackinnon et al., 2013; Stoeber, 2018). Participants must rate their agreement with the 15 statements on a scale of 1 (strongly disagree) – to 7 (strongly agree), reflecting the direction and source of perfectionism.

A high SOP score indicates the high standard individual sets for herself. A high SPP score suggests her beliefs regarding high expectations from her significant others. A high OOP score suggests that an individual considers it crucial for others to perform to meet his standards. Our analysis revealed that the short version of MPS has a good internal consistency (Cronbach α for SOP = .82, OOP = .67 and SPP = 0.80), which is in accordance to prior study (Cox et al., 2002).

4. 2. 2. 2. 3. Exercise behavior. Exercise behavior is operationalized the volume or total minutes spent exercising per week. To measure this, I asked participants to report: (1) how many times per week do you exercise in a typical week (frequency); and (2) how many minutes per session (duration) do you do the exercise in a typical week. We then calculated the total time spent exercising by multiplying the answers to both questions.

4. 2. 2. 3. Data Analysis

The analysis started with a bivariate correlation analysis for all the variables of interest. Subsequently, a path analysis with the MPLUS program was conducted. Different regulation motives would be the mediating variables in the association between exercise volume and perfectionism in our model. The analysis used a maximum likelihood estimation with robust

standard errors (MLR) because this estimator can overcome problems arising from non-normally distributed data (i.e., skewed or kurtosis).

4. 2. 3. Results

4. 2. 3. 1. Relationship between exercise volume, perfectionism, and different exercise regulation

Table 3 details the bivariate correlation of the included variables. In general, all variables seemed to correlate, except for the OOP. OOP in our finding was not correlated or had a significant but weak association with SOP and amotivation. For this reason, OOP was dropped from the model. Moreover, we observed a high correlation between identified and integrated regulation (r = .83); identified regulation and intrinsic motivation (r = .79); and intrinsic motivation and integrated regulation (r = .78). The highly correlated variables created redundancy, in which two predictors may cause the problem of multicollinearity (M. P. Allen, 1997). Multicollinearity could undermine the statistical significance of a model. Hence, we decided to trim the exercise motives to resolve the multicollinearity issue.

The identified regulation, introjected regulation, and external regulation remain in the model. The identified regulation was strongly associated with intrinsic motivation and integrated regulation, but the strength of association was still below the .70 level, which indicated the presence of multicollinearity. Introjected regulation was the second motive, as research suggested the prominence influence in exercise behavior (Duncan et al., 2010b; Edmunds et al., 2006a). Finally, the third motive was external regulation, representing the most controlled form of exercise regulation. The study captured three different exercise regulation motives of varying autonomous degrees.

Table 3

Estimated correlation for the latent variables

	1	2	3	4	5	6	7	8	9	10
1. Self-oriented perfectionism										
2. Other-oriented perfectionism	**.17**									
3. Socially prescribed perfectionism	**.41**	**.08**								
4. Amotivation	.02	**-.07**	**.23**							
5. External regulation	**.17**	**-**.03	**.33**	**.47**						
6. Introjected regulation	**.17**	.01	**.12**	**-.11**	**.15**					
7. Identified regulation	**.17**	-.04	-.01	**-.26**	.05	**.66**				
8. Integrated regulation	**.13**	-.01	.00	**-.15**	**.10**	**.64**	**.83**			
9. Intrinsic motivation	**.07**	-.05	**-.06**	**-.25**	-.05	**.49**	**.79**	**.78**		
10. Exercise minutes	**-.10**	-.04	**-.17**	**-.26**	**-.23**	**.32**	**.47**	**.50**	**.48**	
Mean	18.3	14.6	14.7	6.8	8.3	10.5	13.4	11.1	13.9	90.2
SD	4.1	2.6	4.3	2.9	3.4	3.9	3.4	4.1	3.8	103.3
Cronbach's alpha	.82	.67	.80	.82	.79	.87	.83	.90	.91	-

Note: N = 1365

Bolded correlation coefficients are significant $p < .05$

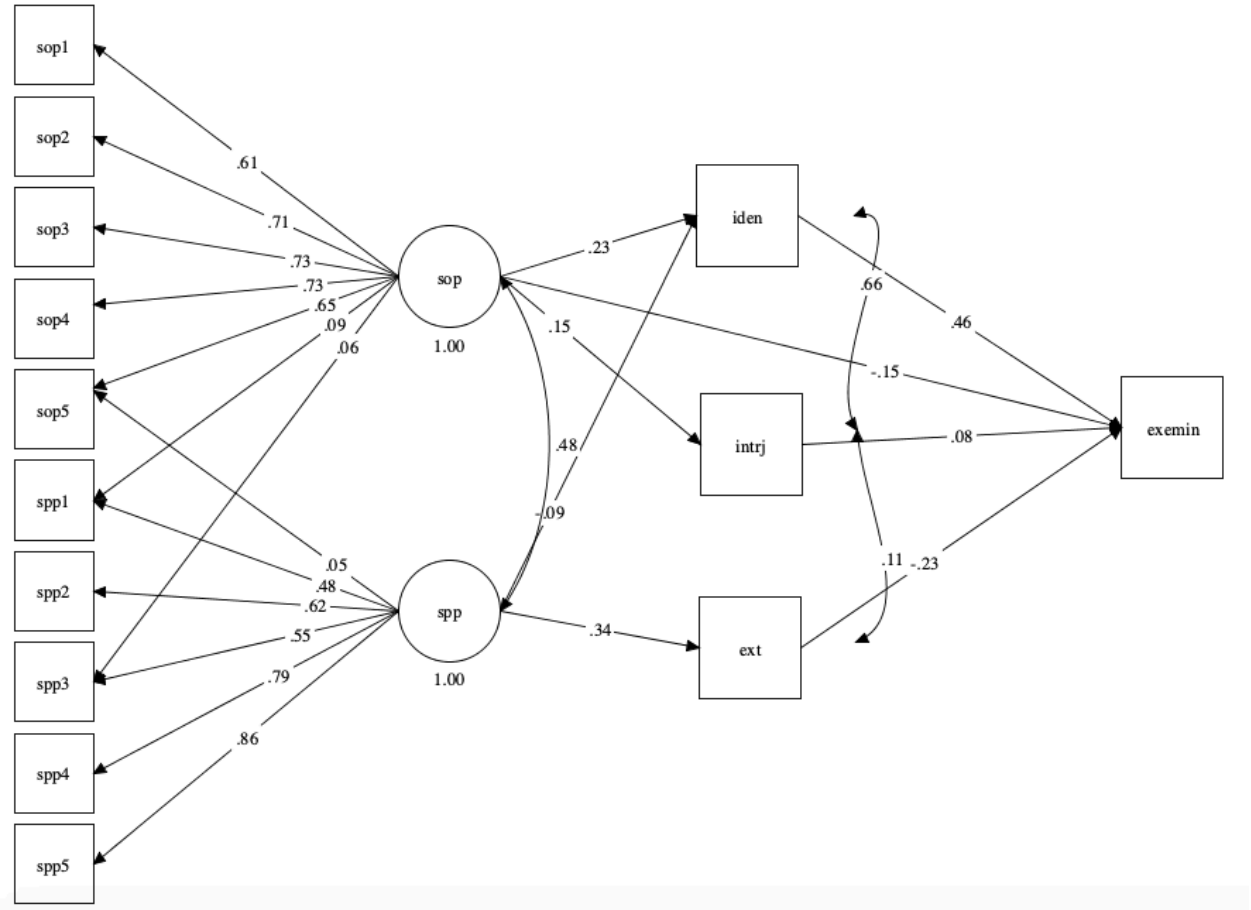
4. 2. 3. 2 The mediating role of exercise regulation in exercise volume and perfectionism relationship

I continued the analysis by performing a path analysis in MPLUS. My hypotheses would predict exercise volume from perfectionism by the mediating power of different exercise motives. I used the maximum likelihood estimation with robust standard errors (MLR) as this could overcome problems from possible non-normal distributed data.

