## Understanding Physical Activity in Older Adults: The Role of Psychological and Situational Determinants

Cumulative doctoral thesis presented to the faculty of Human Sciences at the University of Bern for the degree of Doctorate in Psychology

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Von der philosophisch-humanwissenschaftlichen Fakultät der Universität Bern auf Antrag von Prof. Dr. Jennifer Inauen, Prof. em. Dr. Hansjörg Znoj angenommen.

Bern, den 04.06.2025

Der Dekan: Prof. Dr. Elmar Michael Anhalt

Every man desires to live long, but no man wishes to be old. Jonathan Swift (Irish author, 1667–1745)

#### Acknowledgments

Firstly, I would like to express my gratitude to my supervisor, Professor Jennifer Inauen. Thanks to your encouragement and understanding, I was able to finish my dissertation, which means a lot to me. I would also like to thank my second supervisor, Hansjörg Znoj for giving me the opportunity to accomplish my doctorate.

Furthermore, I would also like to thank my family for their untiring support despite the hardships we faced. I cannot stress enough how much your encouragement has helped me in times when my body and mind were feeling worse with every passing day. I would especially like to thank my mother, who, despite her cancer diagnosis, tried her best to support me in the last stretches of my dissertation. You are truly a role model for resilience for me, and I am thankful for every day I can experience with you. I would also like to thank my grandfather, who always helped me in tough times, encouraged me, listened to me, and ignited my spark for understanding how someone can be healthy in one's older age. Finally, I would like to express my gratitude to my late grandmother, who helped raise me and later sparked my interest in working with older adults after her Parkinson's diagnosis. I will always remember you.

Donc, ces doux mots sont pour vous: vous êtes la meilleure famille et sans vôtre amour et surtout vôtre compréhension, je ne serais pas là où je suis maintenant. Comme dit Le Petit Prince: "On ne voit bien qu'avec le cœur. L'essentiel est invisible pour les yeux."

I dedicate my dissertation to everyone who has a disability, especially disabled academics. I struggled with finding the right diagnoses for my condition, and sometimes, working on this dissertation was hard while having debilitating symptoms that were somewhat unexplainable and hard to manage at times. However, I somehow persevered and have been able to complete this dissertation.

#### Abstract

Aging and physical activity are crucial topics in public health, particularly as the global population of older adults continues to grow. Physical activity is a key health behavior that can significantly enhance the quality of life and reduce the risk of chronic diseases among older adults. However, maintaining regular physical activity can be challenging due to various psychological and situational factors.

This dissertation aims to explore these factors by integrating three interconnected studies that investigate different aspects of behavior change and physical activity in older adults.

Firstly, in a longitudinal study, self-efficacy and health status were the strongest predictors of intention to engage in physical activity after lockdown, while volitional factors like action control and planning had no significant effects. Fear of COVID-19 did not significantly effect the intention-behavior relationship. Secondly, in a qualitative study using the thinkaloud paradigm, older adults often viewed planning as unnecessary or restrictive. Yet the process of creating implementation intentions encouraged self-reflection and highlighted barriers such as irregular routines. Some participants found planning beneficial for resuming activities, while others struggled with its applicability. Thirdly, in a qualitative study using an interpretative phenomenological approach, participants emphasized the importance of physical activity for well-being, mental health, and aging, describing it as both a need and a source of joy as autonomous motivations. However, societal pressures as controlled motivation sometimes made it feel arduous. They desired autonomy in choosing activities but acknowledged the value of external monitoring and noted that enjoyment often increased once they began exercising.

This research expands on the understanding of the unique behavioral determinants that influence older adults' physical activity. It shows how certain situational determinants like the Covid-19 pandemic can influence physical activity in older adults and indicates what protective factors are. Furthermore, it gives insights into the attitudes of older adults towards certain strategies, namely implementation intentions for changing their physical activity. It shows the importance of self-determination for maintaining physically activity over a lifetime. Which psychological needs have to be satisfied for older adults to sustain their physical activity, are also analyzed. This knowledge can be used be to inform future research and interventions, by giving concrete recommendations and guidance through situational changes. This will enhance their self-efficacy through social support, understanding their thought processes and enabling autonomy. Ultimately, the aim is to help older adults to adopt active lifestyles and promote healthy aging.

### Abbreviations

ANOVA	Analysis of Variance
BCTs	behavior change techniques
BCW	Behavior Change Wheel
НАРА	Health Action Process Approach
HBM	Health Belief Model
IBM	Integrated Behavior Change Model for Physical Activity
IPA	Interpretative Phenomenological Analysis
MET	Metabolic Equivalent and Accelerometry
MoAs	Mechanisms of Action
РАНО	Pan American Health Organization
SDT	Self-Determination Theory
TPB	Theory of Planned Behavior
TTM	Transtheoretical Model
WHO	World Health Organization

## List of figures

Figure 1 Schematic Representation of Potential Interactions Among Determinants of Physical
Activity
Figure 2 Pathway from the Satisfaction of Basic Psychological Needs to Behavioral Outcome
Based on Self-Determination Theory15

## List of tables

|--|

### Table of contents

Acknowledgments I
AbstractII
Abbreviations III
List of figuresIV
List of tablesV
Chapter I – General Introduction1
1. Introduction2
2. Overview of the Theories of Aging
3. Healthy Aging4
4. Significance of Physical Activity for Older Adults4
<b>5. Inside the Black Box: Determinants of Physical Activity in Older Age</b>
5. Conceptualization of Determinants: Behavior Change Theories
6. Health Action Process Approach
7. Self-Determination Theory       13         7.1. Types of motivation       13         7.2. Basic psychological needs       14         7.3. Self-determination theory and evidence on physical activity and older adults       15
8. Aims and Research Questions17
Chapter II – Overview of Empirical Studies19
Study 1 – SERENA: Physical Activity Among Older Adults Post-Lockdown
Study 2 – Think Aloud: Thoughts on Implementation Intentions for Physical Activity Among Older Adults
Study 3 – SelfACT: The Role of Self-Determination for Physical Activity Among Older Adults
Chapter III – Results
Article 1: Older adults' physical activity after lockdown: Testing the health action process approach and the moderating role of fear of Covid-19
Article 2: What do older adults think about when formulating implementation intentions for physical activity? Evidence from a qualitative study53

Chapter IV – General Discussion	
1. Summary	
2. The Impact of Situational Factors on Physical Activity in Older Adu Example of the COVID-19 Pandemic 2.1 COVID-19 as a Life Event: Stressors to Physical Activity in Older Adults	<b>Ilts: The</b> <b>114</b> s <i>114</i>
<ul> <li>3. The Role of Attitudes and Beliefs about Physical Activity in Older Adult 3.1 Negative attitudes towards physical activity strategies in older adults can implementation</li></ul>	t <b>s 116</b> n hinder 116 e each other 118
<b>4. The Role of Motivation for Physical Activity in Older Adults</b>	<b>119</b> 119 120
5. Recommendations for Promoting and Sustaining Physical Activity in O	lder Adults
<ul> <li>5.1 Guidance through changes</li> <li>5.2 Enhancing self-efficacy by providing social support</li> <li>5.3 Understanding older adults' thought processes</li> <li>5.4 Enabling autonomy</li> </ul>	
6. Research Directions	
7. Strengths and Limitations	
8. Conclusions	
References	
Appendix	

## Chapter I

General Introduction and overview of this dissertation

#### 1. Introduction

Aging is one of the few aspects that concerns every one of us. It is a natural and inevitable process that encompasses biological, psychological, and social changes. With regard to recent demographic changes, our society is living longer than ever before, due to decreased infant mortality, advances in medicine, and better control of infectious diseases (Davenport, 2020). This demographic shift over the last century has resulted in a growing proportion of older adults and a shrinking proportion of younger adults, driven by increased longevity and declining birth rates. Additionally, improvements in the treatment of age-related chronic diseases have significantly extended the number of years people can live without disabilities, a benefit known as the "longevity dividend" (Crimmins et al., 2016; Olshansky et al., 2006). This shift has led to significant changes in population structure, with important societal and economic implications. It has also led to a gradual shift in awareness, from the belief that aging is beyond your control, marked by a focus on diseases and disengagement, to a more salutogenic perspective that emphasizes health, wellness, and active engagement.

For example, in the last century, Sigmund Freud, one of the most famous psychoanalysts and pioneers of psychology, feared aging and associated it with sickness (Woodward, 1991). Later, the first attempts to understand how we age and what happens when we age were undertaken as early as the post World War II years (Schroots, 1996). This made room for a continuous but steady shift to understanding why some individuals age successfully and what we can actively do to promote it. This short historical summary of research on aging depicts how our understanding of aging has changed during the last century, from a more deficit-driven perspective where someone only encounters losses to a more actor-driven perspective where individuals can actively influence their trajectory of aging.

However, the rising numbers of elderly adults come at a cost for healthcare systems since we will eventually need more resources in long-term care. One approach to alleviate the health care system is to ensure that geriatric adults age as healthily as possible (Osareme et al., 2024). It is becoming more evident that morbidity depends critically on individual behavior (Yoon et al., 2016), especially since nowadays the main reasons for death are noncommunicable diseases, which are greatly influenced by one's lifestyle and personal choices (Keeney, 2008). Thus, it is crucial to foster health-promoting behaviors.

#### 2. Overview of the Theories of Aging

One of the earliest theories, the Disengagement Theory (Cumming & Henry, 1961), proposed that aging involves a natural withdrawal from social roles and activities, while Activity Theory (Havighurst, 1961) countered this by arguing that remaining active and socially engaged leads to greater life satisfaction. These early theories primarily focused on social roles and activities, often portraying aging either as a decline or as a process that could be mitigated by remaining active. Later, the Continuity Theory (Atchley, 1989) suggested that maintaining consistent patterns of behavior and lifestyle is key to successful aging. By the late 1980s and early 1990s, the concept of aging shifted further towards a more positive and comprehensive view, emphasizing the potential for continued growth, adaptation, and well-being throughout later life. The Socioemotional Selectivity Theory (Carstensen, 1991), for example, posited that older adults prioritize emotionally meaningful relationships due to a perception of limited time, and the Selective Optimization with Compensation Theory (Baltes & Baltes, 1990) described adaptive aging strategies by focusing on key goals and compensating for losses. During the same period, the Lifespan Development Theory (Baltes, 1987) presented aging as a dynamic process of gains and losses. These theories paved the way for a new approach that centers on the individual and their active engagement with the aging process.

Rowe's and Kahn theory of *successful aging* is the first influential theory that claims that older adults can influence their own aging trajectories (Caspersen et al., 1985). It posits that successful aging is not just about living longer but about living well—maintaining health, cognitive function, and active involvement in life. It challenges the traditional view that aging is inevitably associated with decline and instead promotes a more positive and proactive approach to aging. It is one of the first theories that effectively tries to give a theoretical rationale as to why some older adults age more successfully. Rowe & Kahn (1997) postulated that in order to age successfully, an individual needs to engage into three different activities: (1) actively avoiding disease (2) maintaining high physical and cognitive functioning, and (3) continuing to engage with the world as far as possible. This definition represents a significant departure from earlier deficit-focused perspectives, promoting a more positive view that aging can be a period of continued vitality, health, and social involvement.

#### 3. Healthy Aging

This preliminary work also funded the adoption of the concept of *healthy aging* which the World Health Organization (WHO) further outlines in the World Report on Ageing and Health (2015). Based on accumulated knowledge, the years between 2021 and 2030 were, therefore, titled "the UN Decade of Healthy aging" by the WHO (World Health Organization, 2024) in order to focus on improving the quality of life for older adults. It focuses on creating age-friendly environments, preventing disease, supporting active participation in society, and enhancing care systems to promote healthy, fulfilling aging.

Healthy aging is defined as a continuous process of optimizing opportunities to maintain and improve physical and mental health, independence, and quality of life throughout the life course (*Healthy Aging - PAHO/WHO* | *Pan American Health Organization*, n.d.)

According to the WHO, healthy aging is thus based on three concepts: firstly, the intrinsic capacity, secondly the environment, and thirdly the functional ability. The intrinsic capacity is the summary of all physical and mental capacities, like genetic inheritance, personal characteristics, and the health characteristics an individual has. The environment is described as the environment in which one lives, encompassing physical, social, and policy environments. Functional ability on the other hand, is composed of both factors and their interactions with each other.

According to the WHO, numerous entry points can be identified for actions to promote healthy aging, but all will have one goal: to foster functional ability. One entry point is by encouraging older adults to engage in healthy behaviors, which have been defined by Kasl & Cobb (1966) as activities undertaken by a person believing themselves to be healthy for preventing disease or detecting it at an asymptomatic stage. Therefore, one can partake in many health relevant behaviors in order to achieve healthy aging. Examples of healthy behaviors include: healthy eating, abstaining from smoking, and physical activity.

#### 4. Significance of Physical Activity for Older Adults

Physical activity has been shown to be an important health behavior providing significant benefits in mental and physical health and healthy aging. It is defined as "any bodily movement produced by skeletal muscles that results in energy expenditure" (Caspersen et al. 1985). Whereas exercise is a physical activity that is planned, structured, repetitive, and purposive, in the sense that the improvement or maintenance of one or more components of physical fitness (NHIS - Adult Physical Activity - Glossary, 2019), physical activity can entail

occupational sports, household activity, or other activities (Dasso, 2019). Thus, even activities not directly associated with structured exercise (e.g. household chores and gardening) can be regarded as physical activities (Murphy et al., 2013).

According to the WHO (2020), physical activity contributes to the prevention and management of non-communicable diseases such as cardiovascular diseases, cancer, and diabetes and reduces symptoms of depression and anxiety, thus improving overall well-being (Warburton & Bredin, 2017). Furthermore, it enhances cognitive function and brain health and can help increase overall quality of life and longevity. By promoting various processes in the human body like enhanced mitochondrial function, reducing inflammation, enhancing insulin sensitivity, and supporting neurogenesis, regular exercise is essential for maintaining both physical and mental well-being throughout life (Eckstrom et al., 2020).

One validated way of measuring such activity is by using the Metabolic Equivalent and accelerometry (MET; e.g. Jetté et al., 1990). The MET is defined as the ratio of the work metabolic rate to the resting metabolic rate. One MET is defined as 1 kcal/kg/hour and is roughly equivalent to the energy cost of sitting quietly (Compendium of Physical Activities, n.d.). Moderate-intensity activities, such as brisk walking, are those that noticeably increase the heart rate and are classified within a range of 3 to 5.99 METs. Vigorous activities, like jogging, are defined as activities with a MET level of 6 or higher, causing rapid breathing and a significant rise in heart rate (Haskell et al., 2007). However, physical activity can also be measured by self-report, providing information about physical activity through questionnaires, surveys or interviews based in their experience (e.g. the International Physical Activity Questionnaire, IPAQ; Craig et al., 2003).

According to physical activity guidelines (Bull et al., 2020), adults should engage in at least 150 minutes of moderate-intensity aerobic activity or 75 minutes of vigorous-intensity activity per week, or a combination of both. For additional health benefits, this can be increased to 300 minutes of moderate-intensity activity weekly (Bull et al., 2020). Moreover, individuals with poor mobility are advised to focus on balance and fall prevention exercises at least three times per week(Bull et al., 2020; Sadaqa et al., 2023). Additionally, musclestrengthening activities targeting major muscle groups should be performed on two or more days each week. Newer studies show that even short periods of activity can have beneficial effects. For example, even 45 minutes of moderate to vigorous activity per week can improve function for adults with low joint pain (Hunter et al., 2004). Furthermore, light physical activity (i.e. activities with a MET of under 3, like easy walking) is also positively related to physical health and well-being. Replacing 30 minutes a day of sedentary time with equal amounts of light physical activity is associated with improved overall physical health (Buman et al., 2010). However, after 60 years of age, physical activity levels decrease in both men and women (Strain et al., 2024).

#### 5. Inside the Black Box: Determinants of Physical Activity in Older Age

As individuals age, several factors can contribute to a decline in physical activity. Research indicates that this is mostly due to barriers like physical limitations, fear of injury, health conditions, lack of social support, psychological barriers, and environmental barriers. These barriers raise the question of what determinants of physical activity influence older adults' physical activity. In order to understand what drives someone's behavior, it is crucial to understand why older adults are active and how older adults are active. Research on older adults shows that these determinants are manifold in older adults but can be best categorized into physical and health-related determinants. Psychological determinants encompass attitudes and motivation, and situational or environmental determinants.

#### 5.1. Psychological determinants: attitudes and motivation

Psychological determinants of physical activity, on the other hand are closely tied to how older adults perceive the behavior, including their beliefs and attitudes, motivation, and confidence in their ability to stay active. As beliefs, opinions, and attitudes are critical determinants of physical activity behavior in older adults, influencing both their intentions and actions (Harrison et al., 2020; Hurley et al., 2014). Negative attitudes towards exercise or a lack of confidence, can reduce intentions to engage in physical activity and influence older adults' motivation to be active (Schutzer & Graves, 2004).

Attitudes and motivation are both critical components in driving behavior but serve different functions. Attitudes are assessments that reflect an individual's positive or negative beliefs about a themselves, others, ideas, and lastly also their behaviors, such as physical activity (Petty et al., 1997). They provide a cognitive foundation that can make an individual more open or resistant to engaging in a behavior (Petty et al., 2014). Motivation, however, is

the actual driving force that propels someone to act (Deci & Ryan, 2013). While positive attitudes toward exercise, for instance, create a favorable mindset, they do not guarantee action unless they activate motivation, which supplies the energy and commitment needed for behavioral engagement (Ajzen, 1991). On the other hand, more recently, there is evidence to suggest that motivation precedes attitudes toward physical activity in particular (Hagger & Chatzisarantis, 2014) showing how tightly interconnected these psychological determinants are.

#### 5.2. Situational determinants

Furthermore, situational factors can influence physical activity. As our environment influences our behavior, change is not solely determined by individual willpower but is influenced by a combination of personal, social, and environmental factors. Situational factors are external, temporary conditions that influence a person's behavior or decisions in specific contexts. In light of health and physical activity, situational factors, including the physical and social environment, have a significant impact. These external influences interact with psychological factors, shaping older adults' behaviors and even altering their beliefs and motivation (Prestwich et al., 2017). They can, for example, dampen motivation to undertake physical activity and can impact attitudes and alter the link between intention and behavior.

External conditions such as safety concerns, limited access to exercise facilities, and environmental barriers can discourage exercise (Yen & Anderson, 2002). The absence of social support—whether companionship or encouragement—further reduces motivation to participate in physical activity (Hughes et al., 2009). Additionally, societal norms, and immediate stressors, such as the COVID-19 pandemic, can trigger changes in behavior and influence activity levels. For example, during the COVID-19 pandemic, situational factors like fear of exposure might weaken motivation (Wilczyńska et al., 2021), while increased social support (e.g. online workout groups) might strengthen it (Schwartz et al., 2021). Thus, unlike stable determinants like health status or personality traits, situational factors fluctuate and can either encourage or discourage physical activity on all stages of the potential pathway from psychological determinants to physical activity behavior (see Figure 1).

#### Figure 1

Schematic Representation of Potential Interactions Among Determinants of Physical

Activity.



Note. This diagram illustrates potential pathways from psychological and situational determinants to physical activity behavior. The determinants include attitudes toward exercise, and motivation to act, as psychological determinants which shape the intention to exercise regularly. While situational determinants, such as the fear of exposure during the COVID-19 pandemic, can influence all determinants.

#### 5.3. Understanding the determinants improves intervention development

In health behavior, research identifying determinants of a behavior is also significant, not only in understanding why people show certain health behaviors or neglect their health, but also in intervention development. In order to change a behavior, one has to understand how a behavior is predicted by its determinants. Whereas there are several different frameworks for intervention development, all have in common that they demand the meticulous analysis of the root causes of a behavior.

A first example is mentioned in the intervention mapping process (Bartholomew et al., 1998), where as one of the first steps after defining the goal of the intervention, the researcher specifies important, changeable determinants. The goal of specifying these determinants is to identify both personal (cognitive) and external (social and structural) determinants that influence behavior. Key questions guide the refinement of these determinants, assessing their relevance, empirical support, and potential for change. The goal of this step in the intervention mapping process is to narrow down to the most important and modifiable factors which can then can be targeted in interventions (Bartholomew et al., 1998).

Secondly, in the Behavior Change Wheel (BCW), a framework for designing behavior change interventions was developed by Susan Michie and her colleagues (Michie et al., 2014). The first step in developing an intervention is to understand the behavior by using the COM-B model. This is a framework for understanding behavior by focusing on three core determinants of behavior: capability, opportunity, and motivation. Thus, for any behavior to occur, individuals must have the capability (both physical and psychological skills or knowledge), the opportunity (physical and social factors in their environment that enable or prompt the behavior), and the motivation (both conscious and unconscious drives that influence behavior). These components interact to either facilitate or hinder behavior. To be effective, interventions aimed at behavior change should target one or more of these elements.

Thirdly, attempts to ascertain the determinants of a specific behavior help to understand processes within participants that influences a behavior. For example, in more recent years researchers have tried to enhance the prediction of intervention outcomes and have tried to link behavior change techniques with Mechanisms of Action (MoAs). MoAs have consequentially been defined as "the type(s) of process by which interventions influence the target behaviour" (Michie et al., 2017). They help to identify the specific processes (e.g., motivation, self-efficacy, intention formation) that drive behavior change. By understanding these mechanisms, researchers can design interventions that effectively target the key drivers of behavior. These can be characteristics of the individual (i.e. intrapersonal psychological processes) and characteristics of the social and physical environment (e.g. social support), and therefore starkly resemble the determinants of a behavior discussed before (Carey et al., 2019).

#### 5. Conceptualization of Determinants: Behavior Change Theories

The identification of the determinants that underlie health behavior is not only important for intervention but is also the basis of behavior change theories, as they conceptualize and combine these determinants in order to predict a behavior. A theory is therefore an abstract, systematic set of interrelated concepts, definitions, and propositions that explains and predicts phenomena by identifying the relationships between variables (Glanz et al., 2008). Thus in health psychology, the primary goal of these theories is to understand the psychological, social, situational, and environmental determinants that influence behavior, to develop interventions that effectively promote positive change, and to maintain that change over time (Glanz et al., 2008). This active participation and choice of action of an individual is also a requirement for all theories of behavior change (Schwarzer, 2008), recognizing that individuals of all ages can contribute to their own health by either adopting health-enhancing behaviors and/or avoiding health-compromising behaviors (Conner & Norman, 2015).

Two different types of theories are distinguishable. Firstly, the stage theories (e.g. the Transtheoretical Model, TTM; Prochaska & DiClemente, 1983) and secondly, the continuum models (e.g. the theory of planned behavior, TPB; Ajzen, 1991). Stage models of behavior change propose that altering behavior involves a series of distinct and qualitatively different shifts in psychological factors and practices, as individuals progressively adopt new behaviors. These shifts can be understood as specific stages that an individual navigates on their path to behavior change. Unlike stage models, continuum models propose that behavior change occurs along a continuous spectrum rather than through distinct stages. These models assume that individuals can vary in their readiness to change and that the movement towards behavior change is a gradual process influenced by various psychological, social, and environmental factors.

Each theory cannot be described as correct or incorrect, but they do vary in their relevance to inquiries. Every theory can provide a distinct way of observing a problem, allowing its investigation from different perspectives and a more complete understanding of its facets (Glanz et al., 2008). The selection of a theory that best fits a particular study is about justifying that the chosen theory meets the research questions, the structure of the research, and the research design (Grant & Osanloo, 2014). 6/4/25 3:15:00 PMTheoretical triangulation (combining two or more theories in a given research project), too, has been seen to provide the opportunity to address the issue being studied comprehensively and to increase the validity of the explanations generated (Ngulube et al., 2015; Rimer & Viswanath, 2024). Theories and

models significantly influence the manner in which evidence is gathered, analyzed, interpreted, and used (Alderson, 1998).

#### 6. Health Action Process Approach

One theory that combines the advantages of both stage and continuum is the Health Action Process Approach (HAPA; Schwarzer, 2008). In the first stage of this two-stage model, forming a behavioral intention involves three key psychological components. Individuals must first assess their expected outcomes, which means considering the potential positive or negative consequences of their behavior. They also need to evaluate their risk perception, or their awareness of specific health risks associated with the behavior. Lastly, they must have sufficient self-efficacy—a sense of personal confidence in their ability to successfully perform the behavior. These three elements combine to shape an individual's motivation and readiness to act (Conner & Norman, 2015).

As opposed to other behavior change theories, the HAPA also emphasizes that forming an intention (motivational phase) is not sufficient to ensure health-promoting behavior. It is also important to create detailed plans and develop self-regulation strategies (volitional phase) to successfully implement and maintain the behavior in a second stage. This model helps in developing interventions that not only motivate people but also support them in achieving their health goals by adding planning as a determinant. It suggests that planning is needed to bridge the intention-behavior gap. The intention-behavior gap refers to the discrepancy between a person's intentions to engage in a certain behavior and their actual performance of that behavior. The HAPA postulates that this gap can be closed by action and coping planning. Schwarzer (2014) describes it thus:

"When a preference for a particular health behavior has been shaped, the intention has to be transformed into detailed instructions of how to perform the desired action. If, for example, someone intends to lose weight, it has to be planned how to do it, i.e., what foods to buy, when and how often to eat which amounts, when and where to exercise, and maybe even whether to give up smoking as well. Thus, a global intention can be specified by a set of subordinate intentions and action plans that contain proximal goals and algorithms of action sequences."

#### 6.1. Planning

Planning is therefore regarded as being an important determinant in the HAPA. Planning entails two strategies: firstly, coping planning, and secondly, action planning. Coping planning, as the name suggests, entails anticipating possible barriers to behavior and then planning how to overcome them (e.g. Schwarzer, 2016). For example, an individual trying to adopt a regular exercise routine might plan to go for a walk indoors if the weather is bad or schedule shorter workouts on busy days. Action planning, on the other hand, is characterized by asking oneself how, when, and where a certain behavior can be implemented (Brandstätter et al., 2001). For instance, an individual might decide to exercise every Monday, Wednesday, and Friday at 7 a.m. in the local park.

Implementation intentions are also seen as an effective strategy within action planning. According to Sheeran et al. (2005), implementation intentions are "if-then" plans that connect opportunities to act with specific cognitive or behavioral activities that will help accomplish one's goal. For example, someone planning to be more active might say, "If I have eaten breakfast, then I will go for a 20-minute walk." These plans are designed to link specific situational cues with automatic behavioral responses, increasing the likelihood that the desired action will occur when the cue arises (Gollwitzer, 1999). While action planning involves broader considerations, including the time, place, and manner of enacting the behavior (Hagger & Luszczynska, 2014). Together, these strategies help bridge the gap between intention and action, increasing the likelihood of sustained behavior change. According to a first meta-analysis conducted by Gollwitzer & Sheeran (2006), the use of implementation intentions to promote physical activity in particular, even though the effects reported are only small to medium (Bélanger-Gravel et al., 2013).

#### 6.2. Health action process approach and evidence on physical activity and older adults

The HAPA has garnered substantial empirical support as an effective framework for understanding physical activity behavior among older adults (Caudroit et al. 2011). Studies have confirmed that action self-efficacy and risk perception are significant predictors of PA intentions while coping self-efficacy drives long-term behavior in retired older adults. Gellert et al. (2012) found that affective outcome expectancy (anticipated affective responses to physical activity) predicted exercise after six months in older adults and that self-efficacy

influenced exercise through affective outcome expectancy and intention. Reuter et al. (2010) further emphasized the importance of action planning in translating intentions into PA, particularly in older populations. Wolff et al., (2016) highlighted action planning and coping planning as critical factors in maintaining regular exercise among older adults. Ziegelmann et al., (2006), meanwhile, found that planning was an effective tool for physical activity adoption and maintenance irrespective of chronological age. A finding supported by (Maher & Conroy (2015) those who demonstrated that daily physical activity intentions are influenced by selfregulatory processes. Additionally, Renner et al., (2007) found that physical activity in older adults could be predicted by planning, coping self-efficacy, and intention, which were, in turn, predicted by action self-efficacy, outcome expectancies, and risk perceptions. In the study, Bierbauer et al. (2017) tested the applicability of the HAPA at both interindividual and intraindividual levels among older adults. While the HAPA model was largely supported at the inter-individual level, at this level, only action control consistently predicted behavior, highlighting the need to evaluate health behavior theories at both levels. This growing body of evidence underscores the robust applicability of HAPA in explaining the social cognitive processes underlying physical activity behavior in older adults, making it a valuable tool for researching cognitive determinants of behaviors in older adults (Renner et al., 2007).

#### 7. Self-Determination Theory

Thus, while planning and self-regulation can be important, it may not always be sufficient on its own, especially for older adults. The self-determination theory (SDT; Ryan & Deci, 1985), on the other hand, focuses on fundamental needs and the types of motivation, providing a comprehensive framework for understanding what drives human behavior and how to create environments that enhance motivation and personal growth.

#### 7.1. Types of motivation

Unlike other behavior change theories, the SDT distinguishes between different types of motivation, particularly intrinsic motivation (driven by personal interest and enjoyment) and extrinsic motivation (driven by external rewards or pressures). The theory posits that behaviors are more likely to be sustained when they are intrinsically motivated or when extrinsic motivation is aligned with personal values and needs. Therefore, it complements other

behavior change theories by clearly defining the quality of an individual's motivation. According to the SDT, motivation ranges from autonomous to controlled (Deci & Ryan, 2013). Intrinsic motivation is the most autonomous, where individuals engage in activities for the inherent satisfaction and enjoyment they provide. Extrinsic motivation varies in autonomy and includes different forms: integrated regulation, where behaviors align with personal values and identity; identified regulation, where behaviors are valued and considered important; introjected regulation, where behaviors are driven by internal pressures or guilt; and external regulation, the least autonomous form, where behaviors are performed to receive external rewards or avoid punishments. Amotivation represents a lack of motivation or intention to engage in a behavior, often due to perceived incompetence or lack of value. SDT suggests that higher levels of intrinsic and integrated regulation are linked to greater psychological wellbeing and sustained engagement.

#### 7.2. Basic psychological needs

SDT also emphasizes the importance of three basic psychological needs: autonomy (feeling in control of one's actions), competence (feeling capable and effective), and relatedness (feeling connected to others). When these needs are satisfied, individuals are more likely to engage in, and maintain, health behaviors. Conversely, when these needs are thwarted, motivation may diminish, leading to less consistent or effective health behavior practices. In health contexts, SDT suggests that interventions should focus on fostering autonomy, supporting competence, and building relatedness to enhance motivation and lead to more enduring health behavior changes (see Self-Determination Theory Model of Health Behaviour Change; Ryan et al., 2008).

#### Figure 2

Pathway from the Satisfaction of Basic Psychological Needs to Behavioral Outcome Based on Self-Determination Theory



Note: The diagram illustrates the sequence of steps from intervention climate to physical activity based on self-determination theory (Deci & Ryan, 1985). This pathway is inspired by the review from Ryan et al. (2008) depicting the Self-Determination Theory Model of Health Behavior Change.

#### 7.3. Self-determination theory and evidence on physical activity and older adults

The SDT has also been applied to understand and promote physical activity in older adults, with various studies highlighting the importance of fulfilling psychological needs autonomy, competence, and relatedness—to sustain motivation. Studies like those by Edmunds et al. (2008) and Fortier et al. (2012) supported the effectiveness of SDT-based interventions in increasing physical activity adherence, particularly by enhancing autonomous motivation.

In light of older adults and their physical activity, Franco et al., (2015) systematically reviewed the application of SDTs across various populations, including older adults. They emphasized the importance of autonomous motivation in sustaining physical activity and demonstrated that that interventions grounded in SDT improved motivation and physical activity in older adults by fostering a supportive motivational climate.

Similarly, Kirkland et al., (2011) found that SDT-based motivational processes mediated the relationship between psychological need satisfaction and physical activity, confirming the theory's relevance in older populations. Furthermore, Solberg et al. (2012) found that perceived autonomy support moderated the effects of different trainings highlighting the importance of autonomy support and need satisfaction in exercise outcomes in older adults. While Jones et al. (2020) examined exercise motivations among older adults, revealing those who engaged in exercise generally had higher autonomous motivations compared to those

who did not exercise. Additionally, Ferrand et al. (2008) explored motivational determinants of PA in retired adults, identifying factors that support or undermine autonomous motivation. Wilson et al. (2008) and Vallerand & O'Connor (1989) provided theoretical insights into how SDT can be applied to older populations, confirming the theory's broad applicability in promoting active aging. Collectively, this body of research demonstrates that SDT offers a robust framework for understanding the psychological factors that drive and maintain physical activity in older adults. However, more work is needed to understand how the SDT translates into aging populations as despite several empirical studies having applied SDT in the context of health and well-being, they primarily focused on general populations rather than specifically on older adults (e.g. Gillison et al., 2019; Ng & Ho, 2020).