The model had good fit indices (χ^2= 316.1, RMSEA = 0.06, CFI = .95, TLI = .92, SRMR = 0.03). The model showed that SOP could predict exercise volume directly and indirectly. Indirectly, the identified regulation mediates the link between SOP and exercising time. The SPP can only predict total exercising time when mediated by external regulation. The specific pathway of the accepted model can be seen in figure 9.

Figure 9

The final model with standardized path coefficients



Note. All estimations were significant at the p<.05 level. **SOP** = self-oriented perfectionism **SPP** = socially prescribed perfectionism **Ext** = external regulation **iden** = identified regulation **Intrj** = introjected regulation **exemin** = total exercising minutes

4. 2. 3. 3. The differences between exercisers and non-exercisers

Further dissection of the model showed the model has good fit indices for both non-exercisers (χ^2= 193.8, RMSEA = 0.06, CFI = .93, TLI = .90, SRMR = 0.03) and exercisers (χ^2= 164.7, RMSEA = 0.05, CFI = .96, TLI = .94, SRMR = 0.03). However, different patterns emerged between the two groups. In non-exercising participants, the SOP can predict the

exercise volume directly or when mediated by the identified regulation. The SPP can only predict introjected and external regulation, but not the total exercise time. Figure 10 shows the model for non-exercising and exercising group participants.

Table 4

Standardized estimates of direct and total indirect effects of perfectionism and mediating exercise motives to total exercise minutes in exercising and non-exercising participants

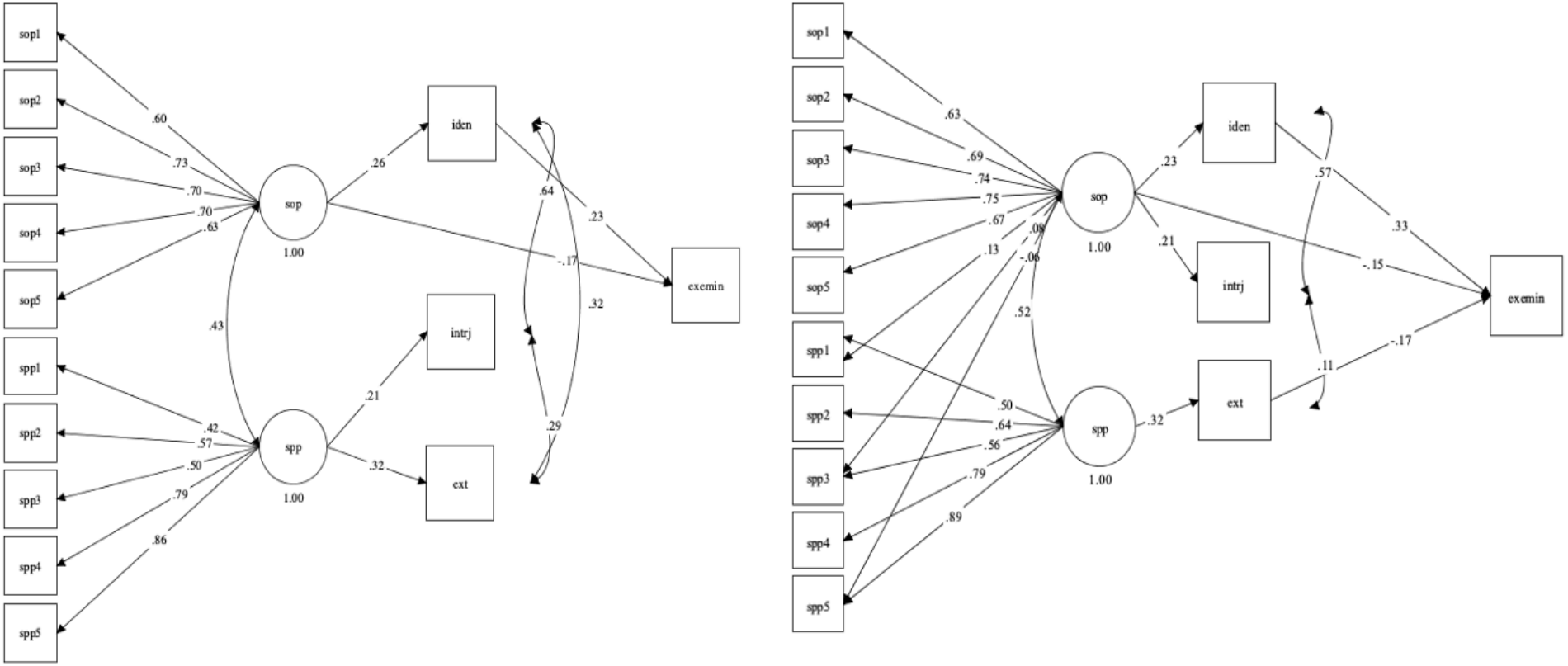
Antecedent variables	Standardized direct effect	*P*	A standardized total indirect effect	*P*
Self-oriented perfectionism effect to the total time spent exercising				
Exercising participants				
SOP → Exercise minutes	**-0.15**	**. < 0.01**	**0.08**	**< 0.01**
SOP → IdentReg → Exercise minutes			**0.08**	**< 0.01**
Non-exercising participants				
SOP → Exercise minutes	**-0.17**	**< 0.01**	**0.06**	**< 0.01**
SOP → IdentReg → Exercise minutes			**0.06**	**< 0.01**
Socially prescribed perfectionism effect to the total time spent exercising				
Exercising participants				
SPP → Exercise minutes	-0.06	0.20	**-0.09**	**< 0.01**
SPP → ExtReg → Exercise minutes			**-0.06**	**< 0.01**

Note. Bolded texts indicate significant at least at $p \leq 0.05$

SOP = self-oriented perfectionism **SPP** = socially prescribed perfectionism **ExtReg** = external regulation **IdentReg** = identified regulation

Figure 10

Model comparison between the non-exercising group (left) and the regularly exercising group (right) with standardized path coefficients



Notes: All estimations were significant at the p<.05 level. **SOP** = self-oriented perfectionism **SPP** = socially prescribed perfectionism **Ext** = external regulation **iden** = identified regulation **Intrj** = introjected regulation **exemin** = total exercising minutes

Both SOP and SPP can predict the exercise volume in the regularly exercising participants. SOP can predict exercise volume directly or when mediated by identified regulation. However, the SPP can also predict exercise volume mediated by external regulation. Participants with a high SPP score will use more identified regulation strategies and exercise more. Table 3 estimates the total direct and indirect effects of perfectionism.

4. 2. 4. Discussion

The current study showed that only SOP had a significant association with exercise volume. The association is relatively small but significant. The study finding is contrary to that in a previous study which showed that both SOP and SPP had a small but significant positive association with exercise behavior (Longbottom et al., 2012). Hence, my first hypotheses is partially accepted. The difference between the current and Longbottom's study might stem from the fact that the current study recruited not only regularly exercising individuals, but also those who are not exercising regularly.