#### 8. Aims and Research Questions

Given the complexity of understanding older adults as a heterogeneous demographic, shaped by accumulated life events, medical history, and diverse life experiences, it becomes essential to explore the unique determinants of health behavior change in later life. As factors such as physiological changes, cognitive limitations, and evolving mental processes, as well as increasing variability in plasticity, must be carefully considered when examining how health behaviors shift in older age (Lippke & Kuhlmann, 2013). It is crucial not to limit ourselves to the theory of behavior change. To achieve lasting results, we must involve the people concerned, especially in older adults. Thus qualitative and participatory research becomes increasingly more important (Blair & Minkler, 2009).

These factors can also affect their health behavior, and particularly their physical activity. Therefore, the goal of this thesis is to understand which behavioral determinants influence older adults' physical activity and to use this knowledge to inform future research and interventions. It explores different aspects of how older adults engage with, or think, about physical activity. This includes changes in behavior due to situational changes (first question), the psychological processes behind using behavior change techniques (second question), and the role of motivational factors (third question).

The first example is the impact of the COVID-19 pandemic as a situational determinant or stressor on physical activity levels, especially among older adults, which remains a critical area of investigation. While a great deal of research has explored the immediate effects of lockdowns on physical activity, the long-term influence of situational stressors like the covid pandemic on older adults' physical activity, and especially its determinants postlockdown in older adults, has not yet been explored. Given the unique challenges faced by this population—such as prolonged isolation, increased vulnerability to illness, and disrupted routines—understanding how these factors have affected physical activity behaviors postlockdown is crucial. The knowledge gained may also be applicable to other stressors or pandemics.

Furthermore, in light of planning one's physical activity in older age, despite implementation intentions being a well-established planning tool to support behavior change, there is a notable gap in understanding how older adults perceive this strategy specifically for the promotion of their physical activity. Additionally, little is known about how older adults tailor these strategies to fit their circumstances, which may affect the practical application of this intervention tool.

Lastly, the role of self-determination in for older adults' physical activity behavior, in particular, is also underexplored. While self-determination theory is widely applied in health promotion, there is limited research on the key motivations older adults express, particularly regarding their intrinsic and extrinsic drivers for engaging in physical activity (see Gillison et al., 2019; Ng & Ho, 2020). Understanding how older adults express their needs for autonomy, competence, and relevance, particularly throughout their life course, is vital to designing interventions that foster sustainable, intrinsic motivation.

Together, these gaps highlight the need for more nuanced research into the motivational, psychological, and situational determinants of physical activity in older adults. This is especially relevant in the context of the COVID-19 pandemic and when examined through the lens of established frameworks like the Health Action Process Approach (HAPA) and Self-Determination Theory (SDT). Building on this existing knowledge, the goal of this dissertation is to expand the understanding of key determinants in this demographic. Thus, several research questions can be formulated:

1. How did older adults' physical activity change after lockdown? What motivational and volitional factors predict intention and behavior, and did the fear of COVID-19 effect the intention-behavior relationship?

2. What are older adults' perceptions of implementation intentions as a planning tool for physical activity?

3. What is the role of self-determination when older adults talk about their physical activity and their need to be more active?

# **Chapter II Overview of Empirical Studies**

#### Study 1 – SERENA: Physical Activity Among Older Adults Post-Lockdown

This study investigated the changes in physical activity levels among older adults following the COVID-19 lockdown, using the Health Action Process Approach (HAPA) to examine the motivational and volitional factors that predicted intentions and behavior. The study also explored whether fear of COVID-19 moderated the relationship between intention and actual behavior. The study employed a longitudinal 3-wave panel design to investigate changes in physical activity among older adults after the COVID-19 lockdown. Conducted with participants aged 65 and above, data was collected in two waves: shortly after lockdown (T1) and one month later (T2). Participants completed questionnaires assessing physical activity levels, motivational factors (such as self-efficacy, risk perception, and outcome expectancies), volitional factors (such as action and coping planning and action control, the intention to be active, and fear of COVID-19. In the main analyses, a repeated-measures analysis of variance (ANOVA) was conducted first to investigate the development of physical activity after the first lockdown. Then, two linear regression analyses were performed to investigate intention and physical activity after lockdown. Firstly, we hypothesized that motivational factors predict the intention to be active at T1. Secondly in the action model, it was hypothesized that volitional factors predict physical activity to T2. To test the influence of fear of COVID-19 on the relationship between intention at T1 and behavior at T2, a moderator analysis was conducted with fear of COVID-19 at T1 as a continuous moderator.

## Study 2 – Think Aloud: Thoughts on Implementation Intentions for Physical Activity Among Older Adults

This study explored the thought processes of older adults when creating implementation intentions for physical activity across three countries (United Kingdom, Germany, and Switzerland). The aim was to identify potential barriers and facilitators while forming implementation intentions. Using a qualitative research design, the study involved in-depth interviews using a think-aloud paradigm with older adults aged 65 and above to gain insights into their ongoing thought processes while formulating implementation intentions. Participants were provided with information about physical activity recommendations from the World Health Organization. They were then guided to create up to three (United Kingdom /Germany/Switzerland) implementation intentions for daily physical activities. British participants completed in-person sessions, German participants followed similar procedures but online

#### Chapter II – Overview of Empirical Studies

due to Covid-19 restrictions, while Swiss participants were part of a broader intervention study. Participants were asked to discuss their experiences and strategies for planning physical activity using implementation intentions, as well as any challenges they faced or factors that helped them in the formulation of them. The data was analyzed inductively using thematic analysis following Braun and Clarke's six-step approach to identify key themes. Emerging themes were then grouped following the process of formulating implementation intentions, namely before formulation, during formulation, and after formulation as it best categorized the findings.

# Study 3 – SelfACT: The Role of Self-Determination for Physical Activity Among Older Adults

The study aimed to explore the role of self-determination in older adults' physical activity and how concepts of Self-Determination Theory (SDT) relate to their needs for improving their physical activity. The study used a two-wave qualitative approach embedded in an intervention aimed at promoting physical activity in older adults through implementation intentions and autonomy-supportive goal reviews. Two semi-structured interviews, conducted pre- and post-intervention, were analyzed. Participants were 14 older adults aged 65 and over, recruited due to their motivation to increase physical activity. Interviews explored participants' narratives, using a narrative approach at the beginning of each interview, to let participants describe their physical activity experiences unprompted, thus capturing changes over time. The data was analyzed using interpretative phenomenological analysis (IPA; Osborne & Smith, 2008) (Van Roie et al., 2010) to explore individual experiences, following the recommended steps by Smith and Osbourne. Initially, thematic analysis was planned, but IPA was chosen due to its focus on personal experiences. Transcripts were analyzed in stages, involving multiple readings, coding, and thematic refinement in collaboration with the researchers. Themes were aligned with self-determination theory, with care taken to avoid bias. Findings were organized into a final table of themes, highlighting key psychological factors driving older adults' physical activity behaviors.

Chapter III – Results

# Chapter III Results

## Article 1: Older adults' physical activity after lockdown: Testing the health action process approach and the moderating role of fear of Covid-19

This published article:

Bösch, V. D., & Inauen, J. (2022). Older adults' physical activity after lockdown: Testing the health action process approach and the moderating role of fear of Covid-19. *Applied Psychology: Health and Well-Being*, 1–21. https://doi.org/ 10.1111/aphw.12384



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# Older Adults' Physical Activity after Lockdown: Testing the Health Action Process Approach and the Moderating Role of Fear of Covid-19

#### Abstract

The coronavirus pandemic has influenced many lives, particularly older adults'. Although isolation protects from infection, health behaviors like physical activity (PA) are important to reinstate after lockdown. However, fear of Covid-19 may act as a barrier, e.g. by preventing people from going outside. Based on the health action process approach (HAPA), we investigated whether and why older adults' PA changed after lockdown, and whether fear of Covid-19 moderates the intention-behavior relationship. Participants of this longitudinal study aged 65+ from German-speaking Europe completed an online questionnaire about their PA, fear of Covid-19, and HAPA factors in April and May 2020. Data were analyzed using multiple linear regressions. Results showed that moderate to vigorous activity (MVPA) remained stable after lockdown and that self-efficacy most robustly influenced the intention to be active.PA was not explained by any volitional factor, but was strongly related to past PA. Interestingly, the relationship of past and future MVPA was attenuated by fear of Covid-19, but this finding was not robust when outliers were removed. In conclusion, self-efficacy is the most important motivator for PA in older adults after an interruption like a lockdown. Strong physical activity habits may facilitate PA after a period of isolation.

**Key words:** Covid-19, Health Action Process Approach, physical activity, older adults, fear of Covid-19

#### Background

Coronavirus Disease 2019 (Covid-19) is a viral respiratory disease that has affected and will continue to affect millions of people worldwide (Moro & Paoli, 2020). Due to the rising numbers of infections, many countries implemented restrictions early in 2020 to slow the spread of the virus and thus to prevent health systems from collapse. Restrictions included lockdowns in many countries, in which a range of social interactions were prohibited, shops were shut, and stay-at-home policies were instated (Han et al., 2020). One group that was substantially affected by these governmental measures were older adults.

#### Older adults during the Covid-19 pandemic

Due to risks of complications and mortality that was potentially higher than for those to the general population, adults older than 65 years were declared a risk group (Public Health Emergency, 2015) and advised to stay at home (Shahid et al., 2020). Older adults' vulnerability to contracting Covid-19 was extensively discussed in the media, leading to high avoidance and fear among this age group (Rahman & Bahar, 2020). However, even during such a time, maintaining health behaviors, such as regular physical activity, is important for physical and mental health (Inauen & Zhou, 2020).

Regardless of their health status, older adults can benefit from physical activity (Hupin et al., 2015). Physical activity has conferred multiple benefits particularly during the pandemic. First, physically active individuals have better control over high-risk comorbidities, such as cardiovascular diseases and diabetes, which can increase susceptibility to severe complications from Covid-19 (Moro & Paoli, 2020), engaging in moderate-to-vigorous physical activity is recommended (World Health Organization, 2020; Bull et al., 2020). However, even light physical activity during the Covid-19 pandemic can help alleviate some of the negative mental health impacts that older adults may experience while isolated (Callow et al., 2020). Notably, maintaining a healthy life style can influence the perceived quality of life during the pandemic in older adults (Duan et al., 2021).

In spite of these benefits, activity tracker data suggest that step counts decreased worldwide after Covid-19 was declared a global pandemic (Tison et al., 2020; Warren & Skillman, 2020). Moreover, there is evidence that older adults in particular engaged in less physical activity during the first wave of the pandemic (Rhodes et al., 2020). This is further substantiated by older adults' self-reports of decreased physical activity (Visser et al., 2020). Liang et al. (2021) for example found that 35% of older adults reported a decrease in physical activity in the first wave of the pandemics. Also, the odds of decreased vigorous activity after

#### Chapter III - Results

lockdown is bigger in older adults than in other populations (Bu et al., 2021). This suggests that the Covid-19 pandemic can negatively affect older adults' physical activity in the long term (Hall et al., 2021). To avoid such prolonged effects, recovering physical activity is important. However, it is unknown whether and which older adults recover their physical activity is as Covid-19 related public health restrictions are lifted.

#### The Health Action Process Approach—an explanatory model of physical activity

A model that can provide insight into the recovery of physical activity is the health action process approach (HAPA; Schwarzer, 2008). The HAPA model describes how motivational and volitional factors influence health behavior intentions and actions. It suggests a distinction between preintentional motivation processes, collectively termed the "motivational phase," that lead to a behavioral intention, and postintentional volition processes, also termed the "volitional phase", that lead to the actual health behavior. In the motivational phase, risk perception, outcome expectancies, and self-efficacy predict the intention. Risk perception may involve, for instance, people perceiving the risk that lack of physical activity may lead to cardiovascular diseases (Dubbert et al., 2002; Schwarzer, 2008). In contrast, outcome expectancies are formed when people balance the consequences of certain behavioral outcomes. Thus, people may decide to go for a walk because they are sure that it boosts their wellbeing while in isolation. Lastly, self-efficacy means that an individual believes in their own capability to perform a desired action. For example, when leaving the house is not advised, an individual must be sure of their capabilities of remaining physically active at home, even if they do not have the same equipment as a gym. All three factors then predict the intention to perform a certain target behavior.

In the volitional phase, coping plans, action plans, and action control are crucial for the adoption, maintenance, and recovery of a behavior (Schwarzer, 2008). Coping and action plans mediate the effect of the intention on behavior. Coping plans are formed in the anticipation of barriers by generating alternative behaviors to overcome them (Schwarzer, 2008). For example, if someone cannot go to their fitness class due to Covid-19 restrictions, they can instead identify activities that they can perform from home. Action plans, in turn, include specific situational cues (when and where to be active) that are linked to the desired action (Schwarzer 2008; Hagger & Luszczynska, 2014). Adapting to the current pandemic, individuals may plan to go for a walk in the park in the evening, since such choices minimize the number of other people in their vicinity. Lastly, action control involves self-regulatory processes that enable the maintenance of a behavior (Sniehotta et al., 2005). It describes the
degree of control someone can exert despite internal or external factors that interfere with the execution of a behavior (Kuhl & Beckmann, 2012).

Empirical evidence overall strongly supports the assumptions of the HAPA model (Zhang et al., 2019), including for physical activity for various groups (Barg et al., 2012; Caudroit et al., 2011; Parschau et al., 2014). Therefore, the HAPA model can be considered a suitable theoretical framework for this study. However, previous studies that used the HAPA model have predominantly focused on the adoption and sometimes maintenance of physical activity. Less attention has been paid to the recovery of physical activity after an interruption, such as the first Covid-19 lockdown.

## Recovering physical activity after an interruption: The role of fear of Covid-19

Although evidence shows that many people reduced (and others increased) their physical activity during the first Covid-19-related lockdown (Naughton et al., 2020), little is known about whether physical activity recovered when lockdown restrictions were lifted, and if so whose. Besides the predictors of health behavior change such as those specified by the HAPA model, there is evidence that the fear of Covid-19 could be an important explanatory factor. Presti et al. (2020) define fear as an emotional reaction that occurs in the presence of a danger and is often accompanied by emotional distress and behavioral avoidance. The role of fear of Covid has been extensively examined with respect to preventive behaviors (e.g. Pakpour & Griffiths, 2020; Stolow et al., 2020). Fear of Covid-19 was found to correlate significantly with such avoidant behaviors as staying at home (Jørgensen et al., 2020), which could disrupt regular physical activity. Moreover, the fear of Covid-19 positively predicted public health compliance in the Covid-19 pandemic (Harper et al., 2020). However, little to nothing is known about whether and how fear of Covid-19 influences health behaviors. Previous research on positive emotions and health behavior has shown that emotions relate to health behavior by moderating the intention-behavior relationship. For example, positive affective responses like expected pleasure, enjoyment and exercise affect can have an effect on the translation of intentions into physical activity (Kwan & Bryan, 2010; Rhodes & Dickau, 2013). Negative emotions may similarly moderate the intention-behavior relationship, although likely in the opposite direction. Based on the concept of behavioral avoidance, fear of Covid-19 may act as a behavioral barrier. Persons with greater fear of Covid-19 may feel a stronger need to stay indoors to protect themselves from infection, which thus may inhibit the enactment of physical activity intentions.

# Purpose of the present study

The aims of the present study are firstly to investigate the change in older adults' physical activity after the first Covid-19 lockdown. Second, we investigate whether the HAPA model can explain the intention to be active and physical activity after the restrictions were lifted. Third, we investigate whether fear of Covid-19 acts as a barrier to physical activity after lockdown. We hypothesized that the higher risk perception, positive outcome expectancies, and self-efficacy are, the higher is the intention to be physically active after lockdown. For the action model, we also hypothesized that the higher the intention and action control and the more detailed an older adult's action and coping plans are, the more physically active they will be after lockdown. Lastly, we hypothesized that fear of Covid-19 moderates the relationship between intention and physical activity after lockdown by inhibiting the translation of intentions into action in fearful individuals.

#### Methods

This study was part of a larger 3-wave panel study that took place between April and August 2020. The present study analyzed the first two time points (T1 and T2). These time points were the closest to the lockdown, making this a suitable time window for investigating the recovery of the intention to be active and physical activity after lockdown. Additionally, high attrition at T3 impeded conducting a multi-wave analysis.

T1 data collection started on 21 April 2020, approximately one month after the initiation of the lockdown, which started in Austria on 18 March, Switzerland on 19 March, and Germany on 23 March 2020 (see Plümper & Neumayer, 2020). T2 started on 21 May. See Figure 1 for an overview of the data collection contrasted on the course of the first pandemic wave. The Ethics Committee of the University Bern (Nr. 2020-04-00012) approved this study.

## Chapter III - Results

#### Figure 1

Survey Waves Plotted Against the Reported Covid-19 Cases for the First Wave of the Pandemic in Austria, Germany, and Switzerland





# Procedures

The sample size was estimated via a priori power analysis using the software package, GPower (Faul & Erdfelder,1992). The sample size of 395 was estimated for finding a small effect ( $f_2 = .02$ ) for a significance level of  $\alpha$ =0.05 and a power of 0.80.

Participants (N = 263; targeted N = 395) were recruited Germany, Switzerland, and Austria. To take part in the study, participants had to be at least 65 years old, speak German, and be willing to be recontacted for the subsequent panels of the survey.

No explicit exclusion criteria were set. The survey was then administered online with Qualtrics XM software. The link was distributed via Facebook advertisements, flyers, and forum entries. After providing written informed consent to the study, participants completed an online questionnaire (N = 263) where they were asked about their physical activity, questions about the HAPA constructs, and how fearful they were about the pandemic and contracting the virus. One month later, participants (N = 155; dropout rate = 40,8 %) completed the same questionnaire a second time (see Figure 1). Further information about the study process can be retrieved from the flowchart in Figure 2.

# Chapter III - Results

# Figure 2

# Flowchart of study process



Notes. Additionally, the survey was distributed via snowballing (N unknown).

#### Chapter III – Results

#### Measures

## Physical activity

Physical activity was measured with the International Physical Activity Questionnaire (IPAQ). The IPAQ is a validated questionnaire that measures self-reported physical activity (Graig et al., 2003). It measures the amount of light physical activity, moderate to vigorous physical activity, and time spent sitting in hours and minutes per week and in days per week. The minutes of walking per week of each participant was then calculated by transforming the hours of walking into minutes. Moderate to vigorous physical activity (MVPA) was calculated by transforming the hours of vigorous and moderate activity into minutes and then summing both values to arrive at the MVPA score. The total physical activity was calculated by summing the minutes spent walking and the MVPA.

## HAPA Variables

The motivational factors of the HAPA model were measured with three items each. All item answers ranged from 1 (not at all) to 5 (very strong). The complete list of items used can be found in Table S2 at

https://osf.io/j7e4z/?view\_only=aebc66fb117748faa4e6b8a8cfdd4c75.

The items for outcome expectancies ( $\alpha_{T1} = .67$ ;  $\alpha_{T2} = .60$ ) and motivational self-efficacy ( $\alpha_{T1} = .94$ ;  $\alpha_{T2} = 0.86$ ) were adapted from Schwarzer (2008), and the items for risk perception ( $\alpha_{T1} = .83$ ;  $\alpha_{T2} = 0.95$ ) were adapted from Bierbauer et al. (2017). Volitional factors were measured by adapting four items from Schwarzer (2008) for intention ( $\alpha_{T1} = .89$ ;  $\alpha_{T2} =$ .86) and three items for action planning ( $\alpha_{T1} = .93$ ;  $\alpha_{T2} = .94$ ) and coping planning ( $\alpha_{T1} = .89$ ;  $\alpha_{T2} = .90$ ). Action control ( $\alpha_{T1} = .94$ ;  $\alpha_{T2} = .92$ ) was adapted from Sniehotta et al. (2006).

# *Fear of Covid-19*

The fear of Covid-19 was measured with the Swine Flu Inventory (SFI; Wheaton et al., 2012). The SFI was originally used to measure the fear of the H1N1 influenza virus but was modified to fit the current situation by changing its focus to the Covid 19 pandemic. It was then used to measure the fear of Covid-19 by inquiring about concerns about the Covid 19 pandemic, the perceived likelihood of contracting Covid-19, the perceived severity of infection, avoidance of certain places, the use of safety behaviors, and exposure to information about Covid-19 ( $\alpha_{T1} = .68$ ;  $\alpha_{T2} = .71$ ). Because the scale had a low overall Cronbach's alpha, indicating that not all items represented the fear of Covid as an emotional reaction, an

exploratory factor analysis was conducted. Two factors were found: One factor was conceptually closer to the construct of risk perception, which was not in line with the research question, so the second factor better depicted emotional fear and thus was chosen for the analyses (Table S3 containing the factor analysis and Table S4 with the adapted and translated items can be found here:

<u>https://osf.io/j7e4z/?view\_only=aebc66fb117748faa4e6b8a8cfdd4c75</u>). The Cronbach's alpha for this second factor was  $\alpha_{T1} = 0.73$  at T1 and  $\alpha_{T2} = .72$  at T2. Moreover, the item "To what extent do you believe that Covid-19 could become a 'pandemic' in Europe?" was not included in the questionnaire since Covid-19 was already declared a global pandemic on 11 March, before the initial distribution of the survey (WHO, 2020). Responses to all items were gathered on Likert scales with four increments ranging from one "least likely" to five "most likely".

## Sociodemographic Data

Participants were asked about their retirement status (yes; no), age of retirement, and possible employment after retirement (no; yes, and the employment percentage). Information was also gathered about their gender, civil status (single; married; divorced; widowed; in civil union; dissolved union), and highest educational status (primary school; secondary school; apprenticeship; college; technical college; university; other). Other questions concerned their living situation (retirement home; assisted living; alone in an apartment or house; together with a partner in an apartment or house; together with family in an apartment or house), such as where they lived, how many people they lived with, and which people (e.g., spouse) they lived with. Lastly, the survey asked about their socioeconomic status (I do not have enough money to pay my expenses; I have enough money to pay my expenses; I have more than enough money to pay my expenses) and health status (1= poor; 5 = very good).

# **Data and Analysis**

First, a dropout analysis was conducted to compare those who completed both surveys (n = 152) to those who dropped out after T1 (n = 111) with independent *t* tests. In the main analyses, we handled missing data using listwise deletion, because multiple imputation is not recommended when missing data exceeds 40% (Jakobsen et al., 2017). Still, to test the robustness of the results, we conducted sensitivity analyses using data substituted by multiple imputation (Sterne et al., 2009). Because the results did not substantively differ between the two methods, we added these results to the supplementary material (https://osf.io/j7e4z/?view\_only=aebc66fb117748faa4e6b8a8cfdd4c75).

In the main analyses, a repeated-measures ANOVA was conducted first to investigate the development of physical activity after the first lockdown. Then, two linear regression analyses were conducted to investigate correlates of physical activity after lockdown. The first model tested the motivational factors at T1 as predictors of the intention to remain physically active at T2. The second model tested the volitional factors at T1 and previous physical activity as predictors of the amount of physical activity at T2. As a sensitivity analysis, models were computed again, adding age, gender, education, and socioeconomic status and health status as covariates. To improve the interpretation of the findings, all independent variables representing the HAPA factors were grand-mean-centered by subtracting the sample mean value from the individual value of the participants (e.g. Asparouhov & Muthen, 2006). Outliers were approached to the distribution by replacing them with the highest value which was still within two standard deviations (SD) of the mean (e.g., Amidan et al., 2005). For better understanding of the results, the effect sizes (f<sup>2</sup>) for each coefficient were calculated and reported (Selya et al., 2012). For the interpretation of these we reference Cohen (1988), where a f<sup>2</sup> of 0.02 represents a small effect, 0.15 a medium effect, and 0.35 a large effect.

To test the influence of fear of Covid-19 on the relationship between intention at T1 and behavior at T2, a moderator analysis was conducted with fear of Covid-19 at T1 as a continuous moderator. In case of significant moderation, a simple slopes analysis was conducted, testing the intention-behavior relationship at low fear of Covid-19 (= M - 1 SD); average fear, and high fear (= M + 1 SD). All analyses were computed with jamovi version 1.2.27.0 (2020) or SPSS 27 and all supplementary materials are available online (https://osf.io/j7e4z/?view\_only=aebc66fb117748faa4e6b8a8cfdd4c75).

#### Results

# **Participants characteristics**

Participants were on average 69.9 years old (SD = 4.3). Of these, 68.8% (n = 181) were women, 93.2% (n = 187) were retired (mean retirement age 62.8 years; SD = 3.4), and 59.3% (n = 156) married. Most had completed an apprenticeship or higher education, and most were in good or very good health (M = 4.02; SD = 0.9). Some 61.2% (n = 161) lived with their partner (Table S1 with all descriptive statistics of the sociodemographic variables can be found at <u>https://osf.io/j7e4z/?view\_only=aebc66fb117748faa4e6b8a8cfdd4c75</u>).

# **Dropout Analysis**

Dropouts did not significantly differ from completers in socioeconomic status (t(260) = 1.71, p = .574), mean walking time at T1 (t(229) = 0.30, p = .762), mean MVPA at T1 (t(161) = 0.35, p = .725) and total PA T1 (t(159) = 0.44, p = .659). However, health status (t(259) = -2.44, p = .016) and education (t(207) = -2.40, p = .014) were significantly better among completers. Further, self-efficacy (t(260) = -2.25, p = .025), intention (t(260) = -3.11, p = .002), and coping planning (t(249) = -2.89, p = .0.004) at T1 were significantly higher in completers than dropouts (see Table S5 at

https://osf.io/j7e4z/?view\_only=aebc66fb117748faa4e6b8a8cfdd4c75).

# Physical activity development over time

On average, participants engaged in 147 minutes walking time at T1 (SD = 7.9) and 141 minutes at T2 (SD = 6.8) at T2. The mean walking time did not change significantly between time points (F(1,131) = 0.58, p = .446,  $\eta^2_p = .004$ ). For the MVPA, participants engaged on average in 284 minutes at T1 (SD = 13.6) and 307 minutes at T2 (SD = 17.1). This was similar in the imputed data set (See Figure 2). When only analyzing completers, the mean MVPA did not change significantly between time points (F(2,144) = 1.91, p = .170,  $\eta^2_p =$ .022). However, the same analysis was conducted with the imputed data, the mean MVPA increased significantly from T1 to T2 (F(1,262) = 5.05, p = .025,  $\eta^2_p = .019$ ). Lastly, the average total physical in minutes at T1 (SD = 19.8) and 460 minutes at T2 (SD = 22.5) and didn't change over time (F(1,83) = 1.64, p = .203,  $\eta^2_p = .019$ ).

# Predicting intention and physical activity after lockdown

To test whether the motivational factors of the HAPA model at T1 correlate with intention to be active at T2, a linear regression was conducted (see Table 1). The descriptive statistics of all factors (Table S1) and the correlations between them (Table S6) can be found here:

# https://osf.io/j7e4z/?view\_only=aebc66fb117748faa4e6b8a8cfdd4c75).

Intention to be physically active at T2 was significantly predicted by self-efficacy and outcome expectancies but not risk perception at T1. The overall model fit was adj.  $R^2 = 0.29$ .

Only partially in line with the hypothesis, when age, gender, education, socioeconomic status, and health status were added to the model, self-efficacy remained significant, and risk perception attained significance, but outcome expectancies were no longer significant. The overall model fit was adj.  $R^2 = 0.35$ .

# Table 1

								95% C	Ί
		В	SE	β	Т	р	$f^2$	LL	UL
1	Intercept	3.99	.06		64.66	<.001***		3.86	4.11
	Self-efficacy T1	0.34	0.06	0.40	5.54	<.001***	0.21	0.22	0.46
	Risk perception T1	0.10	0.05	0.12	1.79	0.075	0.01	-0.01	0.20
	Outcome expectancies T1	0.23	0.07	0.24	3.27	0.001**	0.06	0.09	0.37
2	Intercept	3.17	1.13		2.81	0.006*		0.94	5.41
	Self-efficacy T1	0.26	0.06	0.30	4.01	<.001***	0.11	0.13	0.38
	Risk perception T1	0.12	0.06	0.15	2.12	0.036*	0.02	0.01	0.22
	Outcome expectancies T1	0.14	0.08	0.15	1.87	0.064	0.02	-0.01	0.29
	Age	0.01	0.01	0.02	0.25	0.805	-0.01	-0.02	0.03
	Gender	-0.08	0.13	-0.04	-0.57	0.570	< 0.01	-0.33	0.19
	Health status	0.24	0.08	0.24	3.04	0.003*	0.06	0.09	0.40
	Socioeconomic status	-0.29	0.13	-0.16	-2.25	0.027*	0.04	-0.55	-0.04
	Education	0.05	0.05	0.06	0.89	0.375	0.01	-0.06	0.16

# Linear Regression Analysis of the Intention to be Physically Active at T2

Notes. *B*, unstandardized regression coefficient; *SE*, standard error;  $\beta$ , standardized regression coefficient; all predictors were grand-mean-centered, \*p < .05; \*\*p < .01; \*\*\*p < .001.

To test the association of volitional HAPA factors at T1 on walking time, MVPA and total PA at T2, linear regressions were conducted (see Table 2). When the model was analyzed for the walking time (n = 129), contrary to hypotheses, the self-reported walking time at T2 was not significantly predicted by any volitional factor at T1. The overall model fit was adj.  $R^2 = -0.02$ . When the walking time at T1 was added as covariate, none of the HAPA variables attained significance, but the walking time at T1 predicted the walking time at T2. The overall model fit was adj.  $R^2 = 0.111$ . When adding the covariates only the walking time at T1 remained significant.

The results of the linear regression for MVPA (n = 84) were similar. Only the MVPA at T1 predicted the MVPA at T2. The first model had a fit of adj.  $R^2 = -0.02$ , when adding the MVPA at T1 the fit changed to adj.  $R^2 = 0.12$ , and lastly the fit when adding all covariates, was adj.  $R^2 = 0.09$ .

Lastly, similar results were also found for the total amount of physical activity (n = 81). Only the past total physical activity could predict the total amount of physical activity at T2. The first model with only the volitional factors had a fit of adj.  $R^2 = -0.04$ , when adding the total amount of physical activity at T1 the fit changed to adj.  $R^2 = 0.16$ , and lastly the fit when add-ing all covariates, was adj.  $R^2 = 0.14$ .

# Chapter III – Results

# Table 2

# Linear Regression Analysis of Physical Activity at T2

			Wall	king tii	me						MV	PA							Tota	l PA				
							95% C	I							95% C	Ι							95% C	I
	В	SE	ß	Т	р	$f^2$	LL	UL	В	SE	ß	Т	р	$f^2$	LL	UL	В	SE	ß	Т	р	$f^2$	LL	UL
1 Inter-	139.9	7 47		18.7	<		125.1	154.7	297.5	10.24	0	15.3	<		259.0	336.0	449.2	26.25		15.3	<		259.0	336.0
cept	3	/.4/		4	.00***		5	1	7	19.54	0	9	.001***		7	6	5	20.23		9	.001***		7	6
Turkan			-		0.968	0					-		0.669	0					-		0.669	0		
Inten-	-0.55	13.7	0.0	-			-	26.57	-16.2	37.75	0.0	-			-	58.94	-16.2	37.75	0.0	-			-	58.94
tion 11			1	0.04			27.67				8	0.43			91.33				8	0.43			91.33	
Action			0.1		0.294	0.01					-		0.911	< 0.0					-		0.911	< 0.0		
plan-	10.15	9.64	0.1	1.05			-8.92	29.22	-2.74	24.42	0.0	-		1	-	45.87	-2.74	24.42	0.0	-		1	-	45.87
ning T1			3								2	0.11			51.35				2	0.11			51.55	
Coping			-		0.783	< 0.0					0.1		0.558	0.01					0.1		0.558	-		
plan-	-3.26	11.79	0.0	-		1	-	20.08	18.3	31.1	0.1	0.59			-	80.2	18.3	31.1	0.1	0.59		0.09	-	80.2
ning T1			4	0.28			26.61				2				43.61				2				43.61	
Action			0.0		0.976	0					0.1		0.471	0.01					0.1		0.471	0		
control	0.32	10.4	0.0	0.03			-	20.9	19.13	26.43	0.1	0.72			-	71.74	19.13	26.43	0.1	0.72			-	71.74
T1			1				20.27				4				33.47				4				33.47	
2 Inter-	00.57	12.97	0	7.04	<		65 11	116.0	168.3	40.44		4 16	<		07 01	248.8	168.3	40.44		4 16	<		07.01	248.8
cept	90.57	12.07	0	7.04	.001***		05.11	4	6	40.44		4.10	.001***		07.04	8	6	40.44		4.10	.001***		07.04	8
Inton			-		0.859	0.03					-		0.790	0					-		0.790	0		
tion T1	-2.27	12.73	0.0	-			- 27 47	22.93	-9.4	35.27	0.0	-			-	60.82	-9.4	35.27	0.0	-			-	60.82
			2	0.10			27.47				5	0.27			19.02				5	0.27			79.02	
Action			0.2		0.095	0.02			_		-	_	0.575	< 0.0	_		_		-	_	0.575	< 0.0	_	
plan-	15.19	9.02	0.2	1.68			-2.66	33.04	12.92	22.96	0.0	- 0.56		1	- 58 64	32.79	12 92	22.96	0.0	- 0.56		1	- 58 64	32.79
ning T1			U						12.72		8	0.50			50.04		12.72		8	0.50			50.04	

	Coping plan- ning T1	-9.48	11.04	- 0.1 2	- 0.86	0.392	0.01	- 31.34	12.37	20.17	29.02	0.1 3	0.69	0.489	0.01	- 37.62	77.95	20.17	29.02	0.1 3	0.69	0.489	0	- 37.62	77.95
	Action control T1	-1.58	9.67	- 0.0 2	- 0.16	0.871	0	- 20.72	17.56	15.44	24.68	0.1 1	0.63	0.534	0	-33.7	64.57	15.44	24.68	0.1 1	0.63	0.534	0	-33.7	64.57
	Physical activity T1	0.34	0.07	0.3 9	4.55	< .001***	0.17	0.19	0.49	0.47	0.13	0.3 7	3.57	0.001**	0.13	0.21	0.74	0.47	0.13	0.3 7	3.57	0.001**	0.23	0.21	0.74
3	Inter- cept	- 103.4 8	121.7 6		- 0.85	0.397		- 344.6 1	137.6 5	179.8 8	304.5 7		0.59	0.557		- 427.1 3	786.8 9	179.8 8	304.5 7		0.59	0.557		- 427.1 3	786.8 9
	Inten- tion T1	-1.4	13.41	- 0.0 1	-0.1	0.917	0	- 27.94	25.15	-1.21	36.38	- 0.0 1	- 0.03	0.974	0	- 73.72	71.3	-1.21	36.38	- 0.0 1	- 0.03	0.974	<0.0 1	- 73.72	71.3
	Action plan- ning T1	13.67	9.1	0.1 8	1.5	0.136	0.02	-4.36	31.69	-13.7	23.59	- 0.0 9	- 0.58	0.563	<0.0 1	- 60.71	33.31	-13.7	23.59	- 0.0 9	- 0.58	0.563	0	- 60.71	33.31
	Coping plan- ning T1	-7.08	11.37	- 0.0 9	- 0.62	0.535	<0.0 1	- 29.61	15.44	21.27	30.18	0.1 4	0.7	0.483	0.01	- 38.89	81.43	21.27	30.18	0.1 4	0.7	0.483	0	- 38.89	81.43
	Action control T1	-4.28	10.09	- 0.0 6	- 0.42	0.672	<0.0 1	- 24.26	15.69	16.56	25.19	0.1 2	0.66	0.513	0	- 33.64	66.77	16.56	25.19	0.1 2	0.66	0.513	0	- 33.64	66.77
	Physical activity T1	0.33	0.08	0.3 8	4.44	< .001***	0.18	0.18	0.48	0.48	0.14	0.3 8	3.5	0.001**	0.12	0.21	0.75	0.48	0.14	0.3 8	3.5	0.001**	0.25	0.21	0.75

			0.1		0.194	0.01					-		0.728	-					-		0.728	-		
Age	2.02	1.55	0.1	1.31			-1.04	5.08	-1.24	3.56	0.0	-		0.07	-8.33	5.85	-1.24	3.56	0.0	-		0.03	-8.33	5.85
			I								4	0.35							4	0.35				
			-		0.363	0.01					-		0.316	0.01	-				-		0.316	0.02	-	
Gender	-13.43	14.71	0.0	-			-	15.7	-	35.44	0.1	-			106.4	34.84	-	35.44	0.1	-			106.4	34.84
			8	0.91			42.56		35.19		2	1.01			2		35.79		2	1.01			2	
Socioec					0.224	0.01							0.208	0.02					<u>.</u>		0.208	0.03		110 -
onomic	18.07	14.78	0.1	1.22			-	47.35	46.18	36.33	0.1	1.27			-	118.5	46.18	36.33	0.1	1.27			-	118.5
status	10.07	11.70	1				11.21	.,		00.00	4	1.27			26.24	9	.0.10	00.00	4	,			26.24	9
status					0.427	<0.0							0.007	0							0.007	0		
Health			0.0		0.427	<0.0	-				-	-	0.907	0	-				-	-	0.907	0	-	
status	7.02	8.81	7	0.8		1	10.43	24.47	-2.68	22.88	0.0	0.12			48 27	42.92	-2.68	22.88	0.0	0.12			48 27	42.92
status			/				10.45				1	0.12			40.27				1	0.12			40.27	
Educa-	2	6.01	0.0	0.22	0.739	0	0.00	12.0	0.70	15.27	0.0	0.64	0.526	0.01	-	40 41	0.70	15.27	0.0	0.64	0.526	< 0.0	-	40 41
tion	2	6.01	3	0.33			-9.89	13.9	9.78	15.37	8	0.64			20.84	40.41	9.78	15.37	8	0.64		1	20.84	40.41

Notes. *B*, unstandardized regression coefficient; *SE*, standard error;  $\beta$ , standardized regression coefficient; all predictors were grand-mean-centered, \*p < .05; \*\*p < .01; \*\*\*p < .001

#### Sensitivity Analyses

After multiple imputation, the intention to be physically active at T2 was significantly predicted by self-efficacy and outcome expectancies but not risk perception at T1. The range of the model fit over all five imputed data sets varied from adj.  $R^2 = 0.11$  to adj.  $R^2 = 0.16$ . Only partially in line with the hypothesis, when the covariates were added to the model, self-efficacy remained significant but risk perception and outcome expectancies were no longer significant predictors of intention. The model fit ranged from adjusted  $R^2 = 0.12$  to adj.  $R^2 = 0.17$  over all imputations. The results of the action model for walking time, MVPA and total PA were unchanged after imputation. (see all sensitivity analyses with the imputed datasets in Supplement 7 and 8:

https://osf.io/j7e4z/?view\_only=aebc66fb117748faa4e6b8a8cfdd4c75).

# Does fear of Covid-19 moderate the intention-behavior relationship?

Contrary to our hypothesis, the effect of intention on walking time (B = -17.81; C.I. [-36.99, 1.36], p = .069), MVPA (B = -20.2; C.I. [-64.27, 23.90], p = .369) or total physical activity (B = -33.1; C.I. [-91.11, 25.00], p = .265) was not moderated by fear of Covid-19 either for completers or when including imputed data (see Supplement 9: https://osf.io/j7e4z/?view\_only=aebc66fb117748faa4e6b8a8cfdd4c75).

#### **Exploratory Analyses**

However, since walking time, MVPA and the total amount of physical activity at T1 were the only factors that significantly predicted MVPA at T2, an exploratory moderation analysis was conducted with these variables and the fear of Covid-19. No moderator effect was found for the waking time (B = -0.049, C.I. [0.10, -0.49], p = .0.628).

For MVPA, the fear of Covid-19 moderated the effect of MVPA at T1 and physical activity at T2 (B = -0.34, C.I. [-0.33, -0.04], p = .001). A simple slopes analysis revealed that MVPA at T1 was only predicted by MVPA at T2 for older adults with low (1 SD below the mean; B = 0.77, SE = 0.16, C.I. [0. 451, 1.09], p = <.001) to average fear of Covid-19 (B = 0.53, SE = 0.12, C.I. [0. 29, 0.76], p = <.001). For older adults with high fear, the effect was disrupted (1 SD below the mean of Covid fear; B = 0.28, SE = 0.15, C.I. [-0.015, 0.58], p = .063). Similar results were found for the imputed data set. However, this effect disappeared after identifying and removing potential bivariate outliers in the completers (B = -0.09, C.I. [-0.35, 0.17], p = .0.500) and imputed data set (B = -0.09, C.I. [-0.22, 0.02], p = .0.113). Moderation analysis for the total amount of physical activity was again not significant (B = -0.194,

C.I. [-0.425, -0.036], p = .0.098). The results remained substantially unchanged when the imputed data was included. (For all results see Supplement 10: https://osf.io/i7e4z/?view\_only=aebc66fb117748faa4e6b8a8cfdd4c75)

## Discussion

The purpose of this study was to gain a better understanding of whether and why some older adults' physically activity changed after the lockdown of the first wave of the Covid-19 pandemic. The results showed that physical activity stayed mainly the same or improved over time as lockdown restrictions were lifted. Partially in line with our hypotheses, self-efficacy and health status robustly positively predicted the intention to be physically active. Thus, older adults with higher self-efficacy showed stronger intentions to be active as lockdown restrictions eased. Contrary to our hypothesis, none of the volitional factors of the HAPA model predicted physical activity after lockdown. Only past physical activity predicted activity after lockdown. Our results indicated that the fear of Covid-19 did not qualify the intention–behavior relationship. Exploratory results provided some evidence that fear of Covid-19 can moderate the past behavior–future behavior relationship such that past behavior might not be predictive of future behavior in fearful individuals. However, these results are preliminary as they did not hold when outliers were removed.

# Physical activity of older adults after the lockdown

As lockdown restrictions eased, physical activity over time was consistent or improved further. This is encouraging given the evidence that physical activity was negatively impacted by the restrictions faced in the first wave of Covid-19 (Naughton et al., 2020), especially among older adults (Bu et al., 2021; Carriedo et al., 2020).

Two motivational factors of the HAPA model, self-efficacy and outcome expectancies, related to the intention to be physically active. The results on risk perception were inconclusive as this effect was not significant when analyzing the completers. The nonsignificance of risk perception is a common result and was mentioned, for example, in Zhang et al.'s (2019) meta-analysis, which concluded that the effects of outcome expectancies and risk perception were small and that self-efficacy was the most promising factor in predicting health behaviors in general. Similar findings were observed in a study by Bierbauer et al. (2017), who found that risk perception had no significant association with older adults' intention to be physically active and who argued that the perception of being at risk is not equally important to all health behaviors.

Outcome expectancies related positively to intention, which is in line with previous findings (Williams et al., 2005), where outcome expectancy was found to be a central construct in social-cognitive models of physical activity. However, some evidence shows that health-related outcome expectancy has no effect on intentions or behavior, especially in older adults (Gellert et al., 2012). This uncertainty is reflected in our regression results, which are not as robust as those for self-efficacy; Outcome expectancies lost their significance when the covariates were added.

The evidence on the self-efficacy effect is well funded in social cognitive theory (Bandura, 1998), and robust in our analyses. Self-efficacious individuals approach difficult tasks as challenges to be mastered rather than as threats to be avoided (Bandura & Ramachaudran, 1994). This could explain why self-efficacy is so important during the global crisis of the Covid-19 pandemic, because self-efficacious individuals would be more likely to view remaining active as a challenge to be tackled than a situation that would overwhelm them. Which is in with research that shows that overall people reported significantly less benefit, less enjoyment, less confidence to remain physical active during the Covid-19-pandemic (Lesser & Nienhuis, 2020) making it plausible that self-efficacy was also found to predict the intention to be active nevertheless. Moreover, self-efficacy was also found to predict the intention to perform pandemic-specific preventive behaviors like the intention to perform social distancing (Hamilton et al., 2020) and handwashing in older adults particularly (Duan et al., 2022). Thus, self-efficacy seems an important resource and protective factor for many healthrelevant behaviors of older adults during the pandemic.

This notion of personal resources could also explain the interesting relationship between health status and the intention to remain active. Healthier individuals could be less absorbed with the pandemic's impact on the health system and its consequences for their treatment (e.g., Wosik et al., 2020) and therefore have more resources for being active than individuals who are in poorer health.

Volitional factors alone failed to predict differences in physical activity after lockdown. This is further highlighted by the low or even negative R-squared values in the action model, indicating that volitional factors are not as important for the recovery of physical activity. Therefore, these variables cannot be considered reliable predictors of the dependent variable (e.g., Chicco et al., 2021). This stands in contrast to Lin et al.'s (2020) and Zhang et al. (2020) finding that volitional factors such as especially coping and action planning

### Chapter III - Results

significantly predict health behaviors specific to Covid-19, such as washing hands. Ziegelmann et al. (2006) also found that more detailed action plans led to more physical activity in older adults up to six months after the end of an intervention. And Wolff et al. (2016) confirm that formulating coping and action plans leads to more physical activity in an intervention. Thus, our findings about action and coping planning contrast with previous research overall. However, some previous evidence has shown that action planning is not always useful for older adults, especially for physical activity (Warner et al., 2016).

Moreover, intention did not predict behavior, which is in contrast to numerous findings and theories that assume that the intention to perform a certain health behavior is a key predictor of that behavior (Sheeran, 2002). Our results could be an indicator of the intentionbehavior gap (Sheeran & Webb, 2016). However, because the mean physical activity in our sample was constantly higher than official recommendations, it seems unlikely that our results are due to the intention-behavior gap. An alternative explanation is that the lack of relationship between intention and behavior is due to strong automatization of the behavior: a physical activity habit (Hagger, 2019). Sheeran and Webb (2016) for example, showed that, the predictive value of intention on behavior declines with greater experience, which reflects increased automatization of the behavior. This explanation is supported by a meta-analysis that showed that the intention-behavior gap is smaller in older adults, being experienced, than in younger adults (Hagger et al., 2002). This explanation is further supported by our observation that the amount of physical activity at T1 was significantly related to the amount of activity at T2. This is further underlined by Hagger et al. (2018), who state that past behavior typically exhibits larger effects on future behavior than other social cognitive factors such as intention due to implicit, unconscious processes. Moreover, Di Maio et al. (2021) found that the intention-activity relationship was moderated by habit strength, suggesting that habit has a compensatory effect. And in light of the pandemic preventive behaviors like social distancing were also strongly predicted by habit, suggesting that it could be also central for the maintenance of other behaviors during times were it is more difficult to exhibit a certain behavior (Hagger et al., 2021). Also other studies already show that habit mediates the relationship between past and current physical activity in general in older adults (van Bree et al., 2015). Therefore, when a behavior becomes habitual, like in this case physical activity, volitional factors become less important. Instead, habit plays a greater role (e.g. Rhodes & De Bruijn, 2010). However, certain conditions can cause disruption to routines and restrictions on personal lives during a pandemic, as postulated by Spence et al. (2020), and hence moderate this effect.

#### Moderator Effects of Fear of Covid-19

Contrary to our hypotheses, the relation between intention and behavior was not moderated by fear of Covid-19. However, an exploratory analysis showed some evidence that fear of Covid-19 can disrupt the relation between past and current behavior. This suggests that experiencing fear may disrupt a habitual behavior. This is in line with habit theory, which states that changing context can cause habit to discontinue. Interestingly, this was only found for MVPA, and not for walking time or total PA. Perhaps, activities like walking are less impacted by restrictions such as those imposed by lockdown. The effect for MVPA is preliminary, because the finding was not robust when bivariate outliers were removed. This can be due to the small sample size since the influence of outliers increases the smaller the sample (Van Selst & Jolicoeur, 1994). However, this result can be seen as hypothesis-generating, warranting future research.

### Limitations and further directions

Overall, the sample depicts a healthy and active population of older adults. The oversampling of healthy and active participants may be due to a selection bias of active and interested individuals caused by the use of social media ads as primary recruitment tool. Studies, for example, have shown that smartphone expertise, an inclusion criterion in our study, can correlate positively with health outcomes (Mohlman & Basch, 2021). The high panel attrition may have further contributed to the selection bias. Our dropout analysis indicated that healthier, more educated participants with a higher intention to be active were also more likely to complete both time points. Therefore, the study results may not be generalizable to the entire population of older adults. Further, due to the rapid onset of the pandemic, we did not obtain data before the lockdown. Therefore, we cannot be sure that our sample's physical activity decreased during the lockdown, even though this seems likely given evidence from other studies (Naughton et al., 2020). Encouragingly, our analyses with completers and the imputed data largely converged, indicating the robustness of our findings.

Despite these limitations, the present study has enhanced the understanding of older adults' physical activity after lockdown. Overall, our findings align well with those from other studies in that healthy older adults living at home may be less severely affected by the pandemic than previously assumed (Knepple Carney et al., 2021). Further, the findings support research showing that self-efficacy has an important influence on the intention to be active when staying active is difficult and less enjoyable, making it potentially an important factor to target in behavior maintenance interventions during pandemic times. Especially since

# Chapter III – Results

it's also linked to other pandemic-specific health behaviour like hand washing (Zhang et al., 2020) and mask use (Duan et al., 2022) making it an important protective factor for health relevant behaviors during Covid-19. Finally, strong habits may be a protective factor for maintenance of physical activity during the pandemic, making their promotion even more important. The preliminary finding that fear could potentially disrupt this habitual relationship in older adults provides an interesting avenue for further investigating moderators of the maintenance of healthy habits during a pandemic.

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Chapter III – Results

Health, 21(2), 145–163.

Chapter III - Results

# Article 2: What do older adults think about when formulating implementation intentions for physical activity? Evidence from a qualitative study

This article is published:

Bösch, V. D., Warner, L. M., Nyman, S. R., Haftenberger, J., Clarke, K., & Inauen, J. (2022). What do older adults think about when formulating implementation intentions for physical activity? Evidence from a qualitative study. *British Journal of Health Psychology*, 00, 1–16. https://doi.org/10.1111/bjhp.12621



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# What do older adults think about when formulating implementation intentions for physical activity? Evidence from a qualitative study

## Abstract

# Objectives

Physical activity is an important health behaviour especially for older adults. Forming implementation intentions is an effective strategy to implement physical activity in daily life for young and middle-aged adults. However, evidence for older adults is inconclusive. This study explored the beliefs of older adults about implementation intentions and potential difficulties and facilitators when formulating them.

# Methods

Three samples of older adults from the United Kingdom (n = 8), Germany (n = 9), and Switzerland (n = 17) were prompted to think aloud while formulating implementation intentions. After the task, semi-structured interviews were conducted. Data were analysed using thematic analysis.

# Results

The data suggested that older adults can have pre-established negative beliefs about implementation intentions (e.g. they are habitually active or that planning is too restrictive). Barriers were reported during the formulation of implementation intentions (e.g. absence of a recurring daily routine). Participants also mentioned facilitators of implementation intentions during their formulation (e.g. that the cue was a useful reminder to be active, and that the task triggered self-reflection about physical activity). After the task, a caveat for using implementation intentions was that they are not always applicable due to several circumstances (e.g. spontaneous alternative activities, weather, health-related barriers, Covid-19-related barriers) and they triggered coping planning.

## Conclusions

The results on obstacles and potentials of implementation intentions from older adults' perspectives provide starting points for improving implementation intention effectiveness related to physical activity. Future studies are needed to investigate whether the findings extend to implementation intentions for other behaviours as well. Chapter III – Results

# Key words:

Qualitative, Implementation Intentions, Older adults, Physical activity, Beliefs, Think Aloud

# Data availability statement:

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

# Acknowledgements:

We thank Rahel Schaerli for her valuable contribution to data collection in the Swiss sample.

#### Background

Physical activity is an important health behaviour since it is accompanied by many health benefits (Warburton & Bredin, 2017). It has been shown to effectively prevent a multitude of diseases, and notably non-communicable diseases like heart disease and diabetes (Cunningham et al., 2020). Older adults especially benefit from regular physical activity regardless of their health status (Hupin et al., 2015). However, many older adults fail to attain the World Health Organization recommendations to be moderately physically active for at least twenty to forty minutes per day (Bull et al., 2020). To increase physical activity, a variety of behaviour change strategies have been devised, of which implementation intentions have been considered to be particularly effective (Gollwitzer & Sheeran, 2006). However, evidence of their efficacy for older adults has been mixed.

## Implementation Intentions

Implementation intentions are a specific planning strategy (Hagger et al., 2016; Hagger & Luszczynska, 2014), where the target behaviour is linked to a certain cue, like a certain time of day or a situation using an if-then-formulation (Gollwitzer, 1993). Alternatively, action planning encompasses different information on future physical activities, such as time, place, duration. Implementation intentions have therefore been defined as a specific way of making plans, while action planning can be considered the broader term (Hagger & Luszczynska, 2014). Forming an implementation intention facilitates recalling the target behaviour upon cue encounter, resulting in a greater likelihood that the target behaviour is executed (Gollwitzer, 1993). As an example, someone could define the implementation intention: "If I have eaten breakfast, then I will go for a twenty-minute walk." Formulating implementation intentions has been found to be an effective strategy to recognise and act upon preplanned opportunities to carry out a certain behaviour (Gollwitzer & Sheeran, 2006), i.e. to bridge the intention-behaviour-gap (Sniehotta et al., 2005).

# Implementation intentions to promote older adults' physical activity

Although implementation intentions have generally been found to be a successful behaviour change strategy, their effectiveness can vary for older adults. Some studies have found implementation intentions to be effective in promoting older adults' physical activity (for example in older women, older adults with obesity, and orthopaedic rehabilitation outpatients; (Bélanger-Gravel, Godin, Bilodeau, et al., 2013; Hall et al., 2014; Ziegelmann et al., 2006). However, a systematic review by French and colleagues (2014) showed that including

## Chapter III - Results

action planning or coping planning in interventions for older adults *negatively* affected their physical activity behaviour and self-efficacy. While implementation intentions were not included in this review, the results on very similar self-regulatory behaviour change techniques questions the effectiveness of implementation intentions for older adults. French et al. (2014) assumed that planning in general might either be more cognitively challenging with increasing age, or less needed (e.g. due to more flexible schedules) and therefore less acceptable for older adults. Quantitative and qualitative research highlights that older adults - especially retirees - indeed report different *preferences* when forming implementation intentions. They prefer slower paced activities, more frequent activity bouts, and more flexible time points instead of setting particular starting times (Alley et al., 2018; French et al., 2021). Research into the most *effective* characteristics of implementation intentions formed in a physical activity trial for older adults suggests that using daily routines as if-cues (rather than exact times) and forming heterogeneous implementation intentions with diverse physical activities resulted in higher plan enactment (Warner et al., 2021). However, these conclusions are based on an overall non-effective physical activity randomised controlled trial among older adults (Warner et al., 2016). Overall, these mixed findings on the effectiveness of implementation intentions in older adults, therefore calls for a deeper investigation into what exactly older adults think of implementation intentions while asked to formulate them as a specific planning strategy to increase their physical activity.

# Purpose of the present study

The aim of the present study was to enhance our understanding of older adults' thought processes during the creation of implementation intentions for physical activity. We aimed to answer the following research questions: What do older adults think about when they create implementation intentions for physical activity? What barriers and facilitators do older adults experience when formulating implementation intentions?

#### Method

# Design

We adopted a qualitative approach and used a think aloud paradigm (Genest & Turk, 1981). The goal of this method was to gain insight into the ongoing thought processes while formulating implementation intentions (e.g. Van Someren et al., 1994). To obtain the views of older people from a range of geographical and cultural contexts, we collected data from the United Kingdom (UK), Germany (DE), and Switzerland (CH). Ethical approval was obtained by each of the three Research Ethics Committees of the part-taking institutions.

# Participants

The study population consisted of community-dwelling older adults aged 65+ years, sampled from the UK (n = 8;  $M_{age} = 71.5$  years;  $SD_{age} = 6.1$ ; data collected in September 2019 - March 2020), DE (n = 9;  $M_{age} = 74.8$ ;  $SD_{age} = 6.6$ ; data collected in July 2020) and CH (n = 17;  $M_{age} = 74.8$ ;  $SD_{age} = 6.6$ ; data collected from September 2019 - February 2020). Inclusion criteria in all samples were as follows: participants were community-dwelling; able to independently participate in the study; deemed themselves capable to be physically active, which they had to assess for themselves prior to participating (in the informed consent: "If you want to partake, it is required that you can be physical active, and give your informed consent to participate"); and had not received any contraindications from a health practitioner for being physically active prior to the study. No adults with dementia were recruited, and in the Swiss sample dementia was an explicit exclusion criterion. Participants were recruited via convenience sampling through local organisations (e.g. University of the Third Age). Additionally, snowball sampling through friends, family and neighbours was utilised. Further sociodemographic characteristics of the samples can be found in Table 1.

# Table 1

Sociodemographic Characteristics of Participants

Sample	UK (N = 8)	DE (N = 9)	CH (N = 17)
	n	n	n
Gender			
Female	3	6	7
Male	5	2	10
Marital Status			
Single	1	0	2
Married/ with Partner	4	3	10
Divorced	2	1	4
Widowed	1	3	2
Highest Education			
Not specified	1	1	0
Other professional	2	2	1
A-Levels	1	0	0
College	1	0	0
Apprenticeship	1	0	3
Secondary School	0	0	2
University	0	6	11
<b>Retirement Status</b>			
Retired	6	8	14
Not retired	2	1	3

## Procedure

Before the interview, participants in the UK sample were provided with a participant information sheet. They were asked to discuss the information sheet and raise any potential questions prior to the interview appointment. On the day of the appointment, these questions were discussed prior to the beginning of the task and interview. Participants then completed an informed consent form. The interview started with a practice 'think aloud' task. Participants were asked to speak aloud about what they read, thought, and wrote. Following this, the interview was audio recorded and participants were asked to 'think aloud' during the whole interview. This enabled capturing their beliefs about implementation intentions before, during and after the task. They first read a form on the physical activity recommendations according to the World Health Organisation to provide a reference point for sufficient health-relevant moderate or vigorous physical activity (Bull et al., 2020). As most participants were active already but most not active enough in terms of the WHO recommendations, defining a healthy

amount of activity was intended to motivate participants to strive for more physical activity in their implementation intentions.

They were then provided with prompts and instructions on how to create implementation intentions and asked what physical activities they would like to carry out, which ones they could do daily, when they have time each day to be active, how long they could be active each time and if they would like to be active alone or together with others. We required the implementation intentions to be formed for a daily activity as this procedure enables better habit formation with repeated cue-action links (e.g. Lally & Gardner, 2013). (also see Supplement A1 and A2; all Supplements are stored in the Open Science Framework; https://osf.io/gu9d8/?view\_only=2a19fddc8d574a7caa0dd9bdd8318680).

Afterwards, they were handed a planning sheet and asked to formulate up to three implementation intentions being moderately to vigorously physical active in if-then format (see Supplement A1 and A2).

Following this, participants were questioned on their experiences with the task via a semi-structured interview, using pre-formulated prompts if needed. These open-ended questions aimed to cue participants' thoughts on physical activity, completing the planning task and creating their if-then plans (e.g. What was it like to complete the task, which aspects were motivating and if did i feel natural or not; see Supplement B). Additionally, seven demographic questions were asked (see Supplement A1 and A2). All participants were interviewed in their homes or other venues if preferred (e.g., campus, public café).

The data collection in the DE-sample followed a nearly identical procedure. However, due to the restrictions caused by the Covid-19-pandemic all interviews were held online via a video-telephony provider. Moreover, the sheets where the participants could note their implementation intentions (see Supplement A1 and A2) were sent to the participants' addresses and unpacked from a letter, when prompted by the interviewer.

The data collection in the CH-sample was conducted within a complex intervention study to promote physical activity in community-dwelling older adults using implementation intentions and motivational messages (blinded for review: pre-registration and study protocol; https://osf.io/e37bn/?view\_only=25386b92cefb4c25a9625ccc445c9).

The formulation of the implementation intentions was audio recorded with prior consent of the participants. In contrast to the DE and UK-sample, the Swiss participants were not explicitly instructed to think aloud and had only to formulate up to two implementation intentions, but they answered the same guiding questions (see Supplement A3).

# Data analysis

The fourth and fifth author, and a research assistant (CH sample), transcribed the interview recordings verbatim. The data was then analysed bottom-up by the first author, following the 6-step thematic analysis by Braun and Clarke (2006). In the beginning, they read all transcripts, for each sample separately, to familiarize herself with the data and then proceeded to write down initial topics. Secondly, they coded statements line-by-line, allowing for inclusive codes derived from the data (i.e. manifest codes), while making reflexive notes where necessary. Thirdly, initial codes were coalesced to identify relationships between the codes and combined to larger themes in each respective sample. In a fourth step, the first author reviewed the themes and compared them between the three samples. Fifth, the first and last author critically reviewed the themes and codes until they reached consensus. In a sixth step, during report writing, the first and last author decided to order the themes along their appearance in the planning process (i.e.: before, during, and after the implementation intention task, see Figure 1). Then, the co-authors reviewed a first report of the results and discussed feedback considering the research questions and the reliability of the findings. Lastly, the first author reread all the transcripts, actively searching for negative or contrasting statements to the elaborated themes. None were found.

# Results

In the following, the results are presented along the temporal structure of the planning process (Figure 1). An abbreviation (UK, DE, CH) and a number indicate which sample and participant the quotations originate from (e.g., UK5 would be participant five from the UK-sample).

# Figure 1

Summary of the beliefs of older adults about implementation intentions

Before the task: Thoughts about implementation intentions	During the task: Thoughts about the formulation of implementation intentions	After the task: Thoughts about the enactment of implementation intentions
Lack of necessity to plan	No recurring daily routine	The plan is not always applicable
Planning feels too restrictive	Only wanting to be active at certain times	Spontaneous coping planning
	The plan is a useful reminder	
	Resuming previous activities	
	Self-reflecting about physical activity	

# Before task: Thoughts about implementation intentions

Before writing down their personal implementation intentions, participants mentioned initial thoughts about planning that seemed to shape their attitude towards the task and its effectiveness to facilitate physical activity. This manifested in thoughts that implementation intentions are not necessary to be more active or that planning did not allow for spontaneity, and therefore was too restrictive. These themes will be further elaborated in the next paragraphs.

# Lack of necessity to plan

A theme identified in all three samples was that planning physical activity was not necessary, because participants felt that they were already physically active on a daily basis. In those cases where participants had pre-established routines, they saw no need in planning,
as illustrated in the following statement by participant DE7: "I usually let things come to me and if there's time, I do it, but since everything already developed into a certain routine, I don't need to do much planning". The formation of this belief may be due to having an established routine as seen in participant UK2, who stated: "I do skiing in the winter, which I've done for the last 50 years". Another reason might be a lack of motivation, as stated by participant UK5: "I don't plan, yeah, I just do it when I want to do it". These beliefs about being sufficiently physically active that can inhibit planning behaviour are best summarized by the statement of participant DE4: "I understood it, but honestly, I don't know what I [...] could do better, what I'm already doing. I'm doing a lot already". Overall, these participants felt that a plan was not necessary since they felt that they did not need a reminder to increase their physical activity.

#### Planning feels too restrictive

Another theme was the experience of if-then planning as too restrictive of personal freedom. For example, Participant UK2: "Yeah again, physical activity ain't really something I put my mind to doing at a certain time or something, just happens so putting time to do a specific thing is kinda limiting." Participant CH6 moreover stated that having to plan was a restraint to them: "Exactly, because afterwards this is somehow a restraint." Notable here is that none of the participants stated that their belief was due to an objective barrier (e.g. pain when being active or bad weather), suggesting that this belief was a personal opinion. This can also be seen in DE7's statement, who said that planning was too restrictive and that they therefore had trouble with the task: "So, I think rather restraining... like I said... I'm actually not very much of a planner and for such things... I have more of a general concept, I want to exercise as much as possible... and at which time of day or which day or so... that is a bit difficult for me to narrow it down."