The study also showed support to the hypothesized model in which different exercise regulation would mediate the link between perfectionism and exercise volume. The current study supports the notion that exercise regulation motives have impacted the perfectionism-exercise connection (Appleton & Hill, 2012; Goodwin et al., 2011, 2014; Hall et al., 2009; Hill et al., 2015; Longbottom et al., 2012; K. J. Miller & Mesagno, 2014). In the current study, SOP had both direct and indirect influence on exercise volume. However, the direction of the effects varied. The different direct and indirect effects' direction of exercise volume indicates a phenomenon referred to as inconsistent mediation (Kenny, 2021; MacKinnon et al., 2007; O'Rourke & MacKinnon, 2018). Our data showed that the SOP was inversely correlated with

exercise volume, meaning that the higher the SOP score would likely result in less time exercising. However, the data also showed SOP might also lead to an increased identification of the benefits of exercising, which would cause the person to spend more time exercising. This finding was contrary to a recent study that suggested the SOP is positively associated with exercise volume (Deck et al., 2021; Longbottom et al., 2010, 2012).

The mediating role of the exercise regulation in my study mimic the conclusion of past studies (Duncan et al., 2010b; Longbottom et al., 2012; Wilson et al., 2004). My analysis showed that the more autonomous form of regulation would mediate the SOP-exercise association while the more controlled form regulation mediate the SPP-exercise association. However, contrary to a prior study which aggregate the exercise regulation (Longbottom et al., 2010, 2012), my study showed that identified regulation (a more autonomous regulation) and external regulation (a more controlled regulation) mediated domains of perfectionism. Moreover, my conclusion is consistent with previous findings that controlled and autonomous exercise regulation can both influence behavior.

The emergence of external regulation as a mediator was somewhat surprising. Earlier studies tend to point to intrinsic, integrated, identified, or introjected regulation as the types of exercise regulation responsible for affecting exercise behavior (Box et al., 2019; Box & Petruzzello, 2020; Edmunds et al., 2006b; Feito et al., 2018; Schutte & Mcneil, 2015; Sicilia et al., 2018; van Lankveld et al., 2021; Wilson et al., 2002; Zeigler-Hill et al., 2021). However, more research is needed to understand how different exercise regulation motives can impact exercising behavior, specifically exercise volume.

The present study also confirmed that exerciser and non-exerciser differences could be attributed to different domains of perfectionism and exercise regulation motives. In the

exercising sample, the SOP could directly predict the total exercising time in the regularly exercising group or indirectly through the mediating factor of identified regulation. At the same time, the SPP could also predict exercising volume through mediation by external regulation.

In the non-exercising group, we observed a different pattern. Only the SOP could predict exercise volume. SOP could both have a direct effect or indirect effect through identified regulation. The different pathways between exercisers and non-exercisers observed in the study indicated a moderated mediation effect of exercise regulation motives on the association between perfectionism and exercise volume (Kenny, 2021; MacKinnon et al., 2007). My results suggested that the exercise regulation motive could interact with exercising habit (regularly exercising or not) in predicting total exercising volume.

4. 3. Study 2: Does gender moderate pathways of perfectionism and exercise regulation motive for exercise behavior?

The first study found different pathways linking perfectionism, exercise regulation motives, and exercise volume for exercising and non-exercising adults. This finding highlighted the complex nature of perfectionism and exercise volume when mediated by exercise motive. Building on the result of the previous study, the author would like to replicate the findings in a different sample to see if a similar pattern emerged.

4. 3. 1. Hypotheses

The study aims to investigate the mediational effect of varying exercise regulation motives on the relationship between perfectionism and exercise behavior in a regularly exercising sample. Two hypotheses from the first study were being re-tested in a different

sample. First, I hypothesized that SOP and SPP would significantly correlate with exercise volume. Second, I also hypothesized that different exercise regulation motive would mediate the link between domains of perfectionism and exercise volume. In the current study, the author conducted an additional analysis for gender. I hypothesized that men and women would have a different pattern as women were often cited to be susceptible to social pressure for "perfect appearance," which could later influence exercising behavior (Corazza et al., 2019; González-Hernández et al., 2021; Lichtenstein & Jensen, 2016; Wilson et al., 2004; Youngman & Simpson, 2014). Social pressure to exercise is an indication of a more controlled form of exercise regulation.

4. 3. 2. Methods

Similar instruments and data analysis was employed in the following study. Hence, the author will not describe the instruments and data analysis, only a description of the second study participants.

4. 3. 2. 1. Participants and sampling procedure

An invitation to participate in the study was distributed through a university bulletin board and a social media platform. We recorded 721 responses from regularly exercising individuals (i.e., exercising twice a week for at least 30 minutes per session). However, our analysis was based on 645 individuals (254 males and 391 females) as the remaining did not finish the survey. The detailed demographic characteristic of the participant is listed in table 5 and 6.

4. 3. 2. 2. Data Analysis

Like study 1, the author began by conducting a bivariate correlation analysis for all the variables of interest. Then a mediation analysis with the MPLUS program was conducted in which different regulation motives would be the mediators in the association between exercise volume and perfectionism in our model. The analysis used a maximum likelihood estimation with robust standard errors (MLR) because this estimator can overcome problems arising from non-normally distributed data (i.e., skewed or kurtosis). The last part of the analysis is a model test for female and male participants to identify possible differences.

4. 3. 3. Results

4. 3. 3. 1. Correlation between perfectionism, different exercise regulations, and exercise volume

Table 7 provides the bivariate correlation among the included studies. After evaluating the correlations among the variables, I dropped the OOP since it is not correlated with almost all other variables or had a significant but minimal association. The data in this study showed that the SOP and SPP have no significant association with exercise volume.

Similar to study 1, I detected high correlation coefficients were among integrated regulation and identified regulation (r =.78); integrated regulation and intrinsic motivation (r = .67); and identified regulation with intrinsic motivation (r = .69). Hence, I decided to exclude the integrated and intrinsic motivation. The amotivation was also removed from the model, resulting in only external regulation, introjected regulation, and identified regulation in the model.

Table 5

Study 2 participants' demographic data

	Male (n = 254)	Female (n = 391)
Age	26.6 ± 10.5	25.7 ± 8.8
Height (in cm)	171.5 ± 5.6	163.2 ± 6.7
Weight (in kg)	70.4 ± 12.6	57.8 ± 10.9
BMI	23.9 ± 3.9	22.5 ± 3.9
Education		
High school or lower	52.5%	54.5%
Vocational college	2.9%	7.4%
Bachelor degree	29.5%	24.5%
Postgraduate	15.1%	14.6%
Employment		
Fulltime	23.0%	24%
Part-time	5.0%	5.2%
Unemployed and looking for one	2.5%	4.5%
Unemployed and not looking for one	1.1%	1.4%
Retired	0.4%	0.7%
Students	55.8%	56.6%
Business owner	12.2%	7.6%
Perceived Health		
Poor	2.9%	3.0%
Fair	38.1%	38.9%
Good	59.0%	58.1%
Exercise Frequency per week		
2-3 times	51.4%	57.5%
4-5 times	36.3%	31.2%
6-7 times	12.3%	11.3%
Exercise duration per session		
16-30 minutes	27.0%	37.1%
31-45 minutes	14.7%	23.1%
46-60 minutes	28.8%	27.6%
> 60 minutes	29.5%	12.2%

4. 3. 3. 2. The mediating role of exercise regulation in exercise volume and perfectionism relationship

The model had good fit indices in the current study (χ^2= 154.2, RMSEA = 0.05, CFI = .96, TLI = .94, SRMR = 0.03). This model supports my hypotheses that different exercise

regulation mediate the relationship between perfectionism and exercise volume, similar to the previous study. The final path model with significant coefficients is presented in Figure 11.