#### During the task: Thoughts about the formulation of the implementation intentions

In this phase participants stated what they experienced while formulating the implementation intention. These included barriers they faced, like having no recurring daily routines, which made finding a good implementation intention difficult. In contrast, facilitators for the usage of implementations as a planning strategy were mentioned, for example that many only wanted to be active at certain times, that the plan was a useful reminder. Further themes that emerged during the task were that participants chose resuming previous activities, and engaged in self-reflection about their current physical activities.

# No recurring daily routine

A lack of daily routine was identified as one difficulty when formulating implementation intentions. Participant CH3 for example mentioned that they had time to be active at all times of day since they had no specific daily routine and needed help from the interviewer in finding a recurring cue for the if-part of the implementation intention: "So, the only fixed routine we have is actually in the morning. Yes, early in the morning [...] we get up at seven at the latest, we [...] have breakfast, so actually one could only integrate something after the breakfast". A similar scenario was mentioned by participant CH11 by stating a lack of situational cues: "So, a fixed thing (routine)... So, with the exception of getting up, going to bed, eating reasonably and such..., but else, in between (I have none)".

#### Only wanting to be active at certain times

A further theme identified was knowing exactly at which times of day participants were (un)willing to be physically active. Participant CH7 for example knew exactly that they did not want to be active in the evening as this would be too strenuous: "[...] it would simply have to be after lunch. In the evening I would rather not do such strenuous things". Analogously, participant CH6 said that they were not fond of being active in the morning: "[...] in the morning I somehow don't manage it, and after lunch I don't want at all, but before dinner it is somehow easier, and afterwards I can watch television or so". There seemed to be a preference for activities at certain times (like in the morning or before noon). Whereas, Participant CH11 said that their favourite time to be physically active was after breakfast since this would be the only time where they were motivated to do so. They stated the reason why by saying: "Because, when I do it in the morning, before noon after breakfast, then firstly I have done it, secondly, I'm the most motivated, thirdly nobody disrupts me". The activity was also frequently planned around a meal like breakfast or lunch, possibly in lack of further recurring daily cues.

#### The plan is a useful reminder

Statements regarding the if-part of the planning task suggested that writing cues down can be a good reminder to be active. Evidence for this theme was especially strong in the UK-sample. Participant UK1, for example, stated: "Usually the fact that I've written something down means that I'm more likely to do it". In addition, the reminder was also considered as motivating as suggested by participant UK 3: "Well, I think writing down the plans was motivating as it gives you something to work on, like a to-do list". This belief was shared by UK6: "Again, it's a good way to remember to do physical activity I'm sure". Interestingly, the implementation intention task encouraged mainly participants of the UK sample to think about their current physical activity.

#### Choosing to resume previous activities

Most participants across all samples had a distinct idea of the type of physical activity they wanted to perform. A minority of participants specifically chose to resume discontinued behaviours like using the stepper (a training device resembling a cross-trainer), restarting a daily fitness routine prescribed from rehabilitation, or daily morning gymnastics. For example, participant CH4 stated: "So, on the one hand, what I would like to reinstate, I had done this for many years, is simply to do such a 10-minute morning gymnastics each morning". They moreover stated that they already knew in detail when, where and in which situation they wanted to reinstate their routine since they had done morning gymnastics for many years but had somehow stopped.

# Self-reflecting about physical activity

Another theme was that some participants started thinking about their physical activity in more detail. This was particularly observed in the UK-sample. For example, participant UK6 said that they didn't think enough about their activity and that the WHO recommendations made them realize that they should plan it more: "My first impression is probably that I don't think enough about my physical activity plans and that maybe I should devote a percentage of time to planning a bit better." However, this could be rebutted by participant UK3 stating that they found the task "a bit depressing initially" as "it makes you realise what I do, I should do more of". But despite the minor negative emotional response, participant UK3 stated that the WHO recommendation and subsequent planning during the task regarding changing their amount of physical activity motivated them to be more active in the future: "Well it makes me feel that I want to do more". Also, the combination of the recommendation and the task led to reflection of their current activity mainly in the UK-sample.

#### After the task: Thoughts about the enactment of implementation intentions

After completing the task, some participants remarked may face barriers while enacting their implementation intentions making its enactment not always applicable. Moreover, these barriers elicited spontaneous coping plans, foremost in the CH-sample.

## The plan is not always applicable

Participants noted that their formulated implementations intentions may not are always applicable and barriers for enactment of their implementation intentions were mentioned like spontaneous alternative activities, weather, health-related problems, or other appointments.

Spontaneous alternative activities. Most participants across the samples mentioned spontaneous other commitments as a barrier when having to implement the task. As suggested by participant UK2, prior commitments may influence the likelihood of implementing the plan, in addition to leading to prioritisation of the commitment over the planned behaviour: "Might clash with something else I've got planned that day". On the other hand, participant CH5 stated that they worked a part-time job and therefore could not guarantee to implement the plan every day to the same degree, as it might coincide with their work schedule. Participant CH13 stated that they staved in their holiday apartment for some time and therefore, could not go to the fitness studio: "So, within the next four weeks, I would, provided I'm not in the holiday home, surely go to the gym once". Further, spontaneous visits from friends and family were mentioned to interfere with the plans. Participant CH16 for example stated after the question, if the plan was possible to be enacted daily: "Yes, sure I can. Yes, but precisely, it is just, then some visitors are suddenly coming, and then I can't go (laughs)". A similar statement about spontaneous changes in plan was also made by participant CH12: "Yes, that is quite difficult then, of course. When one gets a visitor, just like me this week, [...] well, then it's just difficult, that I do it then, on top".

*Weather*. Another barrier named was weather conditions like summer heat or rainfall. Many participants stated that the weather condition was important for planning their physical activity. They remarked that implementation intentions could not always be enacted depending on the weather and should therefore be at least adaptable depending on the weather or season. For example, participant CH1 stated that they did not go walking in the afternoon in the summer due to the heat: "So, in summer one went in the early morning, [...] as we couldn't go walking in the afternoon, [...]". Additionally, participant DE9 stated that they

planned depending on the weather: "Ah, I plan for that, depending, on the weather and what I have planned".

*Health-related barriers*. Another theme comprised the belief that health could interfere with their intended implementation intentions. Participant DE9, for example stated that being sick, could lead to them not being active: "It might occur on a very rare occasion that I have a cold. Then I do nothing, because I know, that isn't good for anybody. But it is very, very rare that I have a cold, long time ago. And so, I have no problems there. I don't need no make a plan". Moreover, participant UK6 answered the question of if anything could make it difficult to enact the if-then plans with: "Well [...], if my knee hurt or if I needed to get home quicker, I'd probably skip walking back".

*COVID-19-related barriers*. Since the German sample was interviewed during the first wave of the Covid-19 pandemic, some participants said that their established physical activity routine or plans to be physically active got interrupted. Participant DE5 for example stated that they could not go swimming now: "[...], but now the indoor swimming pools and every-thing are closed. We are of course considering, when many places are opened up again, to get an authorization online, and then also to go to the public beach or else. But we don't know yet". Similarly, participant DE6 could not visit the gym during shutdown like they did before, which they stated inhibited them: "[...] in non-Corona times I actually go four hours a week to the gym, on average, and do courses there and now that this isn't possible, I ride my bike to work, which is nearly ten kilometres". In conclusion, seven out of nine participants reported that they somewhat faced constraints in their choice of physical activities due to Covid-19, which manifested when having to formulate an implementation intention.

# Spontaneous coping planning

In the CH-sample, the instructions were to develop one to two implementation intentions, which could be implemented daily during the course of the intervention. Interestingly, a majority of the older adults in this sample automatically thought about situations in which the attainment of the plan could be more difficult like a scheduled doctor's appointment, work obligations or holidays and spontaneously formulated elaborate coping plans, even though the study design did not prompt them to do this. Participant CH5, for example, knew that they were invited to a congress for three days. Without being prompted, they thought about how they could still enact their plan of walking daily and came up with the coping plan to walk to the congress location instead of taking the bus: "[...] when I go to Lucerne on Wednesday and Thursday, then I will walk to the train station and also back again". Participant CH6 also wanted to implement daily walking in the morning after breakfast. However, they automatically recalled that they had other commitments. Therefore, they stated that they would first finish these tasks and then take their daily walk: "Because, it is not always clear, that I can go right after breakfast, because I also have some miscellaneous appointments, [...], that I have to go to". Yet another participant, CH13, had a trip scheduled and knew that they would likely be more inclined to go skiing. On days on which they would not go skiing they scheduled a walk to the village to compensate skiing.

#### Discussion

The aim of the study was to determine older adults' beliefs about implementation intentions as a technique for increasing physical activity. Before the task of forming the implementation intentions, two kinds of beliefs about implementation intentions were reported. Firstly, a lack of necessity to plan, secondly that the planning feels too restrictive. Then, during the task, several barriers and facilitators were mentioned, e.g., that participants had no recurring daily routine, only wanted to be physically active at certain times, but also that the task was a useful reminder and encouraged resuming previous activities, and that thinking about physical activity and the planning of it triggered self-reflection about their own current physical activity. Lastly, after the task, participants noted that the implementation intentions were not always applicable and, in some participants, the barriers elaborated in the task even triggered coping planning.

Two themes were identified that might explain why implementation intentions may fail to increase physical activity for older adults in a majority of studies (e.g., French et al., 2014). These are related to unfavourable attitudes towards implementation intentions even before starting the task, such as having the pre-established belief that implementation intentions are either too restrictive or that it feels unnatural to formulate them, which could also be observed among younger samples (Palsola et al., 2020). This finding is in line with self-determination theory (Ryan et al., 2009), where perceived autonomy is an important indicator for whether a person is physically active and was also found in older adults in particular (Arnautovska et al., 2018). Consequentially, implementation intentions in their strict if-then-form could be perceived as too restricting and therefore fail to be perceived as useful or are even opposed to by some older adults. This form of reactance was also found when asking young adults to change their diet or drinking behaviour (Sieverding et al., 2019; Ungar et al., 2015).

A further theme was the failure to understand the necessity of formulating implementation intentions, based on the belief of being active enough already without having to plan. This aligns with findings from the qualitative study from Palsola et al. (2020) where participants stated that they saw no need for planning since they already had routines for physical activity. These results depict that strong habits have to be considered in interventions and can limit the usefulness of implementation intentions, due to conscious self-regulatory effort only being needed in early stages of behaviour change, as more automatic processes take over once a habit has been established (Di Maio et al., 2021; Gardner & Lally, 2018; Labudek et al., 2021). However, it has to be noted that strong habits may not equal sufficient physical activity: Although participants claim to be active, this could be based on a biased sense of accomplishment (Labudek et al., 2021). Yet, it is also possible that this effect arises from reading the WHO recommendations, as some participants mentioned that they were already meeting the criteria after reading them and therefore did not see the need to plan further physical activties.

However, most problems occurred during the if-then-task itself. For instance, when having to formulate the if-part of the implementation intention, finding a cue for physical activity was identified as difficult. One reason was that due to their retirement, some older adults had no event that occurred daily at approximately the same time. In these cases, they needed help from the interviewer. This finding could be based on older adults' lower prospective memory capacity for time-based compared to event-based cues found in laboratory studies (Labudek et al., 2021). So, a practical implication could be to guide adults to plan tasks after events (e.g., meals, daily chores) rather than at particular times of day. This could also be beneficial for habit development since having a regular routine can increase the strength of repeated cue-action links and with that automaticity of daily physical activity behaviour (Gardner & Lally, 2018).

Others also wanted to be active at specific times of the day, limiting the choice of a suitable cue. When both attitudes of having no recurring cue and only wanting to be active at certain times coincide, the selection of a suitable daily cue might be difficult, making the task less applicable for these older adults. However, this theme can also be a facilitator since participants were quickly able to identify when they would not want to be active, and so can avoid those times and plan to be active at different times. Therefore, future research is needed on whether wanting to be active at certain times is a barrier or facilitator for certain older adults.

The then-part also identified as a useful reminder to be active. Furthermore, positive feedback was provided for the then-part of the implementation intentions in combination with the WHO-recommendations. Most prominently, a selection of older adults in the UK-sample stated that this part combined with the WHO recommendations made them think more about their current physical activity. The recommendations could have triggered self-reflection of their current physical activity levels in more detail than usually, and the task the process planning activities in general. Having a clear goal like these recommendations could enhance the effectiveness of implementation intentions on behaviour change since it is dependent on whether a person is actually motivated to perform the behaviour in the first place (Prestwich & Kellar, 2014). By reflecting on their current physical activity compared to the recommended amount during a planning intervention, older adults could become more motivated to change, rendering planning not only a volitional but also a motivational behaviour change technique to some degree. As a caveat of this study, this effect on self-reflection is strongly linked to the WHO-recommendations is also substantially due to reading the physical activity recommendations prior to forming implementation intentions (as they were from a credible source).

A selection of participants also stated that if-then planning encouraged them to resume activities that they had lost track of, supporting the assumption that thinking about their current behaviour and lost routines is motivating. The task of reading the WHO recommendations and subsequently forming implementation intentions might have also automatically triggered another behaviour change technique, known as 'focus on past successes' (Michie et al., 2013).

The results suggest that having read the recommendations and having formulated an implementation intention inspires older adults to think of its enactment. They may then realize that it is not always possible to enact the intentions as planned. Identified barriers for the enactment of their planned physical activity included the weather, Covid-19 restrictions, commitments in other life domains or health issues. Interestingly, many older adults thought about possible barriers to their implementation intention without instructions to do so. This suggests that older adults may be inherently good at anticipating possible barriers to a behaviour, possibly showing their learning history. Results from the CH-sample moreover suggest that older adults also spontaneously create plans to overcome the identified barriers, i.e. they used the behaviour change technique 'problem solving' (coping planning; Michie et al., 2013; Sniehotta et al., 2005), even though they were not prompted to do so by the interviewer. This is in line with research demonstrating that physical activity goal setting and use of plans to

70

overcome barriers to physical activity increase with age (Anderson-Bill et al., 2011; Ziegelmann et al., 2006).

This finding is encouraging, as a meta-analysis has also shown that spontaneous planning has medium to large effects on physical activity behaviour (Carraro & Gaudreau, 2013). Also the use of problem solving is already known to enhance the effects of implementation intentions (Kwasnicka et al., 2013). However, this phenomenon was only seen in the CHsample where the participants were part of a more complex intervention study. They may have been more inclined to enact their physical activity plans. This could explain why in some intervention studies (e.g., Warner et al., 2016) healthy older adults were sceptical about implementation intentions without having the opportunity to set up coping plans at the same time.

#### Strengths and limitations of the study

The findings of this study provide better understanding of what older adults think while planning their physical activity using implementation intentions. Since qualitative data from three different countries were analysed, this gives an insight into the views of older adults across a range of geographical and cultural contexts. Beliefs about implementation intentions encountered in all three sites are likely to be found in other samples. Other beliefs were found to be sample-specific.

The self-reflection on current physical activity only occurred in the UK-sample, whereas unprompted coping plans were only formulated in the CH-sample, even if since they had no instructions to think aloud which could have led to less detailed responses.

The CH-sample may have been more inclined to implement their plans since they took part in an intervention study. They were also monitored with an accelerometer. In turn, the participants in the UK and Germany were not followed-up. Indeed, there is evidence that wearing an accelerometer can boost motivation to implement self-set goals (Mercer et al., 2016), and lead to more physical activity (Cadmus-Bertram et al., 2015). Overall, these differences in procedures could have led to a systematic difference in their perception of the task. However, it is also noteworthy that most themes were found in all samples in spite of differences in procedures.

This suggests that the circumstances can influence the thought process of older adults when faced with an implementation intention task, which should not be neglected when using implementation intentions in an intervention. Yet it is unclear if these differences in the samples are due to the geographic location, culture, or other circumstances. For example, the data from the DE-sample was assessed during the first wave of the Covid-19 pandemic. Due closed places to exercise indoors (e.g., swimming pools, gyms) and governmental physical distancing restrictions limiting the plannability of physical activity the German data is not comparable to the other two samples. However, participants were aware of the remaining options and adapted their implementation intentions accordingly.

Also, it is important to note that some themes (i.e. the lack of necessity to plan and that planning triggers self-reflection about physical activity) can also be solely caused by reading the WHO recommendations about physical activity as mentioned in the discussion. Indeed, giving information can be viewed as separate behaviour change technique. In regards of this, it is also to mention that this study only targeted moderate to vigorous physical activity mentioned in the recommendations. Therefore, the results could differ if we had invited older adults to choose their own intensity of physical activity instead of having them read the recommendations. Nevertheless, there is also some evidence that solely reading recommendations also can fail to change behaviour, but might boost awareness or the intention to be more active and therefrom set the stage for meaningful plans to increase it (Warburton & Bredin, 2019). Thus, the results apply only for implementation intentions when used with the WHO recommendations and targeting moderate to vigorous physical activity. When targeting other physical activities like walking or light activities around the house, older adults may experience less difficulties while planning. For example, such activities may be easier to implement every day or are influenced less by external circumstances. This could explain why especially older adults prefer slower paced activities (e.g. Alley et al., 2018).

As a caveat, participants from all samples were already quite active, motivated to participate in the study, and had a good understanding of their physical activity routines. Therefore, it is likely that they already knew their personal barriers and that some themes like 'the lack of necessity to plan' and to a lesser extent that 'planning feels too restrictive' can be specific to older adults, who are already active. Our findings should therefore be interpreted with caution and further research is warranted using the same implementation intention task and target behaviour with less active participants and older adults in different settings that might profit even more from learning how to use implementation intentions as self-regulatory strategy (e.g., cardiac rehabilitation or retirement homes) (e.g. Luszczynska, 2006). Notably, since their necessity to have strategies to plan their physical activity is more pronounced, for example, for reducing their risk of non-communicable disease and associated morbidity (Geidl et al., 2020). In addition, in all three samples were higher educated than the general population, possibly even underreporting barriers to formulating implementation intentions (Allan et al., 2013).

There was no conclusive indication in the data whether older adults in our samples could be categorized into habitual planners (who like the planning task) and non-planners (who oppose planning) which could be a helpful distinction to be explored as a possible moderator in future intervention studies. Nevertheless, this study gives an insight of the range of perspectives that may help explain why implementation intentions work really well with some people in some contexts, and less so in others.

# Practical Implications

The results of this study encourage considering needs and resources of older adults when using implementation intentions to promote physical activity. Health practitioners should assess these (e.g., current physical activity, beliefs, and attitudes toward planning), to then provide a tailored approach as to whether implementation intentions may be useful for certain older adults. From our findings, implementation intentions may only be accepted by (and possibly only be effective for) older adults who are not yet habitually physically active, have daily routines that can be used as cues, and do not feel restricted by planning their activities in such a format. For those who face one of these barriers that emerged in our interviews, different instructions for the planning task might be needed (e.g., use of more flexible cues such as good weather or mood), or different behaviour change techniques might be more suitable (such as coping planning). Also, the wording of the task could have an effect on how participants perceive it. Arguably, changing the focus from "planning" to "implementing a new habit", "fostering daily activity" or "sitting less", could trigger less reactance in older adults opposed to the concept of planning with implementation intentions.

#### Conclusions

This study extends our knowledge on older adults' thoughts about implementation intentions related to physical activity, possible barriers, and facilitators. These factors should be considered when designing future interventions using implementation intentions for older adults. Tailoring an intervention for a certain population, like older adults, can enhance its effectiveness and sustainability (e.g., Barker, 2018; Gellert et al., 2014). Also, older adults should be involved in planning and evaluating behaviour change interventions (Kok, 2018). This is in line with Hankonen (2018), who states that behaviour change techniques can only work, if participants understand how to use the strategies, acknowledge their usefulness, and

thereby actively engage with the learned strategy in their daily life. Therefore, understanding the thought processes of older adults when forming implementation intentions hopefully helps researchers and practitioners to reflect *who* the agents of the behaviour change techniques are and adapt them according to their needs (Hankonen, 2018).

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# Article 3: The Role of Self-Determination When Older Adults Talk About Their Physical Activity: An Interpretative-Phenomenological Study

This article has been submitted to the British *Journal of Health Psychology* and is under review:

Bösch, V. D., & Inauen, J. (2024). The role of self-determination when older adults talk about their physical activity: An interpretative-phenomenological study. [Unpublished manuscript]. Under review at the *British Journal of Health Psychology*.

# The Role of Self-Determination When Older Adults Talk About Their Physical Activity: An Interpretative-Phenomenological Study

#### Abstract

## Objectives

Physical activity is vital for preventing chronic illnesses and enhancing well-being in older adults, yet it declines with age. Self-determination theory posits that satisfying basic psychological needs—autonomy, competence, and relatedness—can enhance intrinsic motivation and activity levels among older adults. However, little research has explored this from their personal perspectives. This study investigates the impact of self-determination on physical activity and identifies specific needs older adults perceive for increasing their activity.

## Methods

We conducted a two-wave qualitative study within a complex intervention promoting physical activity among community-dwelling older adults. Semi-structured interviews were conducted before and after the intervention to assess attitudes and experiences related to physical activity. Data from 14 participants were analyzed using interpretative phenomenological analysis (IPA) to explore themes related to self-determination.

#### Results

Participants viewed physical activity as essential for well-being and mental health, often seeing it as a necessity or a means to recharge. They identified both intrinsic and extrinsic motivations for staying active, with autonomy, competence, and relatedness as key psychological needs. Autonomy helped maintain control but could also be burdensome. Competence fostered a sense of accomplishment, while relatedness supported social connections. Participants preferred activities that fit into their daily lives, such as walking, requiring personal choice, gradual engagement, and motivation to stay active.

#### Conclusion

The study found a balance between intrinsic and extrinsic motivations, with relatedness as the most prominent need. Active participants had more diverse motivations, underscoring the importance of balancing autonomy and guidance in promoting physical activity among older adults.

# Key words:

Qualitative, Older adults, Physical activity, Self-determination Theory, Motivation

#### Background

Physical activity is a crucial health behaviour associated with the prevention of chronic illnesses, improved musculoskeletal fitness, and reduced overall mortality (Rhodes et al., 2017). Especially in the context of healthy aging, physical activity not only enhances physical health but also contributes significantly to overall well-being during the aging process (Peel et al., 2005). Even minor improvements in PA can yield positive effects in older adults (Buman et al., 2010). However, overall physical activity declines over the lifetime, making effective interventions a priority for promoting physical activity in older adults and to maintain healthy aging.

To encourage an active lifestyle and achieve long-lasting behaviour change, personalized approaches using low-cost behavioural strategies have been recommended (Lachman et al., 2018), such as implementation intentions (Gollwitzer, 1999). However, there is evidence showing that such interventions are not always effective for older adults (French et al., 2014, 2021; Warner et al., 2016). Studies indicate that one reason for this is, that older adults prefer adaptable interventions rather than rigid, detailed ones like implementation intentions (Fleig et al., 2017; Warner et al., 2021). Qualitative evidence from a think-aloud study on implementation intentions, for example, suggests that this is due to older adults' need to maintain flexibility and autonomy (Bösch et al., 2023).

Given these results, frameworks like Self-Determination Theory (SDT; Deci & Ryan, 2000a) might be important to consider for understanding and effectively changing older adults' physical activity. The SDT (Deci & Ryan, 1985) is a framework for understanding human motivation, particularly in how people make choices and self-regulate their behaviour. The theory posits that enhancing autonomy can improve the effectiveness of interventions by fostering an autonomy-supportive climate where the basic psychological needs are met (Aelterman et al., 2019). According to SDT, individuals are more likely to exhibit autonomous motivation, particularly intrinsic motivation, when their basic psychological needs—autonomy, competence, and relatedness—are satisfied. Autonomy refers to the desire to control one's life, whereas competence involves feeling effective and proficient in activities. Finally, relatedness is the need for meaningful connections with others.

The SDT moreover posits, that motivation for physical activity spans a continuum from autonomous to controlled motivation. At one end, autonomous motivation includes intrinsic motivation and two forms of extrinsic motivation: identified and integrated motivation. Identified motivation occurs when individuals recognize and accept the personal importance

83

of an activity, even if it is not inherently enjoyable. Integrated motivation is a deeper form of self-regulation, where the activity aligns with one's values and sense of self, becoming a part of their identity. Finally, intrinsic motivation is driven by personal interest and enjoyment in the activity itself, without reliance on external rewards, fostering well-being, competence, positive coping, and personal growth. In contrast, controlled motivation involves actions perceived as externally pressured and includes introjected and external motivation. Introjected motivation, arises from a sense of obligation or guilt from partially internalized external pressures. External motivation is driven by rewards or pressures such as money or praise. It encompasses introjected and external motivation. Overall, autonomous motivation is more favourable compared to controlled motivation, as it fosters greater engagement and persistence in activities (Sheeran et al., 2021).

In regards to health behaviour change, the SDT has been deemed a helpful framework to study antecedents and outcomes of motivation for various health behaviours (Ng et al., 2012). For physical activity in particular, SDT postulates that satisfying all basic psychological needs is crucial, as it makes individuals more likely to be intrinsically motivated and consequently more physically active (Teixeira et al., 2012). Some evidence (e.g. Kirkland et al., 2011) shows that older adult exercisers have higher intrinsic motivation, extrinsic motivation (both auononmous and controlled), and greater satisfaction of basic psychological needs compared to non-exercisers.

Despite the extensive empirical research applying SDT in the context of health and well-being within general populations, research focusing on the aging population is scarce. It is therefore unclear what role self-determination plays in older adults' physical activity. One way to explore and understand this, is by qualitative research, which provides indepth insight into the complexity of human experiences. Qualitative research seeks to provide insights into people's perspectives, motivations, and the meanings they assign to their experiences. However, qualitative research with old adults is still limited (Gillison et al., 2019). In the present study, we aimed to provide first qualitative evidence on the role of self-determination for older adults' physical activity, particularly if and how, from older adults' own perspective, concepts of the SDT are related to older adults' physical activity and its improvement. Specifically, we formulated the following two research questions: What role does selfdetermination play when older adults talk about their physical activity? What do older adults think they need to be more physically active?

#### Method

We conducted a 2-wave qualitative study, which was nested within an intervention study that aimed at promoting community-dwelling older adults' physical activity using implementation intentions and autonomy-supportive reviews of their goals and implementation intentions. Note that the present paper will focus solely on the interviews. The study was preregistered on the Open Science Framework (<u>https://osf.io/zhnsk</u>). The Ethics Committee of the University Bern (Nr. 2022-06-00005) approved this study. We adhered to the COREQ guidelines for qualitative research.

We used Interpretative Phenomenological Analysis (IPA; Osborne & Smith, 2008) as our framework for this research. The IPA aims to deeply explore how participants understand and make sense of their personal and social worlds, focusing on the meanings that specific experiences, events, or states hold for them. This approach is phenomenological because it thoroughly examines an individual's lived experience and is centred on their personal perception or account, rather than seeking an objective description of the event or object itself (Osborne & Smith, 2008). So, this approach seems especially suited to describe the role of self-determination related to physical activity from older adults' perspectives.

#### **Population and participants**

We aimed for a sample of older adults aged 65 years or older, because this is often considered the standard age for retirement (World Health Organization [WHO], 2015), including in BLINDED FOR REVIEW, where this study was conducted. As this qualitative research was part of an intervention study, the inclusion criteria were that participants were motivated to enhance their current physical activity during the study. Participants were excluded if they had any contraindications that would prevent them from being physically active. Regarding the sample size, according to the interpretative phenomenological approach (Smith & Osborne 2008), a sample must not be too big. The goal is to allow for a detailed understanding of each single case as well as examining similarities and differences between cases. Good results can already be achieved with samples as small as 6-8 participants (Turpin et al., 1997) and sample over fifteen participants are uncommon (Pietkiewicz & Smith, 2014). For the intervention study, we recruited a total of 28 older adults. Two participants stopped their participation during the baseline phase of the intervention study and could not be included since we had no post interview available. Further, 11 participants were interviewed using an initial version of the interview guideline, which did not yield sufficient information to

effectively address the research questions. Also, we had to exclude one transcript (P14), since the quality of the statements were subpar and consequentially the first author was not able to code it meaningfully. Therefore, we ended up analyzing 14 participants in total.

# Procedure

Participants were recruited via flyers, emails, and personal contacts. After recruitment, every participant could choose their preferred location for the testing (e.g. university lab or at home). For the interviews, we utilised a semi-structured interview format (e.g. Kvale, 2007), divided into a pre-intervention and a post-intervention interview after five weeks of the intervention, to explore participants' narratives and experiences related to physical activity. The complete interview guide can be consulted on the OSF (https://osf.io/zhnsk). We opted for two interviews to capture possible changes in participants' narratives after the intervention period. Each interview was between 30 minutes and 1 hour long, depending on the answers of the participants.

After participants completed the written informed consent, the pre-intervention interviews began with an introduction where a trained research assistant explained the purpose of the study, emphasizing that there were no right or wrong answers, and informed participants about the confidentiality of their responses. Then, the interview started with an open question: "Can you please tell me how you became involved in your current physical activity? Please describe everything from the beginning up until now. " At this stage, the interviewer was advised not to interrupt the participants or ask additional questions. This format of questioning was designed to encourage participants to describe their experiences unprompted using a narrative approach (Daiute, 2013). Afterwards, probing questions followed to delve deeper into specific motivations and clarifying unclear statements.

The post-test interview also started with an open question where participants were asked to reflect on their experiences during the intervention, "You aimed to increase your physical activity. Tell me how it has gone for you during the study, from the beginning until now". Afterwards, participants were interviewed in more detail, particularly regarding their engagement with the activities and any changes in motivation or behavior during the intervention phase. In this section, also research questions that extend beyond the focus of this paper were addressed.

#### **Data Analysis**

First, the transcripts collected were all transcribed verbatim by research assistants. The data was then analysed by the first author, a female doctoral student with experience conducting qualitative research with older adults and physical activity, using interpretative phenomenological analysis (IPA; Smith & Osborne, 2008). Important to note is that the analysis method differed from the one we preregistered (thematic analysis). We made this choice, because IPA would allow us to focus more on the individual experiences of each participant, which we ultimately deemed a better fit for our research questions than thematic analysis (https://osf.io/zhnsk).

We used the recommended steps by Smith and Osbourne (2008): First, each transcript was thoroughly read by the first author multiple times and first thoughts and ideas were annotated on the left margin. Second, the same transcript was re-read, and initial codes were annotated.

The initial codes were grouped into broader themes that reflected common perspectives in participants' narratives. To better structure the findings, Self-Determination Theory (SDT) was used as a framework, organizing the themes around key concepts like motivational styles and basic psychological needs. These themes and accompanying quotes were then compiled into a table for each participant and reviewed with the second author. After re-reading the transcript, and with input from the second author, the themes were refined to more accurately capture the participants' experiences. Further, we checked to what extent the themes fit to the SDT concepts. Throughout this process, the authors carefully monitored for potential biases and assumptions to ensure that the findings accurately reflected the participants' views, not their own.

Importantly, in line with IPA, we chose to analyze every participant separately (considering the pre- and post-intervention transcripts at the same time), allowing idiosyncrasy before compiling the final table of superordinate themes (i.e. a master table). After compiling the master table (see OSF), we recognized that the response to the first research question was not sufficiently addressed. To address this, the first author organized themes into a mind map to get a better understanding of how self-determination played a role in older adults' physical activity.

Note that in the results section, the participants are distinguishable with abbreviations (e.g. P8 means participant number eight). The themes are highlighted in bold, to be distinguish them from the quotes of the participants.

#### Results

The analyzed sample consisted of 14 older adults over 65 years of age (M=71.6 years; SD= 4.1). Most were married (n=8), some were working even after retirement (n=3) and most were male (n=8). The average body mass index was 26.6kg/m<sup>2</sup> (SD=3.1, range: 21.5-32.0). The mean self-reported baseline physical activity in minutes was 173.6 per week (SD=119.7), but there was a broad range of weekly activity of 0-450 minutes. More information for every participant can be seen in Table 1.