Table 6

Participants' type of sports

Types of sports	Percentage
Running	31.69%
Bodybuilding	15.84%
Cycling	13.58%
Yoga	8.44%
High-intensity interval training	4.53%
Walking	4.12%
Zumba	3.5%
Swimming	2.88%
Pilates	2.88%
Aerobic dance class	2.26%
Muaythai	1.85%
Boxing	1.65%
Badminton	1.44%
Martial arts	1.23%
Calisthenics	1.03%
Brazilian Jiujitsu	1.03%
Tennis	0.82%
Futsal	0.41%
Taekwondo	0.21%
Kendo	0.21%
Volleyball	0.21%

N = 645 participants

The analysis showed that exercise regulation motives mediated the relationship between perfectionism and exercise volume. Specifically, the identified regulation mediated the association between the SOP with exercise volume. The individual with a high score of SOP would have more increased identified regulation, which could lead to a higher probability of spending more time exercising.

Table 7

The latent variables correlation matrix

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1. Self-oriented perfectionism										
2. Other-oriented perfectionism	**.14**									
3. Socially prescribed perfectionism	**.44**	.02								
4. Amotivation	.04	-.06	**.22**							
5. External regulation	**.17**	-.03	**.31**	**.58**						
6. Introjected regulation	**.22**	.02	**.15**	.01	**.15**					
7. Identified regulation	**.19**	-.04	-.01	**.14**	.04	**.56**				
8. Integrated regulation	**.18**	-.04	.00	-.02	**.10**	**.51**	**.78**			
9. Intrinsic motivation	.06	**-.09**	**-.08**	**-.13**	**-.10**	**.30**	**.69**	**.67**		
10. Exercise minutes	.08	.02	**-.15**	**.15**	**-.16**	**.13**	**.27**	**.31**	**.28**	
Mean	3.6	2.8	2.8	6.0	7.5	11.9	15.1	13.8	15.8	171.0
SD	0.2	0.1	0.1	2.4	3.2	3.9	2.8	3.6	2.9	57.5
Cronbach's alpha	.83	.68	.82	.95	.89	.83	.79	.87	.94	-

Note. N = 645

Bolded correlation coefficients are significant $p < .05$

The identified regulation also mediated the association between the SPP and total exercise time differently. Individuals with high SPP would have lower identified regulation, leading to less time to exercise. The external regulation also mediated the interconnection between SPP and total exercise volume. Table 8 describes the estimate of the mediation effects found in the model.

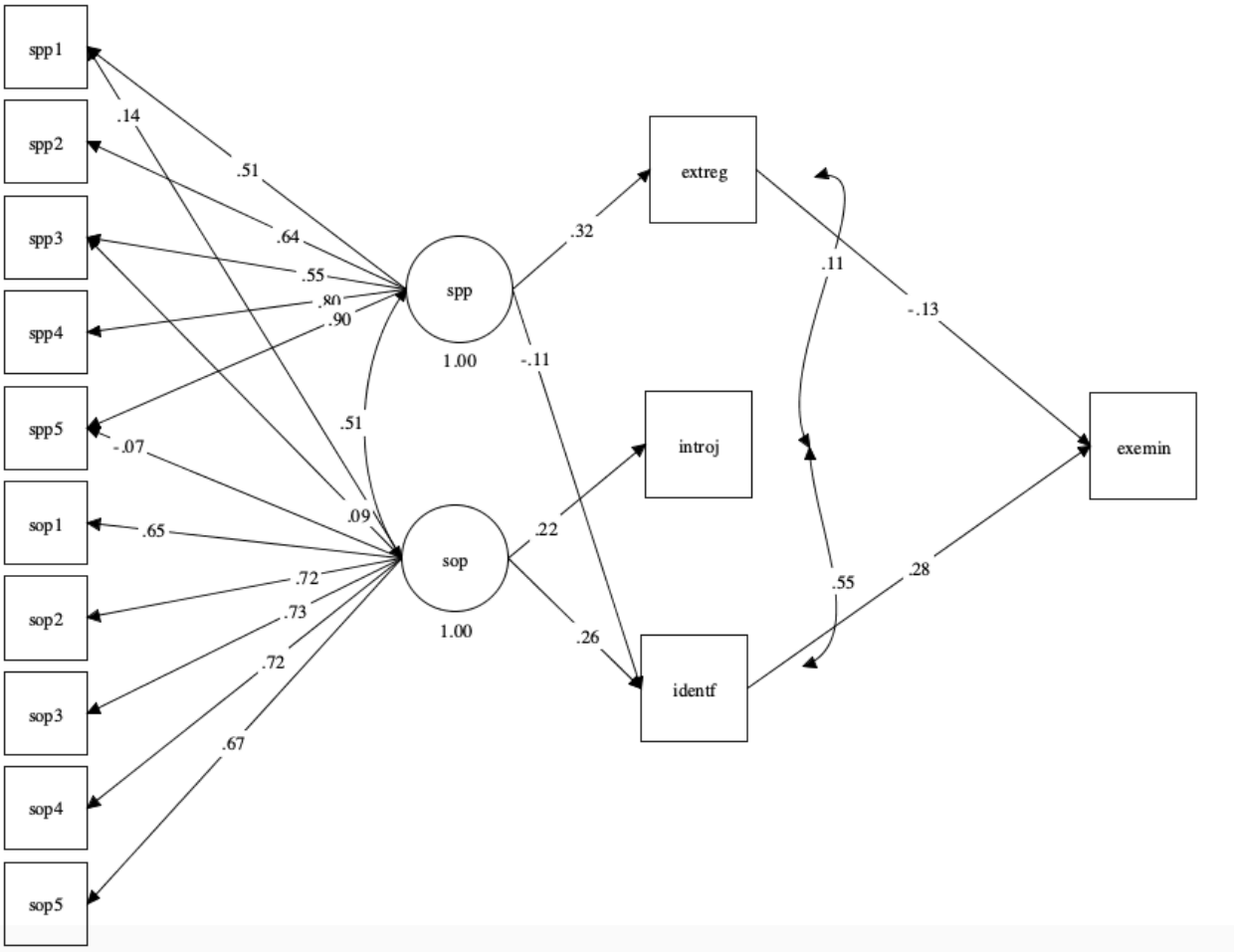
4. 3. 3. 3. The differences between male and female exercisers

Further inspection of the model showed different pathways for men and women. Table 9 describes perfectionism's estimated direct and indirect effect on exercise volume. The analysis showed that identified regulation mediated the association between the SOP and exercise volume in both genders, but the mediating impact of identified regulation was more potent in men. The identified regulation mediated the association between SOP and exercise volume almost

exclusively in men. In contrast female group, the mediating effect of the identified regulation seemed smaller in proportion.

Figure 11

The final model with standardized path coefficients for regularly exercising adult



Note. All estimations were significant at the p <.05 level. **SPP** = socially prescribed perfectionism **SOP** = self-oriented perfectionism **Extreg** = external regulation **identf** = identified regulation **Introj** = introjected regulation **exemin** = total exercising minutes

Table 8

Standardized estimates of direct and total indirect effects on exercise time and mediating variables

Antecedent variables	Standardized direct effect	*p*	Standardized total indirect effect	*p*
Self-oriented perfectionism effect to total time spent exercising				
SOP → Exercise minutes	-0.08	0.10	**0.08**	**< 0.01**
SOP → IdentReg → Exercise minutes			**0.07**	**< 0.01**
Socially prescribed perfectionism effect to total time spent exercising				
SPP → Exercise minutes	-0.08	0.10	**-0.07**	**< 0.01**
SPP → ExtReg → Exercise minutes			**-0.04**	**< 0.01**
SPP → IdentReg → Exercise minutes			**-0.03**	**0.04**

Bolded texts indicate significant at least at $p \leq 0.05$
SOP = self-oriented perfectionism **SPP** = socially prescribed perfectionism **ExtReg** = external regulation **IdentReg** = identified regulation

Exercise regulations mediate the association between the SPP and total exercise time differently in women and men. In women, the mediation was specifically linked to the external regulation motive. A woman who felt she had to be perfect due to external pressures (i.e., high in SPP domain) would have high external regulated motives, which subsequently drop the exercise volume. The three different motives might jointly mediate the association between the SPP and total exercising time in men. Our analysis cannot detect specific pathways, as was the case in women.

4. 3. 4. Discussion

Finding from the second study showed that neither the SOP and OOP have association with exercise volume in exercisers. This result is different than the one found in study 1. The difference

between study 1 and study 2 result might stem from the sample. Whereas study 2 used regular exercisers only as participants, study 1 used both exercisers and non-exercisers. However, other studies that recruited exercisers only also showed that SOP and SPP had positive association with exercise volume (Longbottom et al., 2010, 2012).

Table 9

Standardized estimates of direct and total indirect effects of perfectionism and mediating exercise motives on total exercise minutes in male and female participants

Antecedent variables	Standardized direct effect	*P*	Standardized total indirect effect	*P*
Self-oriented perfectionism effect to total time spent exercising				
Male participants				
SOP → Exercise minutes	-0.05	.50	**0.11**	**< 0.01**
SOP → IdentReg → Exercise minutes			**0.11**	**< 0.01**
Female participants				
SOP → Exercise minutes				
SOP → IdentReg → Exercise minutes	-0.13	.07	**0.05**	**0.04**
			0.04	**0.05**
Socially prescribed perfectionism effect to total time spent exercising				
Male				
SPP → Exercise minutes	-0.08	0.10	**-0.09**	**0.02**
Female				
SPP → Exercise minutes	-0.09	0.23	**-0.06**	**0.02**
SPP → ExtReg → Exercise minutes			**-0.05**	**0.01**

Bolded texts indicate significant at least at $p \leq 0.05$
SOP = self-oriented perfectionism **SPP** = socially prescribed perfectionism **ExtReg** = external regulation **IdentReg** = identified regulation

The non-significant association between SOP and SPP with exercise volume might signal inconsistent direct and indirect effects of the variables with equal power (Kenny, 2021; MacKinnon et al., 2007; O'Rourke & MacKinnon, 2018). Hence, the direct and indirect effects

are cancelling each other out, resulting in zero total effect. Our analysis supported that the inconsistent mediation in SOP-exercise volume association and SPP-exercise volume is cancelling each other out. As can be seen in table 7, the small but significant total indirect effect between SOP and exercise volume is almost equal in power with different directions. Similarly, the total indirect effect between SPP and exercise volume is also comparable with the direct effect with opposing signs.

The model in study two also exhibited good fit indices, similar to the study 1. This model confirms my assumptions that varied exercise regulation mediates the association between perfectionism and exercise volume. Unlike study 1, however, study 2 showed that identified regulation mediated the relationship between SOP and SPP with total exercise time. While the SOP correlated positively with identified regulation, which led to higher exercise volume, the SPP correlated negatively with identified regulation, resulting in less time exercising. Additionally, the SPP—exercising time was also mediated by external regulation so that individuals high in SPP would have increased external regulation, which led to less time spent exercising.

Another aim of study 2 was to know whether different perfectionism and exercise regulation motives surface in men and women. Our findings seemed to support the hypotheses. Our analysis suggested that different pathways emerge in men and women, suggesting that a moderated mediation occurred (Kenny, 2021; MacKinnon et al., 2007). While the identified regulation was found to mediate the relationship between the SOP and exercise volume in both genders, only women showed a mediation effect of external regulation in the association between SPP and exercising volume. Our data showed that women with high SPP had external regulation motives to exercise, which later predicted lower exercise volume. The gender differences in pathways of perfectionism and exercise regulation motives function in exercisers were

vindicating conclusions from prior studies (Duncan et al., 2010a; Jennsen & Dillern, 2021; Luque-casado et al., 2021).

The different pathways of men and women underscored the importance of understanding the individual difference in understanding people exercising behavior. An intervention to increase exercising time should consider the personality and different motivating factors (Molnar et al., 2020). As study 2 suggested, the various domains of perfectionism could associate with varying regulations of exercise, which could later predict exercise engagement. The finding could have significance in intervention for individuals who need to improve their physical activity level. Intervention should be aimed toward helping individuals incorporate exercising benefits into personal life goals might be crucial (Jennsen & Dillern, 2021; Luque-casado et al., 2021).

4. 4. Conclusion

The goal of the two studies was to model how personality and motivational factors function in exercise behavior, specifically total time spent exercising per week. I would like to know if differences among exercisers and non-exercisers could be results of perfectionism and different exercise regulations. As observed in the studies, we found that perfectionism and exercise regulation motives might play roles in exercise in which exercise regulation mediates perfectionism and exercise linkage. The pathways connecting domains of perfectionism, exercise motives, and exercise volume were complex and moderated by exercise status and gender.

The two studies showed that by analyzing both perfectionism and exercise regulation motives, we could find differences between non-exercisers. The author also found gender could moderate the pathways of perfectionism and exercise regulation motives function in exercisers

which showed support from prior studies (Duncan et al., 2010a; Jennsen & Dillern, 2021; Luque-casado et al., 2021). For example, women might be more implicated by external regulation, especially with a high SPP score. In addition, our study suggested that women with high socially prescribed perfectionism could have high external regulation motives (e.g., to get social approval), which might cause them to spend less time exercising. The findings of the studies could influence implications for future studies and interventions to promote physical activity levels. The following chapter will discuss the implications of the studies' finding in the context of physical activity promotion.

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Chapter 5: Implication for future physical activity promotions

The finding of the studies in chapter four that different exercise regulations function differently in exercising and non-exercising groups could significantly impact application. Understanding the gender, perfectionism profile, and exerciser regulation differences brings ramifications to application. In this chapter, the author will outline how the suggested practice for physical activity prevention in a few sections. The first section will focus on how findings from studies in chapter four should be applied. The author will also examine the gap between the suggestion and the current practice of physical activity promotion. The second section of this chapter will describe other factors that should be considered for physical activity promotion. The author will argue the need for researchers to evaluate physical activity levels and the sedentary time in physical activity promotion.

5. 1. Individually tailored intervention: the importance of understanding each individual as unique

The studies in the preceding chapter revealed the different pathways that explain explain why some people are active and others are not. The studies underscored the importance of understanding individual differences in exercising behavior, especially the role of personality and motivation (Engels et al., 2022; Rhodes & Smith, 2006).

5. 1. 1. Personality traits would affect exercise preference

The findings of the studies in chapter four align with the previous research that showed perfectionism played a role in influencing exercise behavior and that different domains of perfectionism had a distinct role in exercise behavior (Longbottom et al., 2012). The finding also concurs that different exercise regulations mediated the link between perfectionism and exercise. The studies in chapter four showed that perfectionism and exercise regulation could also explain the differences between exercisers and non-exercisers. The conclusion that perfectionism that perfectionism could influence exercise behavior adds to evidence of how personality factors could influence exercise behavior.

There have been studies linking various personality factors to exercise. One meta-analysis of studies conducted between 1969 and 2006 concluded that personality factors such as the big five theory are significant physical activity correlates (Rhodes & Smith, 2006). According to the study, extraversion, which concerns the preference for social interaction, had the highest association with physical activity. People who prefer social interaction and lively activity (high in extraversion) would be more likely to engage in physical activity than those who are low in extraversion. The same study also suggested that conscientiousness might be essential in maintaining exercise behavior. A person who is high in conscientiousness shows self-discipline and is purposeful, which could help maintain a positive lifestyle.