# Table 1

# Participant Characteristics and Sociodemographics

Partici-	Age	Gen-	Marital	Living	Highest edu-	Working	Socio-economic Sta-	Self-re-	BMI	Self-reported Baseline
pant num-		der	status		cation	status	tus	ported		Physical Activity per
ber								health		Week
8	70	male	married	living with a partner	apprenticeship	Working	Enough money to sus-	Very good	30.48	100 minutes
				in an apartment or		40%	tain their needs			
				house						
9	79	fe-	widowed	living alone in an	senior second-	retired	Enough money to sus-	Very good	28.20	240 minutes
		male		apartment or house	ary education		tain their needs			
10	77	fe-	single,	living alone in an	university	retired	Not enough money to	Good	22,45	80 minutes
		male	never mar-	apartment or house			sustain their needs			
			ried							
11	72	male	Single,	living with family in	senior second-	retired	Enough money to sus-	moderate	24.80	0 minutes
			never mar-	an apartment or	ary education		tain their needs			
			ried	house						
12	65	male	married	living with a partner	higher tech-	Working	Enough money to sus-	Very good	21.46	275 minutes
				in an apartment or	nical school	40%	tain their needs			
				house						
13	71	male	divorced	living alone in an	university	retired	Enough money to sus-	Good	23.60	100 minutes
				apartment or house			tain their needs			
15	69	fe-	married	living with a partner	apprenticeship	retired	Enough money to sus-	Good	29.04	450 minutes
		male		in an apartment or			tain their needs			
				house						

16	67	male	married	living with family in	university	retired	More than enough	Good	28.40	70 minutes
				an apartment or			money to sustain their			
				house			needs			
17	67	male	married	living with a partner	higher tech-	retired	Enough money to sus-	moderate	29.07	120 minutes
				in an apartment or	nical school		tain their needs			
				house						
18	71	fe-	married	living with a partner	university	retired	More than enough	Very good	23.88	300 minutes
		male		in an apartment or			money to sustain their			
				house			needs			
20	76	fe-	divorced	living in a retirement	apprenticeship	retired	Enough money to sus-	Very good	28.63	180 minutes
		male		residence			tain their needs			
21	77	male	married	living with a partner	apprenticeship	Working	Enough money to sus-	Good	32.00	180 minutes
				in an apartment or		30%	tain their needs			
				house						
22	71	fe-	married	living with a partner	primary	retired	Enough money to sus-	Very good	25.77	45 minutes
		male		in an apartment or	school		tain their needs			
				house						
23	70	male	married	living with a partner	apprenticeship	retired	Enough money to sus-	good	24.76	290 minutes
				in an apartment or			tain their needs			
				house						

Note. The table displays participant characteristics including age, gender, marital status, living situation, highest education level, working status, socio-economic status assessed via questionnaire before the intervention phase. self-reported health was measured using one item ""How would you describe your current overall health status?" and five options for answering ranging from 1 very poor to 5 very good. The Body Mass Index (BMI)

was calculated by dividing a person's weight in kilograms by the square of their height in meters. self-reported baseline physical activity per week was measured using the International Physical Activity Questionnaire (IPAQ; Craig et al., 2003).

## Self-determination in older adults' narratives about their physical activity

Unprompted, participants mentioned concepts related to self-determination when discussing their physical activity in their narratives. Many participants viewed being active as a necessity for living, a basic need, or a means to recharge. They mentioned physical activity's role in promoting general well-being, mental health, and healthy aging, though some felt pressured to keep up with peers or societal expectations. Motivations varied between participants, but most participants mentioned both the role of autonomous and controlled motivations in maintaining physical activity in older age. But active participants tended to more diverse motivations, encompassing both autonomous and controlled factors, compared to those who were less active.

In light of the second research question, motivation was directly mentioned as prerequisite for being more active together with themes more related to situational factors.

Participants stated that they found being active a **necessity to live**, and a **basic need**, or even a means to recharge. For example, P8 stated that "Exercise is simply vital for me and I realize that again and again", and P13 stated that "It's a need, it really is a basic need.". The main reasons to be active stated across participants was that physical activity was part of their general well-being. Notably, participants often mentioned their mental health and mind, that it contributed to healthy aging, and that they wanted to stay a part of society. Both themes contributed to **healthy aging.** However, the relationship they reported with this theme were ambiguous, because some participants stated that they felt pressured to be physically active as they didn't want to be left behind. As P21 stated: "So ves certainly, I'm actually moving well, right? But it has also shown me that it's just very important to simply do something as you get older. Even if you don't feel like it sometimes". This is also seen in the theme of having to keep up with others and comparing someone's own fitness to peers. P16 said, for example: "For example, when I meet up with my colleagues on Friday, I want to be there and show the same physical skills that they have". Therefore, it was also mentioned that physical activity can sometimes be viewed as something effortful and unenjoyable or something that is simply done because it was recommended by others. Other more pragmatic reasons for physical activity included losing weight or fall prevention. P18 stated, for example: "I also know that this fall in old age is often the beginning of the end. That's the main thing [to be active]".

Two themes were elaborated that indicated affective changes. First, the **enjoyment for being active faded** over the life course for some participants. For example, P16 stated that

they liked being active more when they were younger: "Well, the joy is no longer so present. [But] I can still feel it". On the other side it was also mentioned that the **enjoyment emerges when being active**: "It is joy. It is joy. It's also not a must. Sure, maybe the first few steps. Just overcoming your voice of laziness at the moment. After that, it's pure joy". As a protective factor, automatic regulation as seen in habit was also identified, like stated by P21: "Yes, it's practically (the routine) the same. The daily routine is also a bit of a given. Even with the exercise in the barn and cycling".

In light of the second research question where participants where asked about their needs to be more physically active, a theme directly linked to motivation was found. As two participants mentioned that **finding their motivation** was also necessary for their physical activity. P13, for example, said that they don't need much but a bit of motivation: *"It doesn't take much. But it does take a certain, how should I put it, it is ultimately relatively dependent on motivation. The question is always where you get the motivation from"*. On the other hand, two themes not related to motivation but rather to situational circumstances emerged. As another comprehensive theme across participants, some acknowledged the importance of certain **physical prerequisites**. For example, P10 summarized it by saying: "*Of course, it's a prerequisite that your body and joints work in old age, otherwise you can't do anything.*" Last, it was also mentioned by P10 that their activities simply have to be affordable.

#### Satisfaction of basic psychological needs

As further references to self-determination, older adults reported needs related to autonomy, competence, and relatedness as being key for their activity. Autonomy providing a sense of control, competence offering empowerment, and relatedness fostering social connections. The results are summarized in Table 2.

In terms of the second research question, older adults expressed the importance of the need for autonomy when choosing their physical activity, depicted by the following themes: choosing what is best for themselves, knowing their own limits, starting gradually, needing a certain setting, having particular physical activities they prefer, and ensuring physical activity is integrated into their daily life.

#### *Need for autonomy*

For some of the participants, motives related to the need for autonomy was the most important driver of their physical activity. For example, P16 stated having the **possibility to be active when wanted** as essential, as it allowed them to maintain a sense of independence and control over their live: "It's like everywhere else. You have to have control over your own *life. That also applies to personal fitness.*" Additionally, P12 highlighted the importance of autonomy by stating that they liked to be active without necessarily seeking affiliation through sport or group activities.

Moreover, when asked about what participants personally thought they needed in order to be more active, some themes related to the need for autonomy were found. For example, P10 said that the intervention spoke to them since they could have chosen themselves what is best for them: "So this intervention appealed to me because it means that you should become active yourself, and I think it's great that someone doesn't tell me: Now you do this and that and that's good but that you find out for yourself and that I can choose for myself what I think is good for me". This was also seen in the theme that participants, like P12 and P13, best know their own limits in regards of their physical activity. To summarize P12 stated: "What's really important to me is that I can move without feeling like I have to perform at my best." Testing and staying inside their own limits could also be related to P13 statement that they would start being active gradually.. Also, P9 and P10 specify their need even further by saving that they **need a fitting setting** and that certain settings are not suitable for them (i.e. gymnastics, fitness center, or team sports). P9 stated, for example: "I would never go to a gym, for example, because it would be more of a must for me." On the other hand, P10 mentioned that she felt most embraced and inspired by the specific setting in her Eurythmics class. Moreover, P21 and P22, stated that they have particular physical activities they prefer and maintain to this day. P21 said walking and also P22 narrowed it down, by stating: "I guess walking or cycling. Other activities such as football or field hockey are no longer for me." They were the only two to mention it specifically, but it was also visible in the implementation intentions that participants formed during the intervention study, where walking was the most popular choice. Further, consensus was found that **physical activity** has to be integrated into daily life. This is further highlighted by a theme from P8 who said that that he maintains certain activities simply because they are the most easily implemented. For example, P10 stated: "For example, I tell myself I can walk up and down the stairs: I am happy that I can walk again, I take the stairs instead of the elevator".

On the other hand, some themes also related to extrinsic motivation. For example, P16 statement indicated that autonomy can be viewed as **a double-edged sword**, as too much independence without support or guidance may lead to disengagement or a lack of motivation to participate in physical activities: *"You no longer have any external constraints. That gives you freedom, but it also has disadvantages in the sense that you have to take your own* 

*responsibility*". P10 stated, for example, that a **certain pressure** can also help to be stay active, similarly P9 also stated that **being monitored** could also help with their physical activity. Also, participant P13 stated that **incentives** could help them attaining their goals.

#### Need for competence

For P8 on the other hand, competence played a pivotal role in their approach to physical activity, serving as a means to **counteract feelings of incompetence** that they experienced during their school years: «As I said, I was always the worst at sport at school and I didn't like going to school because of that. I always thought on Monday "No, we have gymnastics again on Wednesday". And then I started and completed my first sports instructor leadership training at the age of 28.». Moreover, they found empowerment in supporting and encouraging others in their own physical activity journeys, further reinforcing their sense of competence: «Exactly, I've always been in the gym since I was 17, always as a leader for gymnastics, athletics, but also for various games with young people. And I only did this because I used to be the worst at gymnastics at school. That's why my motivation was to make sure my children got enough exercise and that somehow staved with me.». Overall, competence served as a powerful driver for this participant, enabling them to navigate their physical activity choices with confidence and purpose, while also positively impacting the experiences of those around them. By engaging in physical activity where they could set and complete their own challenges, this participant gained a sense of accomplishment. They stated, for example: "Joy. Above all, simply joy. And not just at the moment when I'm doing it, but simply when you've achieved something and that wonderful feeling of being tired". This theme was also seen in P13, even though that participant's main need was relatedness.

#### *Need for relatedness*

Participants reported the role of relatedness as significant in how they approached their physical activity, encompassing various social and environmental factors that they perceived to contribute to their overall engagement and motivation. P8 for example found fulfillment and enjoyment in **being active within a team or club setting,** where they could connect with others who shared similar interests and goals. **Social exchanges with spouses or partners** also played a crucial role, providing opportunities for companionship, support, and shared experiences during physical activity, like mentioned by P9 P20. P20 said, for example: *"Then I met my second husband and we found that walking alone was boring. We set ourselves a goal"*. P20 also mentioned that the **loss of connection can lead to inactivity**: *"Then came*"

another time, I got divorced and moved far away with the children and then looked for new connections. I didn't do so well. Then I did little or nothing for a relatively long time". Finally, engaging in physical activity as a family, could also foster meaningful connections and create lasting memories, highlighting the importance of social connectedness.

Additionally, a recurring theme among participants was that **feeling connected to others** significantly boosted their motivation to stay active. For example, P10 stated: "Yes, because that also helps me to stay in touch with other people, so that I don't just stay in touch by phone". Furthermore, group activities often entailed a certain level of **commitment and accountability**, motivating individuals to stay consistent and accountable for their physical activity routines, like stated by P13: "I simply have the feeling that the motivation is much better in an association, in a team, than if you always have to plan individually". And P13 additionally mentioned that having a **high need for fairness** influenced their participation in physical activity, seeking equitable opportunities and treatment within group settings.

Conversely, when these needs were not met, it led to a sense of alienation and a decline in their involvement, ultimately resulting in disengagement: *It's quite funny with football. I got into more and more trouble with these older men, who didn't follow me and resorted to means that were alien to me like deliberately hurting someone. In retrospect, that put me off and I withdrew because fairness has always been very important to me.* "Finally, some participants mentioned that **pets serve as companions** for physical activity, particularly dogs. Also, in terms of the needs expressed for being more physically active, P8 specifically mentioned that they needed **contact to other persons** in order to being physically active.

# Table 2

<b>Basic psychological need</b>	Name of theme	Participants	
Autonomy	Having the possibility to be active when wanted	P22	
	Preference to do sports alone	P12	
	Autonomy as double-edged sword	P16	
	Wanting control over one's life	P16	
Competence	Counteracting feeling of incompetence during	P8	
	school		
	Completing own challenges gives a sense of accom-	P8, P13 & P12	
	plishment		
	Empowering others for their PA journey	P8	

Compiled themes for psychological needs that participants mentioned as motives for their past or present physical activity

Relatedness	Being active in a team/club setting	P8	
	Social exchange with spouse	P9&P20	
	Being connected with others	P9, P10, P11	
		& P13	
	Being connected with nature	P9, P15 & P17	
	Having a high need for fairness	P13	
	Groups allude a certain amount of commitment/ac-	P10 &P13	
	countability		
	Finding motivation with others	P13	
	pets serve as companions	P15, P17, P18,	
		P20, P22	
	Being active as family time	P15 &P20	
	Loss of connection leads to inactivity	P20	

Note. This table compiles all themes for research question 2, sorted by participants (P) and the three psychological needs postulated by Deci & Ryan (1985). PA = physical activity.

## Discussion

The goals of this paper were to investigate the role of self-determination for older adults' physical activity and to better understand their needs to be more physically active. Using an interpretative-phenomenological approach, we found that older adults viewed physical activity as crucial for their well-being, mental health, and healthy aging, often describing it as a basic need or a way to recharge. In turn, some felt pressured by societal expectations. Even if some reported that physical activity was effortful, participants also reported finding joy in it. Also, the importance of routines was mentioned. Further, we found that key psychological needs seem to drive older adults' engagement in physical activity, with relatedness being the most mentioned need overall. The results demonstrated high interindividual variability in motives, where more active participants tended to express more varied motivations to be active compared to less active participants. In regards to physical activity facilitators, participants explained that physical activity had to support their feeling of autonomy with fitting settings, allowing them to choose what was best for them and staying within their own set limits, had to be integrated into their daily lives, preferring convenient activities like walking that align with their personal preferences, physical abilities, gradual engagement, and allowing them to find their personal motivation. Also, participants mentioned that being monitored, incentives or activities being affordable could influence their physical activity.

# Role of Self-Determination for older adult's physical activity journey

This study provided first qualitative evidence that self-determination plays an important role in older adults' physical activity from their own perspective. This supports and extends previous findings from quantitative studies (Kirkland et al., 2011; Teixeira et al., 2012). Our results demonstrate that the needs expressed by older adults for being active are closely aligned with the self-determination theory concepts (Deci & Ryan, 1985), highlighting how their perceptions of self-determination significantly influence their motivation to remain active. The themes can be grouped along the assumed continuum of controlled to autonomous motivation (see Figure 1).

# Figure 1



Overview of Themes of Motivation for Older Adults' Physical Activity.

*Note.* The color gradient depicts the shift from more controlled to more autonomous motivation themes. The arrows symbolize how the motivation for these themes changed over time (e.g. more controlled or more autonomous). The rounded boxes depict the different motivational styles defined by Self-Determination Theory (SDT; Deci & Ryan, 1985) that were used
as a framework to arrange the themes. The grey box depicts a theme that is not part of the different motivations defined by SDT but was also found in several transcripts. PA = physical activity.

# Controlled motivation in older adult's physical activity journey

Greater controlled motivation was evident in themes where individuals reported being active to compete with others or because it was recommended to them, which made the activity feel more effortful or unenjoyable. This aligns with the theme that enjoyment of physical activity often declines with age, as younger adults typically report higher levels of intrinsic motivation for being active (Brunet & Sabiston, 2011). For older adults, physical activity seems to become more focused on practical needs, such as weight control, such as explicitly mentioned from P8 and P20, who both had a higher than recommended Body Mass Index for their age (Winter et al., 2014), or for fall prevention. This shift is in line with a study by Sialino et al. (2023), who found that older women's motivations for maintaining a healthy lifestyle are more utilitarian. Similarly, it has been found that more controlled forms of motivation can drive physical activity (Edmunds et al., 2008). This trend appears to be even stronger in older adults (Ferrand et al., 2012). It is also supported by the Selective Optimization with Compensation Theory (Baltes & Baltes, 1990) positing that older adults focus more on key goals and compensating for losses in order to adapt to changes accompanied by aging. Our results also corroborate earlier findings that controlled motivation can be accompanied by adverse psychological effects like anxiety and dissatisfaction (Ng et al., 2012). This tension between intrinsic enjoyment and external pressure is consistent with self-determination theory (Deci & Ryan, 2000) which posits that while intrinsic motivation leads to more sustained and satisfying engagement in activities, extrinsic pressures can undermine this engagement if they conflict with an individual's sense of autonomy.

# Autonomous motivations in older adult's physical activity journey

In terms of autonomous motivation, older adults in our study mentioned autonomously regulated motives slightly more often than controlled motives. They saw physical activity as a necessity to live and a means to recharge, identifying it as an important contributor to their general well-being. This is important because intrinsically motivated older adults are more likely to adhere to long-term physical activity (Teixeira et al., 2012), without possible adverse effects from more controlled motivation. The importance of autonomous motivations was seen in every participant in this sample regardless if they were sufficiently active or not. This

also is consistent with the socioemotional selectivity theory (Carstensen, 1991), which suggests that with age, individuals shift toward pursuing more fulfilling and emotionally rewarding experiences, meaning that physical activity somehow has to stay autonomously motivated to be maintained in older age. Moreover, the most active participant (P15) clearly stated that they were mainly active out of enjoyment again highlighting the importance of autonomous motivation for staying very active in older age.

Interestingly, we also found that in some moderately active to active participants (P13 and P21), they mentioned that their physical activity routines were a protective factor as they are even active in times when they experience lower motivation. This is in line with previous research showing that habit formation may sustain health-promoting behaviors over time, even when people lose motivation (Rothman, Sheeran, & Wood, 2009). This was also seen when older adults talked about their needs for being active as themes like having a preferred activity and wanting physical activity to be integrated in their daily lives emphasized the importance of routines and continuity. This preference for convenience and routine is well-documented in the literature, with walking often cited as the most accessible and sustainable form of exercise for older adults (Paterson & Warburton, 2010).

# The interplay of controlled and autonomous motivations in older adults

Only participants with lower physical activity levels, such as P12 (0 minutes) and P22 (45 minutes), exclusively mentioned autonomous motivation to be active and lacked the richness of themes presented in more active participants. For instance, P12 emphasized physical activity as basic need and its necessity to live but lacked the breadth of motivations seen in more active participants. This again indicates that while autonomous motivations are vital, more controlled motivators such as health goals and societal expectations also play a significant role in shaping physical activity engagement among older adults. Active older adults in this sample are aware that physical activity can be effortful or unenjoyable (e.g. P23 who is 260 minutes active per week) or serve an extrinsic purpose like fall prevention or weight reduction (e.g. P18 who is 300 minutes active per week). Overall, those who were sufficiently active demonstrated a more comprehensive understanding of the benefits of PA, encompassing both autonomous and controlled motivation, whereas those who were least active primarily recognized the necessity of physical activity but lacked the same level of understanding that physical activity can be effortful to maintain sometimes and level of detail in their narratives.

# Prevalent psychological needs in older adult's physical activity journey

Age-related changes were evident in the psychological needs of older adults. In this sample, the need for relatedness emerged as the most prominent, indicating that basic psychological needs for physical activity may shift over time—becoming more about social connection rather than personal aspirations. Interestingly, competence was not perceived as a key need; participants felt no need to prove themselves, knowing their limits, which contrasts with younger populations where competence is often most important (Standage et al., 2003). As participants emphasized the necessity of social interaction, particularly those living alone or in retirement homes, P13 and P20, as vital for maintaining their activity levels. This finding aligns with previous research highlighting the importance of social support in sustaining physical activity among older adults (Smith et al., 2017). And shows how the social aspect of exercise is crucial for enhancing the well-being of older adults, as physical activity fosters social bonds (McAuley et al., 2011).

Participants desired the freedom to choose their preferred activities but also acknowledged the need for external pressure and monitoring to motivate them. This duality was aptly captured by P16, who noted that autonomy in older age can be a double-edged sword. Without clear guidance, excessive autonomy may lead to disorganization as addressed by the circumplex approach (Aelterman et al., 2019). This can be especially the case in older age, as many do not have any obligations after retirement (Holcomb, 2010). Some participants sought more structure and guidance in their physical activity journey, aligning with research indicating that self-monitoring and directive techniques could enhance engagement (French et al., 2021). Although more controlling and less autonomy-supportive these strategies suggest that extrinsic motivation can benefit some older adults, contrary to self-determination theory (Promberger & Marteau, 2013). For instance, older adults in structured group exercise programs had higher activity levels and better adherence than those in less structured ones (Van Roie et al., 2010).

Conversely, another study reported opposite findings (Opdenacker et al., 2008), contributing to the ongoing research on implementation intentions and the paradoxical results seen in various studies (French et al., 2014, 2021). While some research indicates that older adults prefer flexible plans that allow adjustments based on their feelings (Bösch et al. 2023; Fleig et al., 2017; Warner et al., 2021) other studies show that they benefit from structured planning interventions (Bélanger-Gravel, Godin, Bilodeau, et al., 2013; Hall et al., 2014; Ziegelmann et al., 2006). Our study builds on this knowledge, revealing that many older adults' physical activity needs are closely tied to their sense of autonomy. Interestingly, even less active participants expressed a desire for autonomy, though they lacked the specificity of their more active peers. In contrast, active participants articulated clearer needs related to autonomy, such as choosing preferred activities, knowing their physical limits, and having specific activity preferences.

Lastly, P20 noted that the joy of being active increases once they begin exercising, reinforcing the idea that gradually increasing activity can enhance adherence (Collado-Mateo et al., 2021). Understanding these individual differences is crucial for designing effective interventions, as varying psychological needs are evident among older adults. A pattern consistent with research that highlights diverse motivational factors among older women (Stephan et al., 2010)Future interventions should carefully examine the balance of autonomy support and directive strategies to meet the diverse needs of older populations.

# Limitations, strengths and perspectives

The study's qualitative approach effectively captured the nuanced experiences of older adults, providing rich insights into their motivations and psychological needs related to physical activity. This method revealed a deeper understanding of how self-determination influences physical activity, offering a more comprehensive perspective than quantitative methods alone. To the best of our knowledge, this is a novel contribution to previous research on older adults' physical activity. Also, our sample ranged from inactive to very active older adults, depicting a wide range of older adults.

Naturally, there are also some limitations. In terms of the sample, most participants were in good health, so this sample only depicts older adults with comparatively few health-related barriers to being active. This could have influenced the identified themes, because studies have shown that individuals who perceive high barriers (e.g., feeling too tired, having no time, or fearing injury) are more likely to experience lower levels of intrinsic motivation (Biddle & Mutrie, 2007).

Future research should, therefore focus on less healthy individuals or individuals who experience more barriers for being physically active. Also, this study highlighted the need for refining interventions for older adults by tailoring them to individual differences in motivations and particularly balancing flexibility with the right level of directiveness and support. Investigating how varying levels of autonomy-support impact engagement and outcomes will help create more effective interventions targeting older adults.

# Conclusions

The study underscores the vital role of self-determination in shaping older adults' physical activity, highlighting the diverse motivations (both autonomous and controlled) that influence their engagement. By linking physical activity motivations to personal histories and preferences, the findings point to the need for personalized, flexible interventions to support sustainable activity. It shows also that the self-determination theory could be a valuable framework to understand what influences older adult's health behavior and their motivation to be active that got not enough attention in recent years. Ultimately, this study contributes to enhancing physical activity among older adults, laying the groundwork for healthy aging.

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#### 1. Summary

All three studies investigated what determinants influences older adults' physical activity from various viewpoints gathered from three studies. Overall, the three studies are interlinked through their shared focus on understanding physical activity among older adults using various psychological theories and behavior change techniques. They complement each other by addressing different aspects of goal setting, motivation, barriers, and facilitators, providing a comprehensive understanding of the determinants influencing older adults' physical activity.

Study 1 explored the influence of a distinct situational determinant—namely the COVID-19 pandemic—on older adults' physical activity using a longitudinal panel design and the HAPA model as a theoretical framework. The findings revealed that physical activity levels either remained stable or improved as lockdown restrictions were eased. Partly consistent with our predictions and the HAPA model, self-efficacy and health status were strong predictors of the intention to engage in physical activity, with older adults demonstrating a stronger intent to stay active as restrictions relaxed. However, contrary to our expectations, the volitional factors from the HAPA model did not predict physical activity levels post-lock-down. Instead, only previous physical activity was a predictor of future activity. Additionally, our results suggested that fear of Covid-19 did not affect the intention-behavior relationship. Exploratory analysis indicated that while fear of Covid-19 might moderate the link between past and future behavior, this finding was not robust, as it did not persist when outliers were excluded.

Study 2 examined how specific interventions using implementation intentions were perceived by older adults when planning their physical activity and what barriers and facilitators were for formulating implementation intention by using a qualitative approach. Before forming implementation intentions, participants expressed two main beliefs: they felt that planning was unnecessary and that it seemed too restrictive. Those two pre-existing negative attitudes may explain why implementation intentions might not effectively boost physical activity among older adults in many studies and why some showed a general reluctance to engage in the planning process. During the task, they encountered various barriers and facilitators; for example, some participants lacked a regular daily routine or only preferred to be active at specific times. On the other hand, they found the task helpful as a reminder and a motivator to resume previous activities. It also prompted self-reflection about their current physical activity. After the task, participants observed that implementation intentions were not

110

always relevant, and some even used the barriers identified during the task as a basis for coping planning.

Study 3 inspected the role of motivation when older adults talked about their physical activity and their needs for being more active by using a qualitative approach. We found that older adults who met physical activity guidelines viewed it as essential for their well-being, mental health, and healthy aging, often describing it as a basic need or a way to recharge. Some, however, felt they were pressured by societal expectations. While some acknowledged that physical activity could be challenging, many still found joy in it and emphasized the importance of routines. Key psychological needs, particularly relatedness, appeared to drive their engagement, though motives varied between individuals. Participants emphasized the need for physical activity to fit into their daily lives, preferring convenient activities like walking that matched their preferences and abilities. They also highlighted the importance of autonomy, gradual involvement, and personal motivation, as well as the role of monitoring, incentives, and affordability in supporting their activity levels.

The following sections discuss various determinants influencing physical activity in older adults found in the three presented studies. It examines how the COVID-19 pandemic as life event can act as stressor to physical activity and impact activity levels, and explores the role of attitudes, beliefs, and motivation in staying active. It concludes with recommendations for promoting and sustaining physical activity, emphasizing the importance of guiding older adults through changes, understanding their thought processes, and fostering their sense of autonomy.

# Table 1

Summary of the key findings of each presented study

Study	Hypothesis/ Research Questions	Results
Study 1 – SERENA	The higher risk perception, positive outcome expectancies, and self-effi- cacy are, the higher is the intention to be physically active after lock- down.	Only self-efficacy health status robustly predicted the intention to engage in physical activity.
	The higher the intention and action control and the more detailed an older adult's action and coping plans are, the more physically ac- tive they will be after lockdown.	No effect of any volitional determinant
	Fear of Covid-19 moderates the re- lationship between intention and physical activity after lockdown by inhibiting the translation of inten- tions into action in fearful individu- als.	No robust finding that the fear of Covid-19 moderates the in- tention-behavior gap.
Study 2- Think Aloud	What do older adults think about when they create implementation in- tentions for physical activity? What barriers and facilitators do older adults experience when formulating implementation intentions?	Before the task of forming the implementation intentions, two kinds of beliefs about implementation intentions were re- ported. Firstly, a lack of necessity to plan, secondly that the planning feels too restrictive. Then, during the task, several barriers and facilitators were mentioned, e.g., that participants had no recurring daily rou- tine, only wanted to be physically active at certain times, but also that the task was a useful reminder and encouraged resum- ing previous activities, and that thinking about physical activ- ity and the planning of it triggered self-reflection about their own current physical activity.
		Lastly, after the task, participants noted that the implementa- tion intentions were not always applicable and, in some partici- pants, the barriers elaborated in the task even triggered coping planning.

Study 3 –	What role does self-determination	Older adults viewed physical activity as crucial for their well-
SelfACT	play when older adults talk about	being, mental health, and healthy aging, often describing it as a
	their physical activity?	basic need or a way to rejuvenate themes related to autono-
		mous motivation.
		Regarding controlled motivation, some felt pressured by socie-
		tal expectations. Even if some reported that physical activity
		was challenging, participants also reported finding joy in it.
		Furthermore, the importance of routines was mentioned.
		In this sample, the need for relatedness emerged as the most prominent aspect.
	Why do older adults think they need	Participants desired the freedom to choose their preferred ac-
	to be more physically active?	tivities but also acknowledged the need for external pressure
		and monitoring to motivate themselves.
		The enjoyment of being active increases once they begin exer-
		cising, reinforcing the idea that gradually increasing activity
		can enhance adherence.

# 2. The Impact of Situational Factors on Physical Activity in Older Adults: The Example of the COVID-19 Pandemic

The results of this dissertation show that specific events like the Covid-19 pandemic and subsequent lockdowns can impact older adults' physical activity.

# 2.1 COVID-19 as a Life Event: Stressors to Physical Activity in Older Adults

A first example of a stressor to behavior maintenance in this case, is described in Study 1, where it was revealed that the Covid pandemic could have had an impact on physical activity in older adults, especially if they are fearful. Moreover, it revealed potential protective factors of older adults for maintaining physical activity even during stressful life events, like their health status and self-efficacy. It also provided a unique opportunity to explore if and how stressful events impact physical activity among older adults.

Such life events are significant occurrences or transitions that can impact an individual's life, behavior, emotions, and overall well-being (Pearlin & Skaff, 1996). These events often bring about changes that require adaptation or adjustment, and they can be positive, negative, expected, or unexpected. Due to their advanced age, older adults are more prone to encounter numerous significant potentially adverse life events (e.g. retirement, loss of a partner, changes in health) which can potentially also alter their health behaviors (Stahl & Schulz, 2014). These findings correspond with life event research that shows that physical activity can be highly impacted by certain life events (Allender et al., 2008). However, unlike individual life events, such as the loss of a partner, the pandemic affected a broader population, as seen by the general psychological impact of it (Brooks et al., 2020; Xiong et al., 2020), offering insights into how older adults navigate barriers to staying active during challenging times in a larger sample.

The findings of Study 1 are also supported by the results of Study 3, where older adults discussed how their physical activity is linked to their partner and how the loss of connection led to their inactivity. The loss of a partner, hence, is a more widely researched phenomenon in studies focusing on life events in older age. Evidence, however, also suggests that the type of life event, and perhaps the perception of it, has an impact on whether the individual increases or decreases their activity afterwards. For example, one longitudinal study found that entering into retirement was associated with decreased physical activity, while a parent or friend dying were associated with greater physical activity (Richards et al., 2019).

Other the other hand, observed from the point of view of the SDT, a theory on which Study 3 is based, the Covid-19 pandemic can also be seen as an autonomy-restrictive event, especially for older adults. This was also seen in Study 2, where older adults reported Covid-19 specific barriers that impeded their desired physical activity.

The influence of the Covid-19 pandemic on health behaviors is also in line with the notion of situational barriers in the HAPA model. According to the HAPA (Schwarzer, 2014) situational barriers, in this case, the Covid-19 pandemic also ought to be considered when investigating the adoption, or in this case, the maintenance of a behavior. According to Schwarzer (2014), if situational cues are overwhelming, meta-cognitive skills fail to protect the individual and the temptation cannot be resisted. Actions are not only a function of intentions and cognitive control but are also influenced by the perceived and the actual environment. However, these are often overlooked in other studies using the HAPA. However, it is also known that stressors can impact physical activity in the general population (Stults-Kolehmainen & Sinha, 2014). Data from a systematic review revealed that physical activity decreased due to the pandemic and subsequent lockdowns (Stockwell et al., 2021). This effect was also noticeably found in older adults (Lefferts et al., 2022). Our data, however, suggests that physical activity stayed constant or even improved during the three time periods for the general sample, and only in fearful individuals might it decline. Indeed, some evidence suggests that physical activity can even improve in stressful situations in individuals but only if individuals are in the maintenance stage. In any other stage, stress is associated with a decrease in physical activity (Lutz et al., 2010). Some evidence also suggests such life events also can foster positive change, as they found that engaging in new kinds of physical activity behaviors during lockdown and exhibiting autonomous motivation counteracted disruption of physical activity (Maltagliati et al., 2021).