On the contrary, a high score in neuroticism might prevent an individual from exercising. A person with high neuroticism might show more distress, anxiety, and concerns with their physical performance, preventing them from exercising. However, the study also suggested that the relationship between personality and physical activity is not simple and could be moderated by factors such as sex, cultural values, and age of the participants.

The conclusion of the above meta-analysis is later vindicated by a more recent study which found that neuroticism has a negative association with physical activity. In contrast, conscientiousness, extraversion, and openness to experience are positively associated with physical activity (Sutin et al., 2016). The study, which included more than 100,000 participants from 16 countries, however, did not find that the big five contributions to physical activity were moderated by the sex and age of the participants. The two studies agreed that personality factors would influence physical activity (Rhodes & Smith, 2006; Sutin et al., 2016).

Despite differences in personality factors (i.e., the big five, perfectionism) investigated in different studies, researchers agreed that it is important that personality factors should be taken into account to understand exercise better (Aelterman et al., 2016; Box et al., 2019; Box & Petruzzello, 2020; Li et al., 2021; Molnar et al., 2020; Rhodes & Smith, 2006; Sutin et al., 2016). Scholars are also cognizant that the mechanism is not well established (Rhodes & Smith, 2006; Sutin et al., 2016). Researchers began to hypothesize how concepts in SDT could mediate the link between personality and exercise engagement (Engels et al., 2022; Longbottom et al., 2012). Satisfaction of basic needs and different exercise regulations have been found to mediate personality and exercise connection.

A recent study concluded that specific personality types in the big five theory would influence the satisfaction of basic needs in the SDT view, subsequently affecting exercise enjoyment and engagement (Engels et al., 2022). For example, extraversion is related to exercise enjoyment and engagement (Engels et al., 2022). The same study also revealed that an introvert person (whose extraversion score is low) would experience more pleasure in exercise if the circumstances facilitate social relation that is meaningful to the person. A person with a high level of agreeableness would experience more enjoyment if the exercise were perceived as

fulfilling their autonomy needs. The study also concluded that individuals with a high level of neuroticism would enjoy exercise more if it builds their sense of competence.

Regarding perfectionism, studies in chapter four showed the integral role of different exercise regulations as a mediator of perfectionism and exercise volume. The findings highlighted the identified regulation and external regulation contribution as mediators of the association between exercise volume and perfectionism. The results that external regulation could also mediate the link between SPP and exercising book agree with past studies that found a more controlled exercise regulation could influence exercising behavior as much as a more autonomous exercise regulation (Aelterman et al., 2016; Longbottom et al., 2012). A more controlled form of exercise regulation could also mediate perfectionism-exercise connection differently than the autonomous regulation.

Given the crucial role of personality in physical activity promotion, researchers and practitioners should take personality factors for tailoring intervention to ensure a person-centered approach is implemented. Molnar and colleagues (2021) suggested that before working directly to improve physical activity, it is crucial to understand the person's unique profile from perfectionism. It is essential to know how prominent perfectionism or other personality traits influence the exercise. Personality can be a source to guide tailoring intervention to promote physical activity. For example, an individual with low extraversion might not be suggested to engage in group exercise, but perhaps exercises in which meaningful relationships can be built with a 'partner' (Courneya & Hellsten, 1998). Another example would be individuals who are highly organized and structured (high in conscientiousness). They might be better suited for physical activities facilitating a sense of competence, like bodybuilding or running with a coach (Engels et al., 2022; Rhodes & Smith, 2006)

Personality can also function as a barrier to physical activity. An individual with high neuroticism, for example, tends to avoid physical activity over the concerns of negative evaluation from others (Engels et al., 2022; Rhodes & Smith, 2006). Therefore, it is crucial to think of different physical activity mode that matches the individual's personality characteristics. Recent studies showed that different sports had different characteristics (Terwiel et al., 2020). The characteristics of the sports are more complex than indicating whether it is individual or team sports, competitive or non-competitive. Some sports require intellectual strategies, some require cooperation, while others require overcoming adversity. The differences in characterisctis of the sports could explain why some people experience more fun and autonomy over certain type of sports. Terwiel and colleagues (2020) suggested that these varying sport characteristics and personality of the individuals would explain why some individuals enjoy certain type of sports while others differ. Hence, it could be crucial to match certain personality attributes to the situational demand of certain sports. Question like: "In what ways do different forms of physical exercise meet the satisfaction of needs?" or, "Do the BIG 5 operate in the same way across exercise categories?" Answers to these questions might yield useful information on how different sorts of activities meet psychological demands.

Researchers and practitioners should use personality factor to consider the best possible avenue for physical activity promotion and adherence. Taking personality factor into account also signifies the utility of tailoring intervention to ensure a person-centered approach is implemented. There have been plenty of intervention studies to promote physical activities (Hutchison et al., 2009; Knittle et al., 2018; Marshall & Biddle, 2001; Senkowski et al., 2019; Stacey et al., 2015). A large part of the interventions occur in group settings and offer adequate effectiveness in improving physical activity level (Steinmetz et al., 2016). The effectiveness of

intervention in groups might be related to the fact the group presents social support crucial for physical activity (Trost et al., 2002) or satisfy the need of relatedness (Engels et al., 2022). However, intervention delivered in group setting may overlook the potential mediating and moderating effect of personality. All participants are going through the same interventions while their condition differ each individual and abandoning the individual psychological needs.

5. 1. 2. Motivation and exercise regulation's contribution to exercise

Van Lankveld and colleagues (2021) stressed the importance of understanding motivation as the proximal determinant of exercise behavior. The idea of motivation in exercise has been thoroughly researched, and numerous theoretical frameworks have been developed to explain behavioral patterns. These studies often look at participative motivations and behavioral control as predictors of the behavior (Teixeira et al., 2012). That is, it is expected that distinctive participating incentives (e.g., enjoyment) and/or different regulatory behaviors (e.g., intrinsic) will lead to increased physical activity participation (e.g., frequency, adherence). As a result, researchers have worked to establish which participation incentives most impact behavior regulation patterns, as well as how behavior regulation effects behavior directly (Box et al., 2019; Feito et al., 2018).

A recent study of 403 adults who regularly exercised found differences in motives and exercise regulations among those who engage in CrossFit, aerobic exercises (e.g., running, swimming), resistance training (e.g., weight lifting), group exercise (e.g., Zumba, yoga), and sport (e.g., tennis, soccer) (Box et al., 2019). The study found CrossFit training participants reported the strongest affiliation and competition motives than the other groups. They also reported stronger drive for a greater appearance, and strength and endurance. Individuals who

chose resistance training were less motivated by health and weight control than those who chose CrossFit or aerobic exercise. The study shows that the different motives for participating in an exercise result in different exercise regulations strategies employed by the individuals. Participants in the CrossFit group had the lowest external regulations, while also showing a higher introjected regulation. Further, the CrossFit training and Resistance training group indicated had more significant identified regulation compared to Group exercise and Sport.

Different motivation and exercise regulation could also explain differences of intensity and frequency of exercise (Feito et al., 2018). A study with 732 adults engaged in CrossFit training revealed that those who exercise frequently (≥ 5 times per week) had more intrinsic motives (e.g., enjoyment, challenge, or competition) than those who exercise less frequently who were concerned more with weight management. The studies in in chapter four confirms the importance of exercise regulation. My findings also suggested that by incorporating SDT constructs, a better understanding of how personality function in exercise could be achieved (Box et al., 2019; Engels et al., 2022; Longbottom et al., 2012).

There emerged one question: which type of exercise regulation would influence the relationship between perfectionism and exercise. Scholars have yet to agree on which types specifically correlated with exercise (Duncan et al., 2010b; Edmunds et al., 2006a; Hurst et al., 2017; Jennsen & Dillern, 2021; Sebire et al., 2016; Sibley et al., 2013; Sicilia et al., 2018; Wilson et al., 2004). One study suggested that only identified and introjected regulation predicts exercising (Edmunds et al., 2006a). Other studies indicated that the identified and integrated regulation could predict exercise frequency (Duncan et al., 2010b) while another suggested intrinsic and integrated regulation predicted exercise behavior (Jennsen & Dillern, 2021). My findings in chapter four suggested the importance of the identified regulation motives and

external regulation. Given the lack of agreement on which exercise regulation can predict exercise behavior, more research is needed on the topic.

Intervention should also consider the gender of the individual. As study two in chapter four suggested, different patterns of perfectionism and exercise regulation could be seen between men and women. My finding in study two showed a moderated mediation of exercise regulations between the SPP and total exercise time. Women were more tied to external regulation of exercise and the higher externally pressured they were, the less likely they to exercise. The findings that gender moderated the mediating power of exercise regulation was in agreement with previous study which found a gender disparity in physical activity levels and autonomous forms of exercise regulation, which impaired women (Luque-casado et al., 2021).

The finding of study two implicates that efforts to promote physical activity needs to be gender-sensitive (Luque-casado et al., 2021). A variety of social and cultural issues appear to be impeding women's internalization of active lifestyle behavior. Women may object to particular physical activities due to worries about stereotypes, appearance, and body image, or because they feel bound by societal acceptable. An example of this would women resist to exercise because they thought it would make them more muscular and resulting being perceived as less feminine. Another example is women who exercise to strive toward thinness which is valued in their social network. It is essential that physical activity promotion to consider the context of exercise for women by helping them to see how exercise meet their needs and interest.

5. 2. Promotion of physical activity ≠ reduced sedentary time

The vast number of studies in physical activity promotion has mainly focused on increasing the level of physical activity. There are a few drawbacks to this approach. The first is

that intervention in physical activity often has diminishing effect 12 months after the intervention, requiring a maintenance strategy to be employed (Müller-Riemenschneider et al., 2008). The second drawback stems from the assumption that an increased PA level equals a reduction in sedentary behavior. It is often assumed that incorporating physical activity into the daily routine would automatically reduce sedentary behavior. However, a meta-analysis refutes the notion (Wilmot et al., 2012). A meta-analytical study, which included 18 studies, showed strong and consistent associations between sedentary time and diabetes, cardiovascular disease, and cardiovascular and all-cause mortality (Wilmot et al., 2012).. The study's authors suggested that the reported associations were largely independent of physical activity, lending credence to the idea that sedentary behavior is a distinct behavior in its own right.

Sedentary behavior can be operationalized as any conscious action characterized by an energy expenditure of fewer than 1.5 METs in a sitting or reclining position (e.g., television viewing, driving, computer work) (Lewis et al., 2017; Prince et al., 2014; Wilmot et al., 2012). Modern lifestyle often requires people to spend more time in sedentary behavior. Employees often spend most of their work time behind their desks and computers. One study estimated that employees in managerial positions could spend up to six hours per day in sedentary posts doing their work (R. Miller & Brown, 2004). Another study showed that working behind a desk could make up more than half of sedentary time (Kazi et al., 2014). Studies have found occupational sedentary behavior positively correlates with obesity, a risk factor for non-communicable diseases (W. J. Brown et al., 2003; R. Miller & Brown, 2004). Sedentary behavior also increases the risk of premature mortality (Wilmot et al., 2012).

Another part of the modern lifestyle that continues to be associated with declining physical activity level is university life. Transition to post-secondary education (i.e., college or

university) has also been found when emerging adults are the most prone to declining PA levels (Gropper et al., 2020). A more considerable proportion of high school graduates who enrolled in university reduced their physical activity levels than increased their physical activity levels. Although the reduction in physical activity level might stem from the absence of mandatory physical education at the university level, it might also indicate that the lifestyle in higher education fosters a sedentary lifestyle.

Replacing sedentary activities with MVPA has a profound impact on health outcomes, but it does not warrant a reduction in sedentary behavior (Prince et al., 2014). A systematic review of 65 controlled trials looked into whether treatments aimed at increasing physical activity would also decrease sedentary behavior (Prince et al., 2014). The authors of the study found that if intervention focuses on reducing sedentary behavior, there is consistent support for considerable reductions in sedentary time. On the other, when the focus is just on enhancing PA or combining improving PA and reducing sedentary activity, there is no evidence to encourage sedentary behavior decreases. For this reason, researchers started to put another emphasis on reducing sedentary behavior to obtain additional health benefits (Lewis et al., 2017).

A systematic review of 33 studies that targeted substituting sedentary behavior with light-intensity activity or standing concluded that physical activity in light intensity could be beneficial, especially for inactive and obese populations (Batacan et al., 2015). The study found that a lowered blood pressure could be observed by substituting sitting with standing or walking. A similar conclusion was drawn from a survey of nine obese individuals. In this study the individuals who accumulated 2.5 hours of low-intensity physical activity (e.g., leisurely walking) or standing throughout an 8-hour workday had lower blood pressures during and after work could be obtained (Zeigler et al., 2016).

Targeting a substitute for sedentary behavior at work or home could also pose a problem. Given the majority of the studies concentrate on physical activity promotion, the mechanism of reducing sedentary behavior or well-studied alternatives for sedentary behavior is yet to be established (Batacan et al., 2015; Lewis et al., 2017; Prince et al., 2014). There have been guidelines for physical activity by the WHO and other international bodies, while internationally acknowledged guideline for reducing sedentary behavior is yet to be found.

There have been attempts to understand possible alternatives to sedentary behavior, but more research is needed. For example, modifying workplace arrangements to ensure light activity is made available during working hours could reduce the sedentary time (Chu et al., 2016). Another systematic review shared a similar conclusion, even suggesting that reduced sedentary time due to being lightly active did not deter work performance (Neuhaus et al., 2014).

5. 3. Future direction of physical activity promotion

The author has explained the global physical activity level and studies conducted in the area throughout the dissertation. In the first chapter, the author outlines the global decline, known correlations, and theoretical framework to understand physical activity. A theoretical framework helps researchers describe possible underlying factors and mechanisms that shape exercise behavior (Dalgetty et al., 2019; Davis et al., 2015). Although there are different theoretical frameworks, there have been overlaps in the behavior change technique employed across the theories (Davis et al., 2015; Michie & Prestwich, 2010; Samdal et al., 2017; Teixeira et al., 2020).

The author has argued for considering personality factors to understand physical activity better. The studies in chapter four have supported the argument. The studies in chapter four have

only added proof of the importance of personality and motivation regulation regarding exercise behavior. Studies in chapter four showed that different perfectionism and motivational regulation could explain why some people exercise while others do not. Findings from the current dissertation concur with a past study found that personality factors can explain differences in exercise preferred mode (Box et al., 2019) or the desired intensity (Box & Petruzzello, 2020).

At the same time, there has been an extensive effort to classify exercise types systematically, as common exercise classification tends to be oversimplified (e.g., individual vs. team) (Terwiel et al., 2020). Future research should examine to what extent the selection of a particular exercise (and its characteristics) varies as a function of individual characteristics (e.g., personality, motivation, gender). For example, research could address how different personality traits would influence the preference over a particular kind of exercise. This might give useful information on how different sorts of activities meet psychological demands.