In conclusion, our findings emphasize the significance of life events and their varying impacts. We observed that life events can bring about both positive and negative changes, depending on situational factors. For instance, in our sample, the COVID-19 pandemic was generally well-handled by older adults. There were no notable negative effects on their physical activity and also no robust impact of their fear of Covid-19 on their activity levels. In fact, there was even a slight improvement following the easing of lockdown restrictions. However, the type and nature of the life event play a crucial role, as demonstrated in Study 3, where the loss of a partner (e.g. P20) led to negative outcomes. This highlights the importance of how individuals appraise and adapt to such events. Our findings across studies 1 and 3 suggest that different life events yield different outcomes, underscoring the need to consider their

situational and individual contexts and can be seen as window of opportunity but also a phase of vulnerability.

# 3. The Role of Attitudes and Beliefs about Physical Activity in Older Adults

Attitudes and beliefs play a vital role in shaping physical activity behaviors among older adults. Positive attitudes can enhance motivation and perseverance, while negative beliefs may create barriers to maintaining an active lifestyle (e.g. French et al., 2005).

# 3.1 Negative attitudes towards physical activity strategies in older adults can hinder implementation

From Study 2 we learned about the facilitators and barriers for engaging in implementation intentions as a planning tool for older adults' physical activity. We can now better understand what the barriers and facilitators for older adults are for using planning tools to improve physical activity. For some participants, barriers may outweigh facilitators, discouraging them from planning.

Understanding the role of attitudes towards certain behavior change strategies helps explain why older adults may resist planning their physical activity using implementation intentions. Our findings suggest this resistance is largely driven by pre-existing beliefs. Study 2 revealed that the reluctance to use implementation intentions as a planning tool for physical activity stemmed from unfavorable attitudes formed even before starting the task. Participants often perceived implementation intentions as overly restrictive or felt that formulating them was unnatural.

This also corresponds to other behavior change theories that were not mentioned previously. For example, according to the Theory of Planned Behavior (TPB; Ajzen, 1991), attitudes, along with subjective norms and perceived behavioral control, are key determinants of a person's intention to engage in physical activity. According to the theory, individuals are more likely to engage in an activity if they expect positive outcomes from it. Beliefs about consequences act as benchmarks for evaluating the outcomes of engaging in a behavior (Abraham & Sheeran, 2013). Some research shows such attitudes, perceived behavioral control, and subjective norms significantly influence intentions to engage in physical fitness in older adults (Tsai et al., 2022). Also, another model, the Health Belief Model (HBM; e.g., Rosenstock, 1974) posits that individuals always weigh up the costs and benefits before demonstrating certain behaviors. We can conclude from Study 2, that such beliefs also extend to certain techniques used to improve physical activities.

Research indicates that outcome expectancies, such as believing that regular physical activity will maintain agility, are closely linked to physical activity behavior (Bandura, 1986, 2001). Positive outcome expectancies, in particular, play a key role in sustaining physical activity (Klusmann et al., 2016). Interestingly, in Study 1, outcome expectancies did not predict the intention to be physically active, somewhat questioning the assumed importance of weighing pros and cons for older adults' physical activity. However, one of the few studies using the HAPA framework in relation to stress, Zhou et al. (2021), found that positive outcome expectancies could buffer the negative impact of perceived stress on physical activity. This finding partially challenges the result of Study 1. Given that HAPA is generally considered to be a robust framework for identifying psychological determinants of physical activity in older adults (Caudroit et al., 2011; Renner et al., 2007; Ziegelmann et al., 2006), further investigation into this relationship seems warranted.

In Study 1, however, we concluded that these null effects were likely due to the strong physical activity habits present in this sample. Habits are defined as a specific action or behavioral tendency that is enacted with little conscious awareness or reflection, in response to a specific set of associated conditions or contextual cues (Hagger, 2019; Verplanken, 2006). In comparison, in Study 2, they had to implement a new strategy for planning their physical activity, making it more of a conscious thinking process where possible barriers and facilitators have to be evaluated before engaging in a new strategy or, more generally, a new behavior. In Study 1, on the other hand, the physical activity was already established and thus may not have needed such conscious efforts of weighing the pros and cons of this behavior. This dual pathway is also discussed in the Integrated Behavior Change Model for Physical Activity (IBM; Hagger & Chatzisarantis, 2014), where they postulate that either a reflective or an impulsive pathway: In the impulsive pathway, the behavior is typically simple, habitual actions performed frequently in the past, guided by well-learned habits that are easily triggered, i.e., habitual physical activity in Study 1. In contrast, in the reflective pathway, behaviors involve more complex, less practiced actions requiring deliberate thought and less ingrained habits, i.e. implementing a new behavior change strategy, as in Study 2.

#### 3.2 Attitudes and motivation to engage in physical activity mutually influence each other

From Study 3, we also learned that such beliefs about physical activity and motivations are shaped by older adult's life path. For example, Participant 8 demonstrated how their strong need to be active was cultivated in childhood and continued to shape their approach to physical activity throughout their life. This finding is in line with a study on Scanlon-Mogel & Roberto, (2004). Personal attitudes to exercise acquired during participants' life course shaped their engagement in physical activity as older adults. From this, we can already appreciate how beliefs, attitudes, and motivation are interlinked. Stehr, Rossmann, et al. (2021) postulated that if the TPB and its focus on attitudes is augmented by self-concordance from SDT then this can provide an even more comprehensive explanation for the physical activity intentions of older adults. Self-concordance is defined as the extent to which your goals express enduring interests and values (Sheldon & Elliot, 1999). They found that specifically attitude and perceived behavioral control positively influence strong and self-determined intentions to be physically active, while subjective norms relate to non-self-determined forms of motivation (Stehr, Rossmann, et al., 2021). From a qualitative study we ascertain that positive beliefs uttered by participants are linked to more self-determined motivation when it comes to their physical activity. These participants are also more likely to engage in sufficient physical activity (Stehr, Luetke Lanfer, et al., 2021). This indicated that the satisfaction of autonomy is linked to more positive outcome expectancies (Fasbender, 2020). Other studies, meanwhile, suggest that the effects of autonomous motivation on the intention to be active were mediated by attitudes. This suggests a slightly different pathway, yet also shows the interconnection between constructs of the SDT and the TPB (Arnautovska et al., 2019; Hagger & Chatzisarantis, 2014).

This corresponds with Study 3's findings, where positive beliefs, such as viewing physical activity as a need and essential for quality of life, align with integrated and identified regulation, driving stronger self-determined intentions to be active. In contrast, controlled motivation, driven by external regulation and introjection (e.g., being active recommended by others), reflects the influence of subjective norms as the perceived pressure to behave a certain way (e.g. Prestwich et al., 2017). However, we cannot fully conclude from our findings how exactly they interact with each other. Beliefs about a behavior and the motivation to be active have synergetic influences that persists over the lifetime of older adults and are shaped by their experiences.

#### 4. The Role of Motivation for Physical Activity in Older Adults

This shows that motivation is a key internal driver of behavior change. From Study 3, we learned that older adults engage in various types of motivation, either controlled or autonomous. Also, it became evident that constructs related to self-determination like basic psychological needs and motivation, were linked to the narrative of their own physical activity.

#### 4.1 Age-related changes in motivation to be active over the course of life

We also see that as people age, their motivations for staying active undergo significant shifts. The motivations for physical activity in older adults evolve over time and are closely linked to the different stages of aging. These motivations are intrinsically tied to the physical, psychological, and social changes specific to their age. In line with previous studies, we found for example, in Study 3, that the motivation to be active is shaped by themes relevant to aging.

For example, in addition to more general themes, older adults mentioned unprompted "healthy aging," "fall prevention," and "remaining part of society," all motives linked to aging when talking about their physical activity. Similar themes were found in other qualitative studies, underscoring the importance of such age-related motives to remain active. In these studies, older adults also recognize that remaining physically active is a valuable way to prevent illnesses, slow down the aging process, and maintain independence (Maula et al., 2019; S. Sweet et al., 2017; Wahlich et al., 2017). This is also in line with theories of aging, like the selection optimization compensation theory which posits that goals in older age tend to shift toward maintenance and loss prevention and are less oriented toward gains (Baltes & Baltes, 1990; Freund & Baltes, 2002).

Furthermore, our findings suggest that the intrinsic motivation to be active may decline over the lifespan, as participants reported that the joy of physical activity for its own sake gradually faded over life course—though it did not disappear entirely. A phenomenon that was only analyzed in one cross-sectional study comparing young and middle-aged adults but not older adults. It was found that young adults reported higher levels of intrinsic motivation and physical activity than middle-aged adults but also introjected motivation (Brunet & Sabiston, 2011). This is interesting as in the sample of Study 3, a majority of the themes linked to motivation to be active could be attributed to either more identified motivation or even integrated motivation. Both of these are more autonomous types of motivations than introjected motivation.

Thus, we can conclude that even if the intrinsic drive to be active diminishes with age, older adults' motivation to be active remains highly autonomous. This is important, as there is consistent support for a positive relationship between more autonomous forms of motivation and physical activity (Teixeira et al., 2012). From a developmental perspective, it makes sense that the motivation to perform a certain behavior must remain highly autonomous to be translated into action. According to the socioemotional selectivity theory (Carstensen, 1991), older adults are more likely to focus on positive emotions that come with certain behaviors. A growing body of evidence suggests that in later life, individuals tend to prioritize life goals and motivations that are meaningful to them, thus enhancing positive emotions as postulated by Carstensen (2021). Study 3 highlights that physical activity was seen as a necessity to live and a basic need. Each theme represents highly autonomous motivations to be active. Similar findings were reported where key motivations for exercise in active older adults, in addition to slowing aging and maintaining health, included physical activity being an integral part of their personal identity for some individuals. This made their motivation highly intrinsic (Zemancová et al., 2024).

# 4.2 Prevalent basic psychological needs in older adults

Additionally, regarding basic psychological needs, differences between younger cohorts can be observed. Unlike younger populations in Study 3, older adults placed less emphasis on the pursuit of competence as the dominant basic psychological need and instead prioritized connection to others through relatedness in the context of physical activity. This finding aligns with Gavin et al. (2014), which noted that motivations related to mental toughness and personal achievements during physical activity declined with age. Supporting this, other findings suggest that younger adults tend to place more value on the need for competence when engaging in physical activity (Standage et al., 2003).

Boulton et al., (2018), for example, found that the social element of physical activity was highly valued by older adults. For many, meeting new people, forming friendships, and socializing with like-minded people were often more appealing than the activity itself. This finding is supported by Zemancová et al., (2024), who discovered that older adults often use physical activity as a way to connect with others. Physical activity may, therefore, serve as a means to prevent loneliness and maintain social connections, aligning with earlier themes of using physical activity to stay engaged with society and the external world. This notion is further supported by evidence suggesting that satisfying the need for relatedness generally

enhances autonomous motivation, which, in turn, promotes perceived well-being in older adults and encourages active participation in daily life (Tang et al., 2021).

Regarding autonomy, one participant described it as a double-edge sword, effectively capturing the tension between having choices and lacking sufficient guidance. Older adults also expressed a desire for freedom in their choices, wishing to be able to engage in physical activity whenever they desired and to choose specific activities they prefer. The importance of autonomy in choosing one's physical activity is supported by findings that a loss in autonomy in determining the intensity of one's exercise, can negatively impact emotions and potentially reduce adherence to physical activity (Vazou-Ekkekakis & Ekkekakis 2009). More generally, participants in Study 3 expressed a desire for greater control over their lives. According to Chipperfield et al. (2012), a sense of control is a key factor that impacts physical, behavioral, and psychosocial aspects of health in older adults and it is linked to successful aging as it facilitates active engagement in health-related behaviors. However, some participants in Study 3 mentioned that they needed certain pressure, such as being monitored, or incentives to help them achieve their goals, suggesting that guidance is equally important. This highlights the notion that too much autonomy can sometimes be perceived as a burden, with some level of guidance providing necessary support. This is reinforced by evidence suggesting that a structured exercise environment may be more effective in improving older adults' health compared to a non-structured exercise environment (Van Roie et al., 2010). Nevertheless, sufficient autonomy satisfaction remains a core need for physical activity in older adults (Arnautovska et al., 2017, 2018).

From Study 1 we also learned that motivational determinants like self-efficacy predicted the intention to be active after lockdown. These constructs are closely connected to the psychological needs expressed in the SDT. For example, self-efficacy and the basic psychological need for competence overlap and stem from the same meta-theoretical concept of agency (Sweet et al., 2014). For example, competence describes feeling competent in interactions and having chances to use and showcase one's abilities (Deci & Ryan, 2004), whereas self-efficacy describes an individual's belief in their ability to perform specific actions or behaviors needed to achieve particular outcomes (Bandura, 1977). In the context of sports, this refers to the ability to adhere to a regularly practiced sports program (e.g., a daily walk) even under challenging conditions (Fuchs & Schwarzer, 1994). Thus, both are defined by an individual's perceived ability to master a situation. This is interesting, as in Study 3 relatedness was far more important than competence. However, the circumstances of Study 1 may explain why, in this case, determinants linked to competence are more important. As we have already established, earlier life events are significant as they cause stress, which makes personal resources in this phase more important than perhaps relatedness, especially since social interactions where also impeded by the pandemic during this time. This aligns with research that shows that self-efficacy beliefs are not only specific to behavior but also to the situation in which they occur (Fuchs & Schwarzer, 1994).

# 5. Recommendations for Promoting and Sustaining Physical Activity in Older Adults

This dissertation has highlighted key determinants for understanding physical activity in older adults. Based on the findings, several recommendations for interventions can be made. Identifying the determinants of a specific behavior within a particular population, here, physical activity in older adults—using theoretical frameworks, such as the HAPA model, implementation intentions and SDT, allows for the identification of suitable behavior change techniques to enhance such behaviors. To design more effective interventions, it is crucial to understand the underlying determinants of behavior and how they interact with the process of individual behavior change (Carey et al., 2019).

These findings provide critical insights, for both initiating and sustaining physical activity interventions among older adults. Additionally, they offer a nuanced framework for promoting and maintaining physical activity in older age. Evidence suggests that older adults (Ziegelmann & Knoll, 2015) may be less likely to initiate behavioral changes, but more likely to maintain any changes that do occur (Ziegelmann & Knoll, 2015). Therefore, even if participants were not particularly active before retirement, it is crucial to support them in maintaining the physical activity they do engage in to prevent a decline into inactivity. Furthermore, studies show that engaging in some physical activity, even if it does not meet the guidelines can still yield positive effects on the overall health of older adults. Thus, maintaining activity levels is also an important consideration (Wen et al., 2011). These recommendations can also help address age-related health changes by identifying barriers and promoting strategies to adapt effectively.

The findings and the subsequent recommendation align with several key recommendations for promoting and sustaining key factors identified by Kwasnicka et al. (2016) for maintaining health behavior change: Guiding older adults through changes and enhancing self-efficacy is crucial. This can be achieved by providing social support, which helps individuals feel encouraged and capable of overcoming challenges to remaining active. Understanding older

adults' thought processes allows for the development of tailored interventions that resonate with their values and beliefs. This ultimately fosters a deeper commitment to physical activity. Enabling autonomy and providing suitable behavior change strategies for self-regulation empowers older adults to take control of their health and maintain consistent physical activity. Supporting maintenance of physical activity in older adults involves offering enjoyable and motivating options that align with their preferences and needs.

However, maintenance and long-term effects of interventions remain areas of improvement in health psychology, especially in older populations (Kwasnicka et al., 2016; Sansano-Nadal et al., 2019).

# 5.1 Guidance through changes

As we have seen, situational determinants like the COVID-19 pandemic can impact physical activity in older adults. Several implications for guiding older adults through changes in intervention can be deducted from these findings. From Study 1 and Study 3, for example, we learned that lifetime events can be accompanied by unwanted stress and situational changes. We also learned that some protective factors predict the intention to be physically active during such times. Notably, the results show that the health status and self-efficacy predicted the intention to be active post-lockdown. Self-efficacy emerged as a crucial factor that can be cultivated to help older adults remain active, even during difficult times. While health status may not be easily changed, extensive evidence demonstrated that self-efficacy a valuable focus for maintaining physical activity, particularly during challenging times and life transitions.

In Study 1, life events such as the Covid-19 pandemic were mentioned, while in study 3, for example, the loss of a partner was highlighted. However, the insights gained here can be applied to other life events, such as retirement. Regardless of the specific event, major life changes have a significant impact on physical activity behavior, making individuals experiencing such events an important target group for interventions (Engberg et al., 2012). More broadly, each significant life event can be viewed as a window of opportunity and a catalyst for change (Barnett et al., 2012).

Studies show that retirement can also be considered as a stressful life event which most older adults will eventually experience (Fonseca et al., 2024). It comes with a great deal of autonomy but also a lack of guidance. One participant in Study 3 (P16) captured this

dynamic, describing the autonomy experienced after retirement as a double-edged sword: "You no longer have any external constraints. That gives you freedom, but it also has disadvantages in the sense that you have to take your own responsibility. That's why it's also important for me to get involved so that I can get to know myself better in my current situation." Changing from a structured work environment to a more autonomous lifestyle creates both opportunities and challenges (Wang & Shi, 2014). While it offers more freedom, it also means having to decide how to spend that time. Some participants in Study 3 noted that when they were working in physically demanding jobs, staying active was never something they consciously thought about—it was simply part of their daily routine. Others reflected on how, when they were younger, they never considered physical activity, but retirement forced them to reconsider this aspect of their lives.

Based on the results of Study 2, implementation intentions could be an effective strategy for reinstating physical activity. After the loss of the daily routine provided by employment, implementation intentions as a planning tool could help to structure new routines. This approach may be especially worth analyzing in light of the barriers and facilitators mentioned in Study 2. Many of the challenges participants faced occurred during the "if-then" task itself. For instance, some participants found it difficult to formulate the "if" part of the implementation intention, particularly in identifying a cue for physical activity. One reason for this was that, due to their retirement, some older adults no longer had a daily event that occurred at the same time. In these cases, participants required assistance from the interviewer. Retirement can represent a major life transition, often accompanied by a shift in routines, which can leave some older adults struggling to establish new physical activity routines or maintain existing ones that were once built around work schedules.

Nevertheless, the potential for enhancing physical activity after losing track of it is highlighted in Study 2. Some older adults reported that planning their physical activity using implementation intentions not only encouraged them to resume previous activities but also promoted self-reflection on their current levels of physical activity. This suggests that implementation intentions can serve as a valuable entry point for guiding older adults through life changes that may disrupt their physical activity routines. Furthermore, they may represent an effective technique for helping individuals resume physical activities after a period of inactivity.

#### 5.2 Enhancing self-efficacy by providing social support

Regarding the protective factors identified in Study 1 and the influence of self-efficacy on physical activity in older age, evidence suggests that older adults often have lower self-efficacy for overcoming barriers to exercise, reflecting a lack of confidence in their ability to remain physically active (Anderson-Bill et al., 2011). Self-efficacy has been consistently shown to be a key determinant for the long-term maintenance of physical activity in older adults (McAuley et al., 2003, 2006; Perkins et al., 2008) and is widely recognized as an essential factor influencing physical activity and health behaviors more broadly (Pan et al., 2009; Sheeran et al., 2016).

Four sources of self-efficacy can be identified: mastering experiences, observing others succeed (vicarious experiences), encouragement from others (social persuasion), and managing emotional or physiological states. (Bandura, 1977). Thus, one way of boosting self-efficacy is by providing appropriate social support, as encouragement, reassurance, and constructive feedback from others can boost confidence in one's abilities through social persuasion and vicarious experiences. This could be a good entry point for older adults as evidence highlights the critical role of self-efficacy in promoting physical activity among older adults (Allison & Keller, 2004). Studies show that improving self-efficacy can improve physical activity in older adults (Baghbani et al., 2023; Diehl et al., 2020). It aligns with the findings from Study 3 that examined the most important needs that have to be met for sustaining physical activity. We know that the most important need for physical activity for most participants was relatedness. Comparatively few participants reported that they disliked team sports or groups, however, this was often consistent throughout their life. This suggests that most older adults would benefit from physical activity programs with a social component. Thus, offering social support, relatedness, and opportunities for connection can be an effective strategy in enhancing both self-efficacy and physical activity in older adults (Collado-Mateo et al., 2021). As predicted by the compensation hypothesis, receiving social support can have particularly beneficial effects for individuals with lower self-efficacy (Schröder 1997).

This perspective also aligns with SDT more generally. Warner et al. (2011) suggest that social support can compensate for a lack of personal resources, particularly in relation to autonomy, arguing that social resources can step in to provide support when personal resources are insufficient. Evidence indicates that social support significantly enhances self-efficacy in older adults, which in turn promotes higher levels of physical activity (Smith et al., 2017). Some evidence suggests that low levels of social support were linked to lower perceived autonomy among older adults (Sánchez-García et al., 2019). This highlights the

125

importance of developing strategies to strengthen social connections and social support within this group, as this can improve their sense of autonomy. By integrating social interaction into physical activity programs, older adults not only improve their health but also build meaningful connections, effectively addressing two key challenges at once: improving physical wellbeing and reducing loneliness. Metanalytic data reveals that approximately one in four adults over 60 experience loneliness at least some of the time (Chawla et al., 2021). The importance of relatedness, or a sense of connection with others, as observed in Study 3, becomes even more pronounced as people age, making this approach both practical and impactful in addressing multiple issues associated with older adulthood. It may also be the case that older adults are not primarily motivated by the instrumental benefits of physical activity per se, but rather by other factors, such as participating in enjoyable and sociable activities. This underscores the importance of understanding what older adults truly value and seek from physical activity (French et al., 2014). This insight leads directly to the next recommendation.

# 5.3 Understanding older adults' thought processes

By involving older adults in research can provide valuable insights into their cognitive processes when adopting new behaviors (Zihl & Reppermund, 2023). This approach is particularly important for understanding the determinants of behavior, as it enables researchers to gain a deeper understanding of what older adults think and feel when engaging in specific health behaviors and implementing new behavior change strategies.

In Study 2 we found that thinking about physical activity and the planning of it triggered self-reflection about their own current physical activity. Older adults are a heterogeneous group, which is reflected in their thoughts about physical activity. As we have learned, these implicit attitudes and beliefs can change if someone shows a particular behavior or uses a certain behavior change technique. It also helps explain why some research has shown paradoxical evidence regarding the effectiveness of implementation intentions as a behavior change tool and why they may be less effective for older adults compared to other groups. In Study 2, participants were asked to think aloud while formulating their implementation intentions, providing valuable insights into their thought processes. This enabled a better understanding of what works for older adults in interventions using implementation intentions and what does not. It became apparent that some older adults already had preestablished beliefs about implementation intention, making them less feasible for this group. Previous research has shown that techniques that are effective for younger participants may not be effective for older adults (Zubala et al., 2017). In fact, some interventions even yielded null effects

when using implementation intentions for physical activity promotion in older adults (Warner et al., 2016). It is possible that interventions based on self-regulatory or planning strategies may be less effective for older adults compared to younger adults because they may be less acceptable (French et al. 2014). This demonstrates how such attitudes can influence intervention outcomes. Notably, such attitudes tend to be deeply rooted and less susceptible to change in older adulthood. Development psychology suggests that identity, self-image, and attitudes are least stable in young adulthood, reach peak stability in midlife, and then remain relatively unchanged as individuals age into older adulthood (Alwin, 1994). However, while changing these attitudes is challenging, it is not impossible. Even modest changes in attitudes can lead to small to moderate effects on subsequent behavior (Sheeran et al., 2016).

One way of counteracting negative beliefs about implementation intentions could be through reframing. Instead of presenting them as tools for planning physical activity around demands, they could be reframed as a means for self-reflection, allowing older adults to assess their current activity levels and identify ways to improve it. This reframing aligns with findings from Study 2, where self-reflection emerged as a facilitator during the task. This approach is also consistent with insights from the systematic review by French et al. (2014), which highlighted that many behavior change techniques (BCTs) showing adverse effects in older adults focus on fitting physical activity into busy schedules shaped by the competing demands from work or family. However, after retirement, these demands often become irrelevant, and do not meet the needs of older adults.

This brings us to Study 3 and how Self-Determination Theory (SDT) can help us better understand older adults' motivation to be active. For many participants, physical activity was more about maintaining well-being and fostering connections with others rather than pursuing competence. Increasing evidence indicates that in the later stages of life, individuals tend to focus on life goals and motivations centered around seeking meaning and enhancing positive emotions, as suggested by Carstensen (2021). These theoretical perspectives offer an additional lens to better understand the motivations and barriers that influence whether older adults engage in or avoid certain behaviors. Many of the findings in Study 3 can be more clearly explained through these theoretical frameworks, while still being rooted in SDT as behavior change theory that combine knowledge from two fields in psychology. This could improve behavior change intervention for older adults, offering deeper insights into the reasons behind their choices and actions (Diehl et al., 2014; Ziegelmann & Knoll, 2015).

Closely listening to what adults need to be active is crucial for understanding why certain interventions succeed or fail. In Study 3, prominent themes emerged regarding older

adults' preferences for physical activity, highlighting their desire to make their own choices and their belief that they knew their own limits best. These findings align with those from Study 2, underscoring the importance of autonomy in their actions and decisions concerning their physical activity. This emphasis on autonomy reinforces the need for interventions that respect and support older adults' sense of control and self-determination, leading directly to the final recommendation.

## 5.4 Enabling autonomy

Understanding older adults' thoughts and perspectives is closely linked to the final recommendation. When it comes to physical activity, a practical way to support their autonomy is by directly involving them in the decision-making process regarding their activity preferences. This approach not only respects their right to make choices about their own bodies and health but also ensures that their unique needs and desires are considered. Thus, actively involving older adults in personalized, participatory approaches fosters autonomy, ensures interventions meet their diverse needs, and enhances the effectiveness and sustainability of strategies. In the final section, I will therefore discuss how supporting older adults in their physical activity process and giving them choices can lead to improved outcomes in physical activity interventions.

According to the WHO (2015), supporting autonomy has a profound impact on older people's dignity, integrity, freedom, and independence. It is consistently recognized as a core component of their overall well-being. Autonomy is not merely a desirable aspect of aging; it is a fundamental right that allows older adults to maintain control over their lives. This includes making decisions about their living arrangements, the relationships they nurture, how they spend their time, and how they manage their health. In this context, it is essential to recognize that autonomy is deeply tied to the fulfillment of basic needs. When these needs are adequately met, older adults are better equipped to exercise their autonomy effectively. According to SDT, healthy aging can be viewed as a process of self-empowerment, where individuals actively take control of their lives and well-being for as long as they are able (Zimmerman, 1995).

Developing effective autonomy-supportive interventions, requires careful considerations of several key factors. According to the circumplex model (Aelterman et al., 2019), successful interventions must strike a balance between directiveness and need support. Optimal autonomy-supportive is therefore only achieved when the provider of the intervention shows

low directiveness but also high support for the participants' needs. The importance of this balance was evident in the results of Study 3, where participants expressed a dual need: on one hand, they appreciated a certain level of pressure or monitoring during interventions to stay active; on the other hand, they emphasized the importance of having control over their lives, the freedom to choose preferred activities, and the flexibility to by active when they wanted. This underscores the necessity of finding a suitable balance between directiveness in the form of guidance and support in their personal needs. This is crucial for sustainable behavior change intervention for older adults. These findings are reinforced by research showing the most effective BCT to facilitate physical activity in older adults include autonomy support, followed by clear instructions on how to perform the behavior, and access to credible sources of information about physical activity (Arnautovska et al., 2018). This highlights how much older adults value autonomy and how much they profit from autonomy support to foster behavior change followed by guidance through instruction and credible sources. This shows the vital role both aspects play in fostering lasting behavior change.

Integrating SDT's focus on intrinsic motivation and the fulfillment of basic psychological needs, the shortcomings of other behavior change theories like the HAPA can be addressed. This integration results in more comprehensive and effective interventions. For example, interventions involving planning with older adults could be improved. This adjustment could help mitigate the negative effects of self-regulatory strategies in older age as found in studies (French et al., 2014; Warner et al., 2016). Thus, by giving older adults flexibility while planning could be one additional way to enhance the effects for older adults due to their need for autonomy. This might remove one main barrier to using implementation intention in older adults found in Study 3, namely that it is perceived as being too restrictive. Incorporating autonomy-supportive elements, such as allowing older adults to choose their preferred activity, decide when they want to be active, as well as giving them the freedom to adjust their plans if they no longer align with their daily lives, can significantly enhance the effectiveness of planning strategies. This approach addresses the expressed needs for autonomy observed in Study 3, including the desired control over one's life and the freedom to be active when most appropriate. backed upThese findings are supported by research indicating that retired prefer not to adhere to rigid schedules for physical activity to (French et al., 2021). This approach is also consistent with SDTs recommendations to encourage autonomy in physical activity in older adults by using autonomy-supportive language that avoids controlling terms like "have to" or "must" and providing meaningful rationales, such as explaining the purpose behind

specific exercises, which can help fulfill their need for competence (Deci & Ryan, 2002) and improve established behavior change techniques like implementation intentions.

Integrating SDT into physical activity interventions emphasizes not only the quantity but also the quality of motivation, which is essential for both initiating and sustaining behavior change over the long term. By ensuring that individuals are motivated by factors that are more sustainable and deeply rooted in their psychological well-being, SDT supports the development of sustainable behavior patterns. Thus, SDT can influence changes in older adults' physical activity by shifting their motivation from external regulation to a more internally driven form of motivation (Hancox et al., 2018; Lewis et al., 2020). As the opportunity to be active for the purpose of personal growth can foster self-determined motivation and ultimately satisfaction with life in retirement (Fouquereau et al., 2005; Stephan et al., 2008). From a systematic review, one main finding was that enjoyment is key for the acceptability of interventions targeting physical activity in older adults (Devereux-Fitzgerald et al., 2016,).

Findings from Study 3 highlight the importance of addressing adults' basic psychological needs when designing physical activity interventions. Study 3 shows that most notions of needs could be attributed to relatedness, making this a good entry point for future interventions. Despite the clear potential of this approach, it remains underexplored in research targeting older adults. To date, only one study has examined motivation profiles and their influence on physical activity in older adults (Stephan et al., 2010). However, there is still a gap in understanding the prevalent psychological needs in older adults and how these shape their engagement in physical activity.

In conclusion, the recommendations presented in this thesis, align with existing research on the determinants that influence physical activity maintenance in older adults (Franco et al., 2015; Huffman & Amireault, 2021; Hughes et al., 2022; Koeneman et al., 2011; Stathi et al., 2012), while also expanding established findings. To effectively promote and sustain physical activity in older adults, this dissertation concludes that it is essential to guide older adults through situational changes, enhance their self-efficacy through social support, understand their thought processes to address barriers and motivations, and enable autonomy by allowing choice while also providing external support.

# 6. Research Directions

Future research in this area could explore several promising avenues. One potential direction for Study 3 is to analyze the quantitative data and then use a mixed-method approach, where qualitative and quantitative data is triangulated to gain a more comprehensive understanding of the role of self-determination in older adults. This could further explore how the SDT can improve interventions using implementation intentions, combining findings from both qualitative and quantitative findings. This approach could build on research from Study 2, which delved into older adults' thought processes while formulating implementation intentions. Another possibility is developing questions based on Think-Aloud data from Study 2 to assess individuals' preferences for specific interventions, such as implementation intentions. This could help identify which interventions are most suitable for older adults in advance. For example, one could ask older adults about their willingness to use planning as a means to organize their physical activity, thus categorizing older adults into "planners" and "non-planners." Additionally, future studies could investigate the applicability of the HAPA model during challenging life events. Research could examine how individuals maintain or adapt health behaviors under stress or significant life transitions, exploring which determinants are most robust in predicting physical activity during such times, as current results remain inconclusive.