Practitioners who intend to help promote an active lifestyle from an applied standpoint should consider differing personality, motivational, knowledge, and perceived factors before designing interventions for specific individuals. Practitioners must explore and understand varying clients' needs, values, motives, and personalities. The utilization of a person-centered approach in physical activity promotion is crucial. Practitioners or researchers need to take time to understand the client's uniqueness individually. Understanding the intra- and interpersonal factors, the environment in which they live, access to facilities, and past behavior is obligatory to warrant a better success rate (Bauman et al., 2012). Among the intrapersonal factors associated with physical activity, personality could improve physical activity level (Engels et al., 2022; Rhodes & Smith, 2006). Practitioners and scientists need to ask, "How does the individual's personality affect exercise?" or "Would a certain type of activity satisfy the individual's need?"

The getting-to-know process should lay the foundation of the intervention. This process should create a facilitative climate in which supportive and non-judgmental communication techniques are employed. A supportive environment has been found to predict behavior changes (Gillison et al., 2019). The changes are due to enhance intrinsic and autonomous motivation, which stresses that changes are voluntary actions by the individuals and not imposed by others, including the practitioners. To create a supportive climate, practitioners should use non-controlling language while exploring the clients' values, aspirations, and other aspects of the client's life (Gillison et al., 2019; Teixeira et al., 2020). The non-controlling language mimics the techniques in motivational interviewing (MI), which is a client-centered method to enhance intrinsic motivation for change (Samdal et al., 2017). It is essential to help the client internalize the reason for changes, perhaps by assisting the client in aligning exercise with other life aspirations.

Practitioners/ researchers could also explore and acknowledge the barriers and difficulties to exercising target. The process provides a chance to improve the client's autonomy while also feeling accepted (Gillison et al., 2019; Teixeira et al., 2020). Recognizing clients' feelings, anxieties, and other experiences is critical for the client to feel welcomed. Active listening is necessary. Practitioners could help the client by providing a rationale for change or help them reflect on choices they can make (Gillison et al., 2019; Samdal et al., 2017; Teixeira et al., 2020). This process might help the client outline possible solutions to overcome barriers and take ownership of the change process. Practitioners need to facilitate the process. For example, the practitioner can help the client by providing an optimal challenge. An optimal challenge is challenging enough but realistic and achievable. At the same time, it is also necessary to work

together to identify sources of social support the client needs. Does the client have sufficient knowledge to conduct the behavior? Does the client need encouragement from others?

The practitioner should help the client to monitor progress. They need to work collaboratively to know if the solution is successful or not. The client needs to be given constructive and relevant feedback in a non-controlling language. The feedback process should be conducted in ways that participants can gradually monitor their progress. The self-monitoring needs to be gradually introduced for the participant to take responsibility for their improvement.

In line with a recent meta-analysis, changes in physical activity levels should be measured together with sedentary behavior (Lewis et al., 2017; Neuhaus et al., 2014; Prince et al., 2014). Future research should also investigate physical activity levels and sedentary time separately. Past studies suggest that interventions focus more on physical activity promotion but rarely result in reduced sedentary time. For this reason, future research and interventions should look not only at additional activity minutes but also reduce sedentary time both at the workplace and at home.

5. 4. Limitations

The findings of the studies in chapter four are free from shortcomings. The limitations are related to the sampling issues employed, study design, and integration of limited contructs of the SDT in the model.

5. 4. 1. Sampling issues

Since the goal is to identify possible differences in between exercisers and non-exercisers in terms of personality and exercise regulations, we recruited participants who regularly exercise

and those who do not exercise. This is in line with suggestions from past studies which often focused on how perfectionism and exercise regulation function in regular exercisers (Box et al., 2019; Box & Petruzzello, 2020; Feito et al., 2018; Longbottom et al., 2012).. However, the participants were limited to those who agreed to participate in an online survey. Future studies could expand participants to add those who have limited to reduce bias toward people with internet access.

Another issue with the sampling is the divergent type of exercise the participants do. I did not control the type of exercise or assign a quota of samples for different exercises. Different exercises might have suitable features for certain types of individuals (Terwiel et al., 2020). As a result, the author may have overlooked significant individual variances within more specialized exercise modalities (e.g., those who engage in running vs. resistance training; those who engage in particular sports vs. class-based exercise). It is feasible that integrating this information in future research may help find more powerful exercise prescriptions that correspond to specific personality types.

5. 4. 2. Cross-sectional nature of studies

As with past research, the studies in chapter four relied on a cross-sectional design. Because of its cross-sectional methodology, the current study's findings may be restricted in generalization. I cannot conclude causality between perfectionism and exercise regulation and exercise participation. Researchers discovered that while some personality traits influence exercise activity (Box et al., 2019; Box & Petruzzello, 2020; Feito et al., 2018; Longbottom et al., 2012), the opposite is also true: the exercise may also have an impact on personality (Allen & Laborde, 2014). It is impossible to identify the causal link of personality using an experimental

design, as personality is difficult to manipulate (Rhodes & Smith, 2006; Sutin et al., 2016). A longitudinal design could overcome this limitation. A longitudinal design is required to discover how perfectionism might lead to various exercise regulations and later impact exercise behavior.

5. 4. 1. Incomplete SDT change process incorporated

The studies in chapter four incorporated exercise regulation as part of the SDT, but it is only a fraction of the change process implied by the theory. Although this helps better understand how perfectionism might influence exercise, the model only integrated a small part of behavior change in SDT. As described in chapter 1 (see pages 36-38), exercise regulation results from perceived basic needs satisfaction. The perceived needs satisfaction is made possible by a supportive climate, directing causality of the behavior, and changing underlying motive. Future work should integrate more concepts from the SDT (Longbottom et al., 2012). For example, scholars can examine how both need satisfaction and motives could combine to mediate the relationship between dispositional perfectionism and exercise.

5. 4. Contributions of the dissertation to knowledge advancement

The current dissertation's findings add to the body of knowledge the following points:

a) The dissertation is the first study that studies the differences between regular and non-exercisers using perfectionism and exercise regulations. A similar study has been conducted in the past but recruited only regular exercisers and therefore could not conclude if perfectionism and exercise regulation function differently between the groups (Box et al., 2019). The current dissertation participants were broader than prior studies, with almost 2,000 responses recorded and analyzed.

b) This dissertation proves that exercise regulations could mediate the association between perfectionism and exercise. The conclusion is similar to a study conducted by Longbottom and colleagues (2012). However, this dissertation analyzed individual exercise regulation instead of the aggregate used by Longbottom and colleagues. Therefore, the current dissertation could point to specific regulations that played a role in the association between perfectionism and exercise.

c) Additionally, my finding raises the question of which exercise regulations type could mediate perfectionism and exercise. Scholars have pointed to introjected, identified, integrated, and intrinsic regulation as mediating variables in the perfectionism-exercise link (Duncan et al., 2010b; Edmunds et al., 2006a; Jennsen & Dillern, 2021). However, my finding found that external regulation could also mediate. The presence of external regulation suggests that controlled regulation could also predict exercise behavior, albeit different from more autonomous regulations.

d) The current dissertation demonstrates how individual characteristics played a significant role in exercise behavior. Perfectionism and exercise regulations could influence exercise volume, and the pattern is moderated by gender. The conclusion could help practitioners adjust their programs to promote physical activity levels. It is crucial to understand the uniqueness of each individual before tailoring the best-fitting program for that individual.

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