More generally, a promising direction for future research is to apply the Integrated Behavior Model, (IBM) (Hagger & Chatzisarantis, 2014) to explore the connection between SDT, motivations, and their influence on attitudes and beliefs regarding physical activity in older adults. The IBM is specifically designed to understand physical activity and its changes, drawing on two key theories: the TPB and SDT by assuming that autonomous motivation influences attitudes, subjective norms, and perceived behavioral control, which in turn, shape the intention to engage in physical activity (Hagger & Chatzisarantis, 2014). This model has the potential to expand the knowledge gained from Study 3 by offering a more comprehensive framework for understanding physical activity behavior. However, to my knowledge, IBM has not yet been applied to studying physical activity in older adults, thus presenting an opportunity for future research targeting this demographic. Given the limited evidence in this area, such an approach could offer valuable insights into how attitudes and types of motivation influence behavior, as well as the effectiveness of specific behavior change techniques in this population. Finally, future research should also explore the integration of psychological theories of aging with health behavior change models to promote physical activity in older

131

adults. Investigating this intersection could enhance the effectiveness of behavior change interventions for older adults and provide deeper insights into the underlying reasons for their engagement in specific behaviors and physical activity in particular (Diehl et al., 2014; Ziegelmann & Knoll, 2015).

These possibilities offer valuable insights into understanding older adults' determinants for being physically active, optimizing interventions, and understanding behavior change in diverse contexts.

# 7. Strengths and Limitations

A key strength of this lies in the use of qualitative and longitudinal research methods. The qualitative approach helps, for instance, helps explain why some individuals respond better to certain interventions than others, providing valuable insights into the determinants of behavior (Hammarberg et al., 2016). This understanding can lead to personalized approaches that account for individual differences. Qualitative methods are important tools in health psychology as insights gathered from these can also be used in intervention development (e.g. in intervention mapping). They are particularly useful for understanding the factors that influence the behavior of older adults, who represent the most heterogeneous age group in terms of physical, psychological, and social functioning (Diehl et al., 2014).

For example, in this dissertation the use of the Think Aloud paradigm (Genest & Turk, 1981) in Study 2 helped clarify paradoxical findings and provided insights into what works and what does not when using implementation intentions. This type of understanding would have been difficult, if not impossible, to achieve using solely quantitative methods. Incorporating such qualitative approaches can lead to the development of more precise interventions that address the specific barriers or facilitators influencing behavior change, shedding light on why some individuals respond better to certain interventions than others. This knowledge can lead to personalized approaches that account for individual differences in mechanisms discussed beforehand. Additionally, in Study 3, we applied a different qualitative approach, namely the Interpretative Phenomenological Approach (Osborne & Smith, 2008) to best understand each participant's view on the role of self-determination for their physical activity. Together with the narrative first question of both the pre- and post-intervention interview guide, which was chosen in order to see which themes emerged without input from the interviewer, the analysis method allowed us to extract if and which themes related to self-determination to older adults' physical activity journeys.

Moreover, in Study 1, where we focused on the maintenance of physical activity, we conducted a panel study. The strength of longitudinal studies lies in their ability to provide insights into the stability of certain behaviors and the impact of certain changes, as they allow researchers to follow a sample over a given amount of time and across multiple time points (Hsiao, 2022). This approach enables the exploration of the interaction between behaviors and long-term resources (Ziegelmann & Knoll, 2015). The COVID-19 pandemic, in particular, was a suitable as an example to examine how situational stressors impact the health and behavior of older adults, particularly their physical activity. Older adults are especially susceptible to such stressors, and the pandemic provided a unique opportunity to study their effects on a larger scale. While events like the loss of a partner are harder to research due to their sudden and individual nature, the pandemic offered a shared, widespread event among older adults, facilitating a broader investigation into its effects.

All three studies also have a theoretical foundation. Study 1 employed the HAPA model to gain a deeper understanding of the motivational and volitional factors that played a significant role after lockdown, making the findings comparable with other studies using similar theories. For instance, Study 3 built on the findings from Study 2 by using SDT to address the barriers encountered while planning. As in qualitative research, the use of theories is crucial as different theories provide different lenses through which to analyze research problems (Reeves et al., 2008).

On the other hand, all three studies were affected by a significant self-selection bias. This type of bias occurs when individuals disproportionately choose to participate in a study group. In this thesis, it meant that we disproportionately recruited individuals who were already active and in good health. Unfortunately, this issue is prevalent in most studies involving older adults and health promotion and has persisted for some time (e.g. (Traven et al., 1994). The reasons for this bias are manifold and include factors such as lack of trust, transportation barriers (Gonzalez et al., 2007; Ory et al., 2002), caregiver burden, medical concerns, and indifference (Saunders et al., 2003), health issues (Crawford Shearer et al., 2010) and challenges with media use (Yang et al., 2020).

Efforts have been made to recruit a more diverse sample of older adults (Mody et al., 2008) with some notable successes. For instance, McHenry et al. (2015) documented effective recruitment strategies that employed social marketing principles and emphasized building strong relationships with community organizations. Approaches such as face-to-face contact and services like blood pressure checks were particularly effective in reaching this population. Extra time and support were needed to engage vulnerable groups like older adults and

133

minorities. This process necessitated staff dedication, ongoing collaboration, and a commitment to maintaining positive relationships and upholding recruitment principles to ensure broad participation.

However, the costs associated with recruiting and retaining individuals from older and underserved populations are considerable and should be anticipated. This can make it challenging, and sometimes unfeasible, for studies with limited resources and funding to fully engage with these groups (Areán et al., 2003; Katula et al., 2007). These issues may also help explain why research with older adults is often viewed as difficult, especially when it comes to studying health behavior and implementing health promotion interventions. Unfortunately, these are often participants who would benefit most from studies aimed at promoting physical activity, and in observational studies, their exclusion or limited participation could result in biased outcomes.

Several limitations are evident across the individual studies. In Study 1, for instance, a significant limitation was the high dropout rate, which may have introduced bias and affected the robustness of the findings. Up to 42% of participants who completed the first survey were unreachable for the second survey. Furthermore, in Study 1, health status and education were significantly better among completers compared to non-completers. Additional predictors for attrition in older adults are systemically analyzed by Jacobsen et al. (2021). These findings align with our findings (i.e. with health status and education being higher in completers in Study 1), and indicated that participants more likely to drop out tended to be older, male, living alone, had lower cognitive test scores and dementia ratings, reduced functional ability, fewer memory complaints, no physical activity or social engagement, worse self-rated health, and left their homes less frequently. Of particular concern is that in Study 1 completers also differed in key HAPA-related variables, such as self-efficacy, intention, and coping planning, which may have introduced bias and influenced the findings.

Secondly, in Study 2, the lack of a follow-up phase in the German and UK samples limited our ability to assess the long-term impact and sustainability of the implementation intentions formed by the participants in these samples. For instance, it cannot be deducted if the implementation intentions formed improved their physical activity and if participants who had negative attitudes towards forming implementation intentions had different experiences using implementation intentions as a behavior change technique. Qualitative methods during and after the intervention phase could assess intervention delivery and capture responses from both participants and deliverers. After the intervention, context for results could be provided to help explain effectiveness variations. An intervention phase in this research could offer

134
enhanced insights into the implementation process, adding depth to the findings (Lewin et al., 2009).

Third and finally, the absence of a control group in Study 3 limited our ability to compare differing perspectives or situational factors between participant groups. While qualitative studies typically do not rely on control groups to establish causality, having a control group can still offer valuable context and alternative viewpoints, enriching the depth of the findings. This is particularly important given that post-intervention transcripts were also analyzed. It is possible that the intervention components influenced the responses provided in these interviews, potentially introducing bias.

### 8. Conclusions

In conclusion, this dissertation challenges the outdated notion that older adults are unsuitable subjects for studying health behavior change. This perspective fails to recognize the complex realities of aging and overlooks the rich, multifaceted experiences that shape the lives of older adults. As demonstrated in this research, the determinants of behavior in older adults involve a dynamic interplay of internal factors—such as personal values, attitudes, and motivations-and external influences, including situational factors, environmental conditions, and various life events. As individuals age, the relationship between these internal and external factors becomes increasingly complex, as they accumulate experiences and evolve needs over a lifetime. It is essential to acknowledge that understanding these interactions is crucial for developing effective interventions and support systems tailored to the unique challenges faced by older adults. This research highlights that, while encouraging physical activity is critical, maintaining existing levels of activity is equally important. Life events, such as retirement or other stressful transitions can disrupt established routines. Interventions must be designed to foster continuity in activity levels rather than solely focusing on increasing them. By prioritizing maintenance, this approach acknowledges the barriers older adults face and addresses the real challenges they encounter, ultimately fostering more sustainable behavior change.

Furthermore, the understanding of physical activity among older adults needs to be reevaluated and extended beyond traditional definitions. Physical activity encompasses more than just bodily movement produced by skeletal muscles (Caspersen et al., 1985); it is shaped by a multitude of inherent aspects, including the socio-cultural contexts in which older adults

#### Chapter IV – General Discussion

operate. As articulated by Piggin (2020), a broader definition of physical activity recognizes it as "people moving, acting, and performing within culturally specific spaces and contexts, influenced by a unique array of interests, emotions, ideas, instructions, and relationships." This perspective is particularly relevant for older adults, whose prolonged life experiences significantly influence their health behaviors. It illustrates how both internal and external factors can shape not only if and how older individuals engage in physical activity but also the extent to which they wish to remain active. This definition is particularly well-suited for older adults, as their prolonged life experiences have shaped how they perceive and engage in health behaviors. It demonstrates how internal and external factors can determine if and how an older person participates in physical activity, but also the extent to which they wish to remain active.

In light of these insights, I conclude that continued efforts are essential to deepen our understanding of the factors influencing physical activity among older adults. We must recognize not only their capacity for change but also the vast potential within this demographic. By acknowledging their unique experiences and the various determinants at play, we can better support older adults on their journey toward healthy aging. This perspective contributes to a broader understanding of what influences healthy aging as a multifaceted and complex construct that varies across personal, social, and environmental dimensions (Menassa et al., 2023). This commitment extends beyond the individual well-being of older adults; it has farreaching societal benefits. By fostering an environment where older adults are encouraged to stay active, engaged, and empowered, we strengthen the social fabric of communities. Older individuals can thrive, remain engaged, and continue to contribute meaningfully to society. Ultimately, empowering older adults to embrace active lifestyles and prioritize their health not only enhances their quality of life but also addresses the challenges posed by demographic shifts (Menassa et al., 2023). A collective investment in supporting older adults' physical activity is not just a public health goal—it is a societal imperative that promises a richer, more inclusive, and fulfilling aging experience for all.

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Appendix I: Supplementary information: Older adults' physical activity after lockdown: Testing the health action process approach and the moderating role of fear of Covid-19

Appendix II: Supplementary information: What do older adults think about when formulating implementation intentions for physical activity? Evidence from a qualitative study

Appendix II: Supplementary information: The Role of Self-Determination When Older Adults Talk About Their Physical Activity: An Interpretative-Phenomenological Study

## Appendix I: Supplementary information: Older adults' physical activity after lockdown: Testing the health action process approach and the moderating role of fear of Covid-19

### Table S1

Descriptive statistics of the sociodemographic variables of the sample

		Mis-	М	MD	50	Mini-	Movimum
	Ν	sing	11/1	MD	SD	mum	Waxiiiuiii
Health status	262	1	4.2	4	0.91	1	5
Cohabitant number	262	1	1.72	2	0.6	1	5
Cohabitant type <sup>a</sup>	263	0	3.84	3	0.7	1	6
Socioeconomic status <sup>b</sup>	263	0	1.88	2	0.52	1	3
Retirement age	245	18	62.8	64	3.38	41	72
Work status after retirement	263	0	1.85	2	0.52	1	3
Retirement <sup>c</sup>	263	0	1.07	1	0.25	1	2
Education <sup>d</sup>	263	0	4.59	5	1.3	1	7
Civil status <sup>e</sup>	263	0	2.54	2	0.98	1	6
Gender <sup>f</sup>	263	0	1.31	1	0.46	1	2
Age	261	2	69.6	66	4.3	65	85

<sup>a</sup> 1 = partner; 2 = family members; 3 = friends; 4 = group member (e.g. religious groups); 5 = work partners; 6 = other

<sup>b</sup> I = I have more than enough money to meet my needs; 2 = I have enough money to meet my needs; 3 = I have not enough money to meet my needs

<sup>c</sup> 1 = yes; 2 = no

<sup>d</sup> 1 = primary school; 2 = secondary school; 3 = apprenticeship; 4 = A Levels; 5 = technical college; 6 = university

<sup>e</sup> 1 = single; 2 = married; 3 = divorced; 4 = widowed; 5 = civil union; 6 = dissolved civil union

f 1 = female; 2 = male

## Table S2

## Original items, translation and references for all HAPA constructs

Construct	Original Item in German	Translated Item	Reference		
Risk percep-	1. Stellen Sie sich vor, dass Sie nicht	If I am not regularly physically	Bierbauer et al.,		
tion	ausreichend körperlich aktiv sind. In-	active, the probability is high	2017		
$(\alpha_{T1} = .83; \alpha_{T2})$	wiefern denken Sie, dass dann Sie	that I will have get cardiovascu-			
= 0.95)	einmal Herz-Kreislauf-Krankheiten	lar diseases.			
	entwickeln könnten?				
	2. Stellen Sie sich vor, dass Sie nicht	If I am not regularly physically			
	ausreichend körperlich aktiv sind. In-	active, the probability is high			
	wiefern denken Sie, dass dann die	that I will have serious health			
	Wahrscheinlichkeit hoch ist, dass Sie	problems.			
	einmal ernste gesundheitliche Prob-				
	leme bekommen?				
	3. Stellen Sie sich vor, dass Sie nicht	If I am not regularly physically			
	ausreichend körperlich aktiv sind. In-	active, the probability is high			
	wiefern denken Sie, dass sich dann	that I my health status will			
	ihr Gesundheitszustand verschlech-	worsen.			
	tern könnte?				
Outcome ex-	1. Stellen Sie sich vor, dass Sie nicht	Which will be the likely per-	Schwarzer,		
pectancies	ausreichend körperlich aktiv sind.	sonal consequences if you are	2008		
$(\alpha_{T1} = .67; \alpha_{T2})$	Wenn ich ausreichend körperlich ak-	nit sufficiently physically ac-			
= .60)	tiv bin, dann bereitet mir das Schmer-	tive? If I am sufficiently physi-			
	zen.	cally active, then I will be in			
		pain.			
	2. Stellen Sie sich vor, dass Sie aus-	Which will be the likely per-			
	reichend körperlich aktiv sind. Wenn	sonal consequences if you are			
	ich ausreichend körperlich aktiv bin,	sufficiently physically active? If			
	dann bleibe ich beweglich.	I am sufficiently physically ac-			
		tive, then I will stay agile.			
	3. Stellen Sie sich vor, dass Sie aus-	Which will be the likely per-			
	reichend körperlich aktiv sind. Wenn	sonal consequences if you are			
	ich ausreichend körperlich aktiv bin,	sufficiently physically active? If			
	dann bleibe ich beweglich, dann fühle	I am sufficiently physically ac-			
	ich mich zufrieden.	tive, then I will feel content.			
Self efficacy	1. Wie sicher sind Sie sich, dass Sie	How certain are you that that	Schwarzer,		
$(\alpha_{T1} = .94; \alpha_{T2})$	ausreichend körperlich aktiv sein	you can be sufficiently physi-	2008		
= 0.86)	können, auch wenn Sie keine Lust da-	cally active, even if you are			
	rauf haben?				

		bored with being physically ac-	
		tive?	
	2. Wie sicher sind Sie sich, dass Sie	How certain are you that that	
	ausreichend körperlich aktiv sein	you can be sufficiently physi-	
	können, auch wenn dies mal schwie-	cally active, even if being phys-	
	rig wird?	ically active is challenging?	
	3. Wie sicher sind Sie sich, dass Sie	How certain are you that that	
	ausreichend körperlich aktiv sein	you can be sufficiently physi-	
	können, wenn Sie länger zuhause	cally active, even if are staying	
	sind?	longer at home?	
Intention	1. Inwieweit haben Sie generell die	I generally intend to be suffi-	Allen et al.,
$(\alpha_{T1} = .89; \alpha_{T2})$	Absicht, ausreichend körperlich aktiv	ciently physically active	2013
= .86)	zu sein?		
	2. Inwieweit haben Sie für die nächs-	In the next four weeks, I intend	
	ten vier Wochen die Absicht, ausrei-	to be sufficiently physically ac-	
	chend körperlich aktiv zu sein?	tive	
	3. Inwieweit haben Sie für heute die	Today I intend to be sufficiently	
	Absicht, ausreichend körperlich aktiv	physically active.	
	zu sein?		
	4. Inwieweit haben Sie für die Zeit	For the time of the self isola-	
	der Selbstisolation die Absicht, aus-	tion, I intend to be sufficiently	
	reichend körperlich aktiv zu sein?	physically active.	
Action Plan-	1. In den nächsten vier Wochen, habe	I have made detailed plans for	Schwarzer,
ning	ich genau geplant, welche körperli-	how I will be sufficiently physi-	2008
$(\alpha_{T1} = .93; \alpha_{T2})$	chen Aktivitäten ich in den nächsten	cally active in the next four	
=.94)	vier Wochen ausüben werde.	weeks	
	2. In den nächsten vier Wochen, habe	I have made detailed plans for	
	ich genau geplant, wann ich in den	when I will be sufficiently	
	nächsten vier Wochen körperlich ak-	physically active in the next	
	tiv sein werde.	four weeks	
	3. In den nächsten vier Wochen, habe	I have made detailed plans for	
	ich genau geplant, wo ich in den	where I will be sufficiently	
	nächsten vier Wochen körperlich ak-	physically active in the next	
	tiv sein werde.	four weeks	
Coping Plan-	1. In den nächsten vier Wochen, habe	In the next four weeks I have	Schwarzer,
ning	ich genau geplant, wie ich weiterhin	made detailed plans for how I	2008
$(\alpha_{T1} = .89; \alpha_{T2})$	ausreichend körperlich aktiv sein	will be sufficiently physically	
=.90)	werde, auch wenn ich durch COVID-	active, even if I face restrictions	
	19 Einschränkungen habe.	due to Covid-19.	

	2. In den nächsten vier Wochen, habe	In the next four weeks I have					
	ich genau geplant, wie ich trotz mei-	made detailed plans for how I					
	ner anderen Verpflichtungen und In-	will be sufficiently physically					
	teressen ausreichend körperlich aktiv	active, despite other obligations					
	sein werde.	and interests.					
	3. In den nächsten vier Wochen, habe	In the next four weeks I have					
	ich genau geplant, wie ich weiterhin	made detailed plans for how I					
	ausreichend körperlich aktiv sein	will be sufficiently physically					
	werde, auch wenn ich zuhause blei-	active, even if I have to stay at					
	ben sollte.	home.					
Action Con-	1. Haben Sie in den letzten vier Wo-	During the last four weeks, I	Sniehotta et al.,				
4							
troi	chen, alles getan, um ausreichend	have done everything to be suf-	2006				
$(\alpha_{T1} = .94; \alpha_{T2})$	chen, alles getan, um ausreichend körperlich aktiv zu sein?	have done everything to be suf- ficiently physically active.	2006				
$(\alpha_{T1} = .94; \alpha_{T2} = .92)$	chen, alles getan, um ausreichend körperlich aktiv zu sein? 2. Haben Sie sich in den letzten vier	have done everything to be suf- ficiently physically active. During the last four weeks, be-	2006				
$(\alpha_{T1} = .94; \alpha_{T2} = .92)$	<ul><li>chen, alles getan, um ausreichend</li><li>körperlich aktiv zu sein?</li><li>2. Haben Sie sich in den letzten vier</li><li>Wochen Ihr Ziel vor Augen gehalten,</li></ul>	have done everything to be suf- ficiently physically active. During the last four weeks, be- ing sufficiently physically ac-	2006				
$(\alpha_{T1} = .94; \alpha_{T2} = .92)$	<ul><li>chen, alles getan, um ausreichend</li><li>körperlich aktiv zu sein?</li><li>2. Haben Sie sich in den letzten vier</li><li>Wochen Ihr Ziel vor Augen gehalten,</li><li>ausreichend körperlich aktiv zu sein?</li></ul>	<ul><li>have done everything to be suf-</li><li>ficiently physically active.</li><li>During the last four weeks, be-</li><li>ing sufficiently physically ac-</li><li>tive was often on my mind.</li></ul>	2006				
$(\alpha_{T1} = .94; \alpha_{T2} = .92)$	<ul> <li>chen, alles getan, um ausreichend</li> <li>körperlich aktiv zu sein?</li> <li>2. Haben Sie sich in den letzten vier</li> <li>Wochen Ihr Ziel vor Augen gehalten,</li> <li>ausreichend körperlich aktiv zu sein?</li> <li>3. Haben Sie in den letzten vier Wo-</li> </ul>	have done everything to be suf- ficiently physically active. During the last four weeks, be- ing sufficiently physically ac- tive was often on my mind. During the last four weeks, I	2006				
$(\alpha_{T1} = .94; \alpha_{T2} = .92)$	<ul> <li>chen, alles getan, um ausreichend</li> <li>körperlich aktiv zu sein?</li> <li>2. Haben Sie sich in den letzten vier</li> <li>Wochen Ihr Ziel vor Augen gehalten,</li> <li>ausreichend körperlich aktiv zu sein?</li> <li>3. Haben Sie in den letzten vier Wo-</li> <li>chen genau darauf geachtet, ausrei-</li> </ul>	have done everything to be suf- ficiently physically active. During the last four weeks, be- ing sufficiently physically ac- tive was often on my mind. During the last four weeks, I have always been aware to be	2006				

Note. Rating skala for each item is 1-5

### Table S3

## Exploratory Factor Analysis of the SFI-10 adapted for the Fear of Covid

	Factor		
Items	Fear of Covid-19	Risk per- ception Covid-19	Uniqueness
1. To what extent are you concerned about Covid-19?	0.589	0.345	0.535
<ol> <li>How likely is it that you could become infected by Covid- 19?</li> </ol>		0.762	0.419
3. How likely is it that someone you know could become in- fected with Covid-19?		0.748	0.436
4. How quickly do you believe contamination from Covid-19 is spreading in Switzerland, Austria and Germany?		0.389	0.809
5. How much exposure have you had to information about Covid-19?			0.973
6. If you did become infected with Covid-19, to what extent are you concerned that you will be severely ill?	0.693		0.512
7. To what extent has the threat of Covid-19 influenced your decisions to be around people?	0.494	0.384	0.609
8. To what extent has the threat of Covid-19 nfluenced your travel plans?			0.955
9. To what extent has the threat of Covid-19influenced your use of safety behaviors (e.g., hand sanitizer)?	0.667		0.555

Note. 'Maximum likelihood' extraction method was used in combination with a 'varimax' rotation; all loading over 0.3 are being displayed.

## Table S4

## Items and Translation of the SFI-10 adapted for the Fear of Covid

English Original	German Translation
1. To what extent are you concerned about Covid-19?	In welchem Masse sind sie besorgt über COVID-19?
If you did become infected with Covid-19, to what ex-	In welchem Masse hat die COVID-19- Pandemie Ihre
tent are you concerned that you will be severely ill?	Entscheidungen unter Menschen zu gehen beein-
	flusst?
2. If you did become infected with Covid-19, to what	In welchem Masse hat die COVID-19- Pandemie Ihre
extent are you concerned that you will be severely ill?	Entscheidungen unter Menschen zu gehen beein-
	flusst?
3. To what extent has the threat of Covid-19 influenced	Wenn Sie sich mit COVID-19 anstecken würden, inf-
your decisions to be around people?	wiefern wären Sie besorgt ernsthaft krank zu werden?
4. To what extent has the threat of Covid-19influenced	Inwiefern hat die Bedrohnung druch COVID-19 Ihre
your use of safety behaviors (e.g., hand sanitizer)?	Sicherheitsverhalten (z.B. Hände desinfizieren) be-
	einflusst?
5. How likely is it that you could become infected by	Wie wahrscheinlich ist es, dass Sie sich mit COVID-
Covid-19?	19 anstecken könnten?
6. How likely is it that someone you know could be-	Wie wahrscheinlich ist es, dass sich jemand in Ihrem
come infected with Covid-19?	Bekanntenkreis mit COVID-19 anstecken könnte?
7. How quickly do you believe contamination from	Wie schnell denken Sie, dass COVID-19 sich in der
Covid-19 is spreading in Switzerland, Austria and Ger-	Schweiz, Österreich oder Deutschland verbreitet?
many?	
8. How much exposure have you had to information	Wie stark waren Sie Informationen über COVID-19
about Covid-19?	ausgesetzt?
9. To what extent has the threat of Covid-19 influenced	Inwiefern hat COVID-19 Ihre Reisepläne beein-
your travel plans?	flusst?

Note. Note. Rating skala for each item is 1-4

### Table S5

Dropout Analysis	of the	Sociodemographic	Variables and	HAPA-Variables
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						959	∕₀ CI
	Т	df	р	$\Delta M$	$\Delta SE$	LL	UL
<b>Risk perception T1</b>	-0.37	259	0.710	-0.05	0.14	-0.33	0.22
Self-efficacy T1	-2.25	260	0.025*	-0.30	0.14	-0.58	-0.04
Outcome expectancies T1	-1.36	258	0.174	-0.15	0.11	-0.37	0.068
Intention T1	-3.11	260	0.002**	-0.39	0.13	-0.64	-0.14
Coping planning T1	-2.89	249	0.004**	-0.40	0.14	-0.68	-0.13
Action planning T1 <sup>a</sup>	-1.76	200.15	0.080	-0.27	0.15	-0.58	0.03
Action control	-2.60	250	0.010*	-0.39	0.15	-0.69	-0.10
Walking time T1	0.30	229	0.762	3.39	11.21	0.22	0.30
MVPA T1	0.35	161	0.725	7.30	20.75	-33.67	48.27
Total PA T1	0.44	159	0.659	12.75	28.81	0.24	0.39
Age	-0.85	258	0.399	-0.46	0.54	-1.52	0.61
education <sup>a</sup>	-2.40	206.98	0.017*	-0.39	0.16	-0.70	-0.07
gender	-1.21	243.01	0.229	-0.07	0.06	-0.18	0.044
Socioeconomic status	1.71	260	0.088	0.11	0.06	-0.02	0.24
Health status	-2.43	259	0.016*	-0.28	0.11	-0.50	-0.05
Civil status	0.79	260	0.428	0.10	0.12	-0.15	0.34
Fear of Covid-19	-1.19	259	0.236	-0.10	0.09	-0.27	0.07

Note. \*p < .05; \*\*p <0.01; \*\*\*p < .001; a Levene's test is significant (p < .05), suggesting a violation of the assumption of equal variances

## Table S6

## Descriptive statistics of HAPA factors of the sample

		Mis-			Mini-				
	N	sing	M	MD	SD	тит	Maximum		
		Time	point 1						
Self-efficacy T1	263	0	3.12	3	1.09	1	5		
Outcome expectancies T1	261	2	4.24	4.5	0.76	1.25	5		
Risk perception T1	262	1	3.28	3.33	1.12	1	5		
Coping Planning T1	253	10	3.4	3.67	1.18	1	5		
Action Planning T1	252	11	3.46	3.67	1.1	1	5		
Action Control T1	253	10	3.39	3.67	1.18	1	5		
Intention T1	263	0	3.83	4.0	1.02	1	5		
Walking Time T1	231	32	146	120	83	0	360		
MVPA T1	163	100	290	270	142	40	895		
Total PA T1	161	102	437	420	179	60	1020		
		Time	Point 2						
Self-efficacy T2	155	110	3.38	3.67	1.14	1	5		
Outcome expectancies T2	155	108	4.28	4.50	0.73	2	5		
Risk perception T2	155	108	3.36	3.67	1.18	1	5		
Coping Planning T2	153	110	3.55	4.00	1.12	1	5		
Action Planning T2	153	110	3.54	4.00	1.14	1	5		
Action Control T2	153	110	3.53	4.00	1.21	1	5		
Intention T2	155	108	4.04	4.0	0.91	1	5		
Walking Time T2	145	118	140	120	81	0	360		
MVPA T2	108	155	304	300	158	45	890		
Total PA T2	106	157	449	420	207	60	1070.00		

Note. Rating scale for each item is 1-5

## Table S7

		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Inten- tion T1	Pear- son's r	1													
	p-va- lue														
2. Inten-	Pear-	,631													
tion T2	son's r	**	1												
	p-va-	0.00													
	lue	0													
3. MVPA T1	Pear- son's r	- 0.00 1	0.00 4	1											
	p-va-	0.98	0.97												
	lue	8	2												
4. MVPA	Pear-	,203	,319	,412	1										
T2	son's r	*	**	**	1										
	p-va-	0.03	0.00	0.00											
	lue	5	1	0											
5. Wal- king time T1	Pear- son's r	,186 **	0.08 8	,344 **	,335 **	1									
	p-va-	0.00	0.30	0.00	0.00										
	lue	5	3	0	1										
6. Wal-	Pear-	0.08	0.09	,360	,433	,365									
king Time	son's r	6	4	**	**	**	1								
T2		0.00	0.0	0.00	0.00	0.00									
	p-va-	0.30 5	0.26	0.00	0.00	0.00									
<b>7</b> m + 1	n	5	0	0	0	0	4.61								
7. Iotal	Pear-	0.09	0.04	,893 **	,417 **	,731 **	,461 **	1							
PATI	SOILS I	0	0	0.00	0.00	0.00	0.00								
	p-va-	0.25	0.65	0.00	0.00	0.00	0.00								
0	nue	5	/	0	0	0	0	470							
8. Total	Pear-	0.15	,308 **	,431 **	,935 **	,393 **	,724 **	,472 **	1						
FA 12	son's r	/	0.00	0.00	0.00	0.00	0.00	0.00							
	p-va-	0.10	0.00	0.00	0.00	0.00	0.00	0.00							
	lue	/	1	U	U	U	U	U							

# Correlation Matrix of all HAPA-factors and covariates

		1	2	3	4	5	6	7	8	9	10	11	12	13	14
9. self- efficacy T1	Pear- son's r	,614 **	,505 **	0.10 1	0.18 6	,195 **	0.10 0	,168 *	0.18 1	1					
	p-va-	0.00	0.00	0.19	0.05	0.00	0.23	0.03	0.06						
	lue	0	0	8	4	3	2	3	3						
10. risk perception T1	Pear- son's r	,212 **	,163 *	0.10 9	0.04 0	0.07 0	- 0.10 6	0.09 2	- 0.01 7	0.08 1	1				
	p-va-	0.00	0.04	0.16	0.68	0.29	0.20	0.24	0.86	0.19					
	lue	1	4	5	3	0	5	8	6	4					
11. out- come ex- pectancies T1	Pear- son's r	,465 **	,396 **	- 0.10 4	0.11 2	- 0.00 7	0.01 9	- 0.10 5	0.04 6	,264 **	0.10 1	1			
	p-va-	0.00	0.00	0.18	0.24	0.91	0.81	0.18	0.63	0.00	0.10				
	lue	0	0	6	8	7	8	5	8	0	3				
12. action planning T1	Pear- son's r	,636 **	,469 **	0.13 2	,217 *	0.02 1	0.08 4	0.07 6	0.17 1	,490 **	0.11 2	,338 **	1		
	p-va-	0.00	0.00	0.09	0.02	0.75	0.32	0.34	0.08	0.00	0.07	0.00			
	lue	0	0	8	6	0	5	5	2	0	6	0			
13. coping planning T1	Pear- son's r	,716 **	,523 **	0.02 4	,208 *	,141 *	0.01 4	0.07 5	0.14 2	,565 **	,203 **	,349 **	,755 **	1	
	p-va-	0.00	0.00	0.76	0.03	0.03	0.87	0.34	0.15	0.00	0.00	0.00	0.00		
	lue	0	0	6	2	5	1	9	0	0	1	0	0		
14. action control T1	Pear- son's r	,745 **	,571 **	0.12 3	,217 *	0.08 9	0.02 8	0.13 4	0.14 2	,610 **	0.10 0	,392 **	,677 **	,695 **	1
	p-va-	0.00	0.00	0.12	0.02	0.18	0.73	0.09	0.15	0.00	0.11	0.00	0.00	0.00	
	lue	0	0	0	5	3	9	3	1	0	3	0	0	0	

Note. \* p < .05, \*\* p < .01, \*\*\* p < .001

## Table S8

## Regression Analysis of the Intention Model with all imputed Data Sets

								95%	CI
Number of data set			В	SE	β	Т	р	LL	UL
Original	1	Intercept	3.990	.062		64.678	0.000*	3.868	4.112
data							**		
(n=152)									
		Self-efficacy	0.340	0.061	0.403	5.536	0.000*	0.219	0.462
		T1 <sup>a</sup>					**		
		Risk percep-	0.097	0.054	0.123	1.792	0.075	-0.010	0.204
		tion T1 <sup>a</sup>							
		Outcome ex-	0.229	0.070	0.238	3.268	0.001*	0.091	0.368
		pectancies					*		
		T1 <sup>a</sup>							
	2	Intercept	3.174	1.130		2.809	0.006*	0.940	5.409
		Self-efficacy	0.255	0.064	0.302	4.006	0.000*	0.129	0.381
		T1 <sup>a</sup>					**		
		Risk percep-	0.116	0.055	0.146	2.121	0.036*	0.008	0.224
		tion T1 <sup>a</sup>							
		Outcome ex-	0.139	0.075	0.145	1.868	0.064	-0.008	0.287
		pectancies							
		T1 <sup>a</sup>							
		age	0.003	0.014	0.017	0.247	0.805	-0.024	0.031
		gender	-	0.131	-	-0.569	0.570	-0.334	0.185
			0.075		0.039				
		healthstatus	0.242	0.080	0.243	3.037	0.003*	0.085	0.400
		socioecsta-	-	0.131	-	-2.241	0.027*	-0.552	-0.035
		tus	0.293		0.155				
		education	0.048	0.054	0.061	0.891	0.375	-0.059	0.155
Imputed	1	Intercept	3.944	0.051		77.347	0.000	3.844	4.045
data set 1									
		Self-efficacy	0.157	0.049	0.197	3.237	0.001	0.062	0.253
		T1 <sup>a</sup>							
		Risk percep-	0.022	0.046	0.028	0.479	0.632	-0.068	0.112
		tion T1 <sup>a</sup>							

$\begin{array}{ c c c c c c c c c c c c c c c c c c c$			Outcome ex- pectancies	0.218	0.060	0.223	3.654	0.000	0.100	0.335
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $		2	Intercept	2.375	0.967		2.457	0.015	0.471	4.280
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$			Self-efficacy	0.109	0.052	0.136	2.079	0.039	0.006	0.211
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$			Risk percep-	0.057	0.047	0.074	1.209	0.228	-0.036	0.150
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$			Outcome ex- pectancies	0.162	0.062	0.166	2.609	0.010	0.040	0.285
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$			11" age	0.009	0.012	0.045	0.749	0.454	-0.015	0.033
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$			gender	_	0 115	_	-0 116	0 908	-0 240	0 213
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$			Bender	0.013	0.110	0.007	0.110	0.500	0.2.0	0.210
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$			healthstatus	0.194	0.065	0.203	2.990	0.003	0.066	0.322
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$			socioecsta-	0.062	0.104	0.036	0.593	0.554	-0.143	0.266
education         0.013         0.043         0.018         0.298         0.766         -0.071         0.097           Imputed data set 2         1         Intercept         3.975         0.050         79.554         0.000         3.877         4.074           data set 2         Self-efficacy         0.236         0.047         0.292         5.011         0.000         0.144         0.329           T1 a         Risk percep-         0.097         0.045         0.123         2.159         0.032         0.009         0.183           tion T1 a         Outcome ex-         0.185         0.057         0.188         3.226         0.001         0.072         0.299           pectancies         T1 a           2         Intercept         2.652         0.953         2.782         0.006         0.774         4.529           Self-efficacy         0.186         0.051         0.230         3.664         0.000         0.086         0.286           T1 a         Risk percep-         0.117         0.046         0.148         2.513         0.013         0.025         0.208           tion T1 a         Outcome ex-         0.150         0.060         0.152         2.507			tus							
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$			education	0.013	0.043	0.018	0.298	0.766	-0.071	0.097
data set 2 Self-efficacy 0.236 0.047 0.292 5.011 0.000 0.144 0.329 T1 <sup>a</sup> Risk percep- 0.097 0.045 0.123 2.159 0.032 0.009 0.185 tion T1 <sup>a</sup> Outcome ex- 0.185 0.057 0.188 3.226 0.001 0.072 0.299 pectancies T1 <sup>a</sup> 2 Intercept 2.652 0.953 2.782 0.006 0.774 4.529 Self-efficacy 0.186 0.051 0.230 3.664 0.000 0.086 0.286 T1 <sup>a</sup> Risk percep- 0.117 0.046 0.148 2.513 0.013 0.025 0.208 tion T1 <sup>a</sup> Outcome ex- 0.150 0.060 0.152 2.507 0.013 0.032 0.268 pectancies T1 <sup>a</sup> age 0.013 0.012 0.061 1.053 0.293 -0.011 0.036	Imputed	1	Intercept	3.975	0.050		79.554	0.000	3.877	4.074
Self-efficacy $0.236$ $0.047$ $0.292$ $5.011$ $0.000$ $0.144$ $0.329$ T1 a       Risk percep- $0.097$ $0.045$ $0.123$ $2.159$ $0.032$ $0.009$ $0.185$ tion T1 a       Outcome ex- $0.185$ $0.057$ $0.188$ $3.226$ $0.001$ $0.072$ $0.299$ pectancies       T1 a       T1 a       2       Intercept $2.652$ $0.953$ $2.782$ $0.006$ $0.774$ $4.529$ Self-efficacy $0.186$ $0.051$ $0.230$ $3.664$ $0.000$ $0.086$ $0.286$ T1 a       Risk percep- $0.117$ $0.046$ $0.148$ $2.513$ $0.013$ $0.025$ $0.208$ tion T1 a       Outcome ex- $0.150$ $0.060$ $0.152$ $2.507$ $0.013$ $0.032$ $0.268$ pectancies       T1 a $0.013$ $0.012$ $0.061$ $1.053$ $0.293$ $-0.011$ $0.036$	data set 2									
$11^{-4}$ Risk percep- $0.097$ $0.045$ $0.123$ $2.159$ $0.032$ $0.009$ $0.185$ tion T1 a       Outcome ex- $0.185$ $0.057$ $0.188$ $3.226$ $0.001$ $0.072$ $0.299$ pectancies       T1 a       T1			Self-efficacy	0.236	0.047	0.292	5.011	0.000	0.144	0.329
Outcome ex- pectancies T1 a $0.185$ $0.057$ $0.188$ $3.226$ $0.001$ $0.072$ $0.299$ 2       Intercept $2.652$ $0.953$ $2.782$ $0.006$ $0.774$ $4.529$ Self-efficacy $0.186$ $0.051$ $0.230$ $3.664$ $0.000$ $0.086$ $0.286$ T1 a       Risk percep- $0.117$ $0.046$ $0.148$ $2.513$ $0.013$ $0.025$ $0.208$ tion T1 a       Outcome ex- $0.150$ $0.060$ $0.152$ $2.507$ $0.013$ $0.032$ $0.268$ pectancies       T1 a       age $0.013$ $0.012$ $0.061$ $1.053$ $0.293$ $-0.011$ $0.036$			Risk percep-	0.097	0.045	0.123	2.159	0.032	0.009	0.185
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$			Outcome ex- pectancies	0.185	0.057	0.188	3.226	0.001	0.072	0.299
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$			T1 <sup>a</sup>							
Self-efficacy       0.186       0.051       0.230       3.664       0.000       0.086       0.286         T1 a       Risk percep-       0.117       0.046       0.148       2.513       0.013       0.025       0.208         tion T1 a       Outcome ex-       0.150       0.060       0.152       2.507       0.013       0.032       0.268         pectancies       T1 a       age       0.013       0.012       0.061       1.053       0.293       -0.011       0.036		2	Intercept	2.652	0.953		2.782	0.006	0.774	4.529
Risk percep-       0.117       0.046       0.148       2.513       0.013       0.025       0.208         tion T1 a       0utcome ex-       0.150       0.060       0.152       2.507       0.013       0.032       0.268         pectancies       T1 a       age       0.013       0.012       0.061       1.053       0.293       -0.011       0.036			Self-efficacy T1 <sup>a</sup>	0.186	0.051	0.230	3.664	0.000	0.086	0.286
Outcome ex-       0.150       0.060       0.152       2.507       0.013       0.032       0.268         pectancies       T1 a         age       0.013       0.012       0.061       1.053       0.293       -0.011       0.036			Risk percep- tion T1 <sup>a</sup>	0.117	0.046	0.148	2.513	0.013	0.025	0.208
age 0.013 0.012 0.061 1.053 0.293 -0.011 0.036			Outcome ex- pectancies T1 <sup>a</sup>	0.150	0.060	0.152	2.507	0.013	0.032	0.268
			age	0.013	0.012	0.061	1.053	0.293	-0.011	0.036
gender - 0.1130.287 0.774 -0.255 0.190			gender	-	0.113	-	-0.287	0.774	-0.255	0.190
0.052 $0.017healthstatus 0.123 0.063 0.128 1.966 0.050 0.000 0.246$			healthstatus	0.032	0.063	0.017	1.966	0,050	0.000	0.246

		socioecsta-	-	0.102	-	-0.972	0.332	-0.301	0.102
		tus	0.100		0.058				
		education	0.040	0.042	0.057	0.960	0.338	-0.042	0.123
Imputed data set 3	1	Intercept	4.001	0.051		78.154	0.000	3.901	4.102
		Self-efficacy T1 <sup>a</sup>	0.217	0.049	0.268	4.472	0.000	0.121	0.313
		Risk percep- tion T1 <sup>a</sup>	0.098	0.046	0.124	2.130	0.034	0.007	0.189
		Outcome ex- pectancies T1 <sup>a</sup>	0.129	0.059	0.131	2.186	0.030	0.013	0.245
	2	Intercept	2.436	0.968		2.516	0.012	0.530	4.343
		Self-efficacy T1 <sup>a</sup>	0.171	0.052	0.212	3.300	0.001	0.069	0.273
		Risk percep- tion T1 <sup>a</sup>	0.113	0.047	0.143	2.391	0.018	0.020	0.206
		Outcome ex- pectancies T1 <sup>a</sup>	0.098	0.061	0.100	1.615	0.108	-0.021	0.217
		age	0.021	0.012	0.102	1.736	0.084	-0.003	0.045
		gender	- 0.239	0.114	- 0.125	-2.086	0.038	-0.464	-0.013
		healthstatus	0.117	0.064	0.120	1.818	0.070	-0.010	0.244
		socioecsta-	-	0.104	-	-1.300	0.195	-0.339	0.069
		education	0.043	0.043	0.062	1.022	0.308	-0.040	0.127
Imputed data set 4	1	Intercept	3.990	0.049		80.961	0.000	3.893	4.087
		Self-efficacy T1 <sup>a</sup>	0.174	0.047	0.225	3.716	0.000	0.082	0.266
		Risk percep- tion T1 <sup>a</sup>	0.081	0.044	0.108	1.834	0.068	-0.006	0.169
		Outcome ex- pectancies T1 <sup>a</sup>	0.157	0.057	0.166	2.732	0.007	0.044	0.270
	2	Intercept	2.862	0.926		3.091	0.002	1.039	4.686
		Self-efficacy T1 <sup>a</sup>	0.107	0.050	0.139	2.159	0.032	0.009	0.205

		Risk percep- tion T1 ª	0.109	0.045	0.144	2.405	0.017	0.020	0.198
		Outcome ex- pectancies T1 <sup>a</sup>	0.095	0.059	0.100	1.607	0.109	-0.021	0.212
		age	0.009	0.012	0.047	0.803	0.423	-0.014	0.032
		gender	-	0.110	-	-1.108	0.269	-0.337	0.094
			0.121		0.067				
		healthstatus	0.198	0.062	0.213	3.196	0.002	0.076	0.320
		socioecsta-	-	0.099	-	-1.484	0.139	-0.343	0.048
		tus	0.147		0.090				
		education	0.027	0.041	0.040	0.654	0.514	-0.054	0.107
Imputed data set 5	1	Intercept	4.012	0.050		79.642	0.000	3.912	4.111
		Self-efficacy T1 <sup>a</sup>	0.216	0.048	0.271	4.503	0.000	0.121	0.310
		Risk percep-	0.046	0.045	0.059	1.007	0.315	-0.044	0.135
		tion T1 <sup>a</sup>							
		Outcome ex-	0.150	0.059	0.154	2.548	0.011	0.034	0.266
		T1 <sup>a</sup>							
	2	Intercept	3.131	0.963		3.251	0.001	1.234	5.027
		Self-efficacy T1 <sup>a</sup>	0.169	0.052	0.213	3.254	0.001	0.067	0.271
		Risk percep- tion T1 <sup>a</sup>	0.075	0.047	0.096	1.584	0.114	-0.018	0.168
		Outcome ex- pectancies T1 <sup>a</sup>	0.106	0.062	0.108	1.707	0.089	-0.016	0.228
		age	0.003	0.012	0.013	0.217	0.828	-0.021	0.026
		gender	0.092	0.114	0.049	0.807	0.420	-0.133	0.317
		healthstatus	0.150	0.065	0.157	2.320	0.021	0.023	0.277
		socioecsta-	-	0.103	-	-0.137	0.891	-0.217	0.189
		tus	0.014		0.008				
		education	0.000	0.042	0.001	0.010	0.992	-0.083	0.084
Combi- ned impu-	1	Intercept	3.985	0.058		68.737	0.000* **	3.869	4.100

ted Data

(n=263)

	Self-efficacy	0.200	0.060	3.332	0.002*	0.077	0.322
	T1 <sup>a</sup> Risk percep-	0.069	0.058	1.177	0.250	-0.052	0.189
	tion T1 <sup>a</sup>						
	Outcome ex-	0.168	0.070	2.409	0.020*	0.028	0.308
	pectancies						
2	Intercept	2.691	1.015	2.652	0.008*	0.695	4.688
	Self-efficacy	0.148	0.066	2.256	0.033*	0.013	0.284
	TI <sup>a</sup> Risk percep- tion TI <sup>a</sup>	0.094	0.055	1.711	0.093	-0.016	0.204
	Outcome ex- pectancies	0.122	0.070	1.748	0.085	-0.017	0.262
	T1 <sup>a</sup>						
	age	0.011	0.014	0.778	0.440	-0.017	0.039
	gender	-	0.177	-0.354	0.730	-0.451	0.325
		0.063					
	healthstatus	0.156	0.076	2.051	0.046*	0.003	0.310
	socioecsta-	-	0.141	-0.474	0.642	-0.363	0.230
	tus	0.067					
	education	0.025	0.047	0.530	0.597	-0.068	0.117

Notes. B, unstandardized regression coefficient; SE, standard error;  $\beta$ , standardised regression coefficient, all predictors were grand-mean-centered, \*p < .05; \*\*p <0.01; \*\*\*p < .001.
#### Table S9a

#### Regression Analysis of Volitional Factors at T1 on Walking Time at T2

						95% CI			
			В	SE	$\beta$	Т	p	LL	UL
Original data (n=129)	1	Intercept	139.93	7.47		18.740	0.000	125.154	154.712
		intention T1	-0.550	13.701	-0.006	-0.040	0.968	-27.669	26.568
		action planning T1	10.152	9.636	0.131	1.054	0.294	-8.920	29.225
		coping planning T1	-3.261	11.795	-0.040	-0.276	0.783	-26.607	20.084
		action control T1	0.317	10.401	0.004	0.030	0.976	-20.269	20.902
	2	Intercept	90.574	12.866		7.040	0.000	65.107	116.040
		intention T1	-2.267	12.731	-0.024	-0.178	0.859	-27.467	22.933
		action planning T1	15.193	9.018	0.196	1.685	0.095	-2.657	33.044
		coping planning T1	-9.483	11.040	-0.116	-0.859	0.392	-31.335	12.369
		action control T1	-1.576	9.669	-0.022	-0.163	0.871	-20.715	17.562
		Walking time T1	0.340	0.075	0.386	4.555	0.000	0.192	0.487
	3	Intercept	-103.480	121.765		-0.850	0.397	-344.608	137.647
		intention T1	-1.396	13.406	-0.014	-0.104	0.917	-27.943	25.151
		action planning T1	13.669	9.102	0.177	1.502	0.136	-4.355	31.694
		coping planning T1	-7.081	11.375	-0.087	-0.623	0.535	-29.606	15.444
		action control T1	-4.284	10.088	-0.061	-0.425	0.672	-24.262	15.694
		Walking time T1	0.334	0.075	0.379	4.436	0.000	0.185	0.483
		Age	2.021	1.546	0.115	1.307	0.194	-1.041	5.083
		Gender	-13.432	14.710	-0.081	-0.913	0.363	-42.562	15.698
		Socioecomonic Sta-	18.070	14.785	0.107	1.222	0.224	-11.208	47.348
		tus							
		Health status	7.020	8.812	0.075	0.797	0.427	-10.430	24.471
		Education	2.004	6.005	0.029	0.334	0.739	-9.888	13.896
1	1	Intercept	139.251	3.720		37.434	0.000	131.926	146.577
		intention T1	6.501	5.088	0.110	1.278	0.203	-3.518	16.520
		action planning T1	6.308	4.979	0.123	1.267	0.206	-3.497	16.112
		coping planning T1	-6.906	5.760	-0.125	-1.199	0.232	-18.248	4.436
		action control T1	-2.497	4.956	-0.049	-0.504	0.615	-12.256	7.263

2	Intercept	107.363	7.707		13.930	0.000	92.185	122.540
	intention T1	3.674	4.931	0.062	0.745	0.457	-6.037	13.385
	action planning T1	8.952	4.823	0.175	1.856	0.065	-0.545	18.449
	coping planning T1	-9.435	5.567	-0.171	-1.695	0.091	-20.397	1.528
	action control T1	-2.237	4.768	-0.044	-0.469	0.639	-11.626	7.152
	Walking time T1	0.219	0.047	0.284	4.672	0.000	0.126	0.311
3	Intercept	17.308	68.635		0.252	0.801	-117.864	152.479
	intention T1	3.112	5.068	0.053	0.614	0.540	-6.870	13.094
	action planning T1	8.937	4.864	0.174	1.837	0.067	-0.642	18.516
	coping planning T1	-9.152	5.615	-0.166	-1.630	0.104	-20.209	1.905
	action control T1	-2.365	5.060	-0.046	-0.467	0.641	-12.331	7.600
	Walking time T1	0.223	0.047	0.289	4.735	0.000	0.130	0.315
	Age	0.705	0.861	0.050	0.818	0.414	-0.992	2.401
	Gender	-2.273	8.114	-0.018	-0.280	0.780	-18.254	13.707
	Socioecomonic Sta-	12.563	7.575	0.108	1.659	0.098	-2.355	27.481
	tus							
	Health status	5.519	4.482	0.083	1.231	0.219	-3.307	14.345
	Education	-0.521	3.034	-0.011	-0.172	0.864	-6.496	5.454
1	Intercept	139.986	3.730		37.532	0.000	132.642	147.331
	intention T1	5.959	5.066	0.100	1.176	0.241	-4.017	15.935
	action planning T1	4.669	5.048	0.091	0.925	0.356	-5.272	14.609
	coping planning T1	-5.079	5.740	-0.092	-0.885	0.377	-16.382	6.224
	action control T1	-1.765	4.718	-0.035	-0.374	0.709	-11.055	7.526
2	Intercept	107.546	7.728		13.917	0.000	92.328	122.764
	intention T1	3.033	4.907	0.051	0.618	0.537	-6.630	12.695
	action planning T1	7.558	4.888	0.147	1.546	0.123	-2.068	17.185
	coping planning T1	-7.714	5.543	-0.140	-1.392	0.165	-18.629	3.202
	action control T1	-1.580	4.533	-0.031	-0.348	0.728	-10.507	7.348
	Walking time at T1	0.222	0.047	0.288	4.738	0.000	0.130	0.315
3	Intercept	-12.863	68.543		-0.188	0.851	-147.853	122.128
	intention T1	2.700	5.031	0.046	0.537	0.592	-7.209	12.609
	action planning T1	7.335	4.925	0.143	1.489	0.138	-2.366	17.035
	coping planning T1	-7.557	5.560	-0.137	-1.359	0.175	-18.507	3.393
	action control T1	-1.747	4.725	-0.034	-0.370	0.712	-11.053	7.558

		Walking time T1	0.227	0.047	0.295	4.839	0.000	0.135	0.320
		Age	1.138	0.860	0.081	1.324	0.187	-0.555	2.831
		Gender	-4.660	8.105	-0.036	-0.575	0.566	-20.623	11.303
		Socioecomonic Sta-	13.936	7.552	0.120	1.845	0.066	-0.937	28.809
		tus							
		Health status	5.694	4.404	0.087	1.293	0.197	-2.979	14.367
		Education	-0.528	3.043	-0.011	-0.174	0.862	-6.522	5.465
3	1	Intercept	139.121	3.729		37.307	0.000	131.777	146.464
		intention T1	5.157	5.150	0.087	1.001	0.318	-4.984	15.298
		action planning T1	5.205	4.993	0.101	1.042	0.298	-4.627	15.038
		coping planning T1	-3.076	5.585	-0.056	-0.551	0.582	-14.074	7.923
		action control T1	-2.846	5.046	-0.055	-0.564	0.573	-12.783	7.091
	2	Intercept	107.019	7.710		13.881	0.000	91.837	122.201
		intention T1	2.341	4.987	0.039	0.469	0.639	-7.481	12.162
		action planning T1	7.779	4.832	0.151	1.610	0.109	-1.736	17.294
		coping planning T1	-5.379	5.392	-0.097	-0.998	0.319	-15.997	5.240
		action control T1	-2.733	4.852	-0.053	-0.563	0.574	-12.287	6.821
		Walking time T1	0.220	0.047	0.286	4.703	0.000	0.128	0.312
	3	Intercept	9.953	69.120		0.144	0.886	-126.173	146.079
		intention T1	1.893	5.096	0.032	0.371	0.711	-8.143	11.928
		action planning T1	7.555	4.872	0.147	1.551	0.122	-2.039	17.150
		coping planning T1	-5.011	5.444	-0.090	-0.920	0.358	-15.732	5.711
		action control T1	-3.238	5.155	-0.063	-0.628	0.531	-13.390	6.915
		Walking time T1	0.224	0.047	0.290	4.759	0.000	0.131	0.316
		Age	0.810	0.865	0.058	0.936	0.350	-0.894	2.514
		Gender	-1.849	8.134	-0.014	-0.227	0.820	-17.868	14.169
		Socioecomonic Sta-	11.777	7.582	0.101	1.553	0.122	-3.156	26.710
		tus							
		Health status	5.760	4.532	0.087	1.271	0.205	-3.166	14.686
		Education	-0.587	3.040	-0.012	-0.193	0.847	-6.574	5.400
4	1	Intercept	139.919	3.723		37.586	0.000	132.588	147.249
		intention T1	6.455	4.969	0.109	1.299	0.195	-3.330	16.239
		action planning T1	6.228	5.069	0.121	1.229	0.220	-3.755	16.210
		coping planning T1	-3.468	5.742	-0.063	-0.604	0.546	-14.775	7.840

	action control T1	-5.208	4.790	-0.102	-1.087	0.278	-14.641	4.225
2	Intercept	108.210	7.720		14.017	0.000	93.007	123.413
	intention T1	3.491	4.825	0.059	0.723	0.470	-6.011	12.992
	action planning T1	9.209	4.921	0.179	1.871	0.062	-0.482	18.900
	coping planning T1	-6.026	5.554	-0.109	-1.085	0.279	-16.964	4.912
	action control T1	-5.031	4.611	-0.099	-1.091	0.276	-14.111	4.049
	Walking time T1	0.218	0.047	0.282	4.637	0.000	0.125	0.310
3	Intercept	14.090	68.612		0.205	0.837	-121.036	149.217
	intention T1	2.785	4.973	0.047	0.560	0.576	-7.009	12.579
	action planning T1	8.956	4.974	0.175	1.801	0.073	-0.840	18.752
	coping planning T1	-6.043	5.606	-0.109	-1.078	0.282	-17.084	4.999
	action control T1	-4.954	4.847	-0.097	-1.022	0.308	-14.499	4.591
	Walking time T1	0.221	0.047	0.287	4.694	0.000	0.129	0.314
	Age	0.807	0.863	0.058	0.936	0.350	-0.892	2.506
	Gender	-2.980	8.135	-0.023	-0.366	0.714	-19.002	13.042
	Socioecomonic Sta-	11.119	7.615	0.095	1.460	0.145	-3.878	26.116
	tus							
	Health status	5.915	4.459	0.089	1.326	0.186	-2.867	14.697
	Education	-0.726	3.044	-0.015	-0.239	0.812	-6.721	5.269
1	Intercept	139.944	3.741		37.411	0.000	132.578	147.310
	intention T1	4.217	5.362	0.071	0.786	0.432	-6.342	14.777
	action planning T1	3.563	4.890	0.069	0.729	0.467	-6.066	13.192
	coping planning T1	-2.320	5.656	-0.042	-0.410	0.682	-13.458	8.819
	action control T1	-2.325	4.761	-0.045	-0.488	0.626	-11.700	7.050
2	Intercept	108.264	7.761		13.950	0.000	92.981	123.547
	intention T1	1.589	5.195	0.027	0.306	0.760	-8.642	11.819
	action planning T1	6.200	4.743	0.120	1.307	0.192	-3.140	15.540
	coping planning T1	-4.809	5.473	-0.087	-0.879	0.380	-15.587	5.970
	action control T1	-2.190	4.585	-0.043	-0.478	0.633	-11.218	6.838
	Walking time T1	0.217	0.047	0.282	4.609	0.000	0.124	0.310
3	Intercept	1.370	68.772		0.020	0.984	-134.073	136.812
	intention T1	1.331	5.308	0.022	0.251	0.802	-9.123	11.784
	action planning T1	6.463	4.794	0.125	1.348	0.179	-2.980	15.905
	coping planning T1	-5.231	5.506	-0.095	-0.950	0.343	-16.075	5.613

		action control T1	-2.012	4.814	-0.039	-0.418	0.676	-11.493	7.469
		Walking time T1	0.222	0.047	0.288	4.696	0.000	0.129	0.315
		Age	0.903	0.863	0.065	1.046	0.296	-0.797	2.604
		Gender	-2.070	8.165	-0.016	-0.254	0.800	-18.149	14.010
		Socioecomonic Sta-	14.332	7.596	0.123	1.887	0.060	-0.627	29.291
		tus							
		Health status	5.256	4.496	0.079	1.169	0.244	-3.600	14.111
		Education	-0.441	3.045	-0.009	-0.145	0.885	-6.438	5.556
Combined	1	Intercept	139.644	3.757		37.170	0.000	132.280	147.008
imputed data $(x-2/2)$		intention T1	5.658	5.238		1.080	0.280	-4.613	15.928
(n=263)		action planning T1	5.195	5.151		1.008	0.313	-4.912	15.302
		coping planning T1	-4.170	6.040		-0.690	0.490	-16.052	7.713
		action control T1	-2.928	5.071		-0.577	0.564	-12.887	7.031
	2	Intercept	107.680	7.748		13.898	0.000	92.494	122.866
		intention T1	2.825	5.059		0.558	0.577	-7.095	12.745
		action planning T1	7.940	5.019		1.582	0.114	-1.912	17.792
		coping planning T1	-6.672	5.882		-1.134	0.258	-18.256	4.911
		action control T1	-2.754	4.895		-0.563	0.574	-12.372	6.864
		Walking time T1	0.219	0.047		4.666	0.000	0.127	0.311
	3	Intercept	5.971	70.004		0.085	0.932	-131.288	143.231
		intention T1	2.364	5.159		0.458	0.647	-7.749	12.478
		action planning T1	7.849	5.028		1.561	0.119	-2.015	17.713
		coping planning T1	-6.599	5.866		-1.125	0.261	-18.134	4.937
		action control T1	-2.863	5.124		-0.559	0.576	-12.923	7.197
		Walking time T1	0.223	0.047		4.737	0.000	0.131	0.316
		Age	0.873	0.881		0.991	0.322	-0.855	2.600
		Gender	-2.766	8.226		-0.336	0.737	-18.892	13.359
		Socioecomonic Sta-	12.745	7.732		1.648	0.099	-2.415	27.906
		tus							
		Health status	5.629	4.483		1.255	0.209	-3.159	14.416
		Education	-0.561	3.043		-0.184	0.854	-6.526	5.404

#### Table S9b

## Regression Analysis of Volitional Factors at T1 on MVPA at T2

								95%	6 CI
			В	SE	β	Т	р	LL	UL
Original		1 Intercept	297.568	19.339		15.38	0.000***	259.075	336.061
data (n=84)						7			
		Intention T1 <sup>a</sup>	-16.197	37.747	-0.079	-0.429	0.669	-91.332	58.937
		Action plan-	-2.739	24.421	-0.018	-0.112	0.911	-51.348	45.870
		ning T1 <sup>a</sup>	19 205	21 101	0 1 1 0	0.500	0.559	42 (10	80.200
		ning T1 <sup>a</sup>	18.295	31.101	0.118	0.388	0.558	-43.010	80.200
		Action con-	19.134	26.429	0.136	0.724	0.471	-33.472	71.740
		trol T1 <sup>a</sup>							
_	2	Intercept	168.362	40.445		4.163	0.000***	87.844	248.881
		Intention T1 <sup>a</sup>	-9.403	35.272	-0.046	-0.267	0.790	-79.624	60.818
		Action plan-	-12.924	22.964	-0.083	-0.563	0.575	-58.642	32.794
		ning T1 <sup>a</sup>							
		Coping plan-	20.167	29.024	0.130	0.695	0.489	-37.616	77.949
		ning TI <sup>a</sup>	15 425	24 692	0.110	0.625	0.524	22 702	61 572
		trol T1 <sup>a</sup>	15.455	24.082	0.110	0.023	0.334	-33.702	04.373
		MVPA at T1	0.474	0.133	0.374	3.570	0.001**	0.210	0.739
—	3	Intercept	179.880	304.573		0.591	0.557	-427.134	786.894
		Intention T1 <sup>a</sup>	-1.208	36.382	-0.006	-0.033	0.974	-73.717	71.301
		Action plan-	-13.700	23.590	-0.088	-0.581	0.563	-60.715	33.315
		ning T1 <sup>a</sup>							
		Coping plan-	21.269	30.185	0.137	0.705	0.483	-38.889	81.427
		ning T1 <sup>a</sup>	16 562	25 101	0 1 1 9	0.657	0.512	22 642	66 760
		trol T1 <sup>a</sup>	10.303	23.191	0.110	0.037	0.515	-35.045	00.709
		MVPA at T1	0.477	0.136	0.376	3.503	0.001**	0.206	0.748
		age	-1.244	3.558	-0.039	-0.350	0.728	-8.334	5.846
		gender	-35.790	35.439	-0.118	-1.010	0.316	-106.420	34.840
		socioecstatus	46.175	36.333	0.141	1.271	0.208	-26.236	118.586
		healthstatus	-2.676	22.878	-0.013	-0.117	0.907	-48.273	42.920
		education	9.784	15.367	0.076	0.637	0.526	-20.843	40.411

Imputed	1	Intercent	303 647	6 232		48 72	0.000	291 375	315 920
data set 1	1	moropi	505.04/	0.232		-10.72	0.000	4/1.J/J	515.920
aana Set 1		Intention T1 <sup>a</sup>	3.299	8.524	0.033	0.387	0.699	-13.486	20.085
		Action plan-	4.440	8.342	0.051	0.532	0.595	-11.986	20.867
		ning T1 <sup>a</sup>							
		Coping plan-	3.625	9.650	0.039	0.376	0.707	-15.377	22.628
		ning T1 <sup>a</sup>							
		Action con-	4.404	8.304	0.051	0.530	0.596	-11.947	20.755
		trol T1 ª	220.000	10 107		12.50	0.000	102 102	264.014
	2	Intercept	228.999	18.187		12.59	0.000	193.183	264.814
		Intention T1 <sup>a</sup>	5.781	8.262	0.058	0.700	0.485	-10.489	22.051
		Action plan-	0.765	8.110	0.009	0.094	0.925	-15.206	16.736
		ning T1 <sup>a</sup>							
		Coping plan-	6.897	9.361	0.074	0.737	0.462	-11.537	25.332
		ning T1 ª							
		Action con-	1.234	8.062	0.014	0.153	0.879	-14.643	17.110
		trol 11 ª	0 260	0.060	0 262	4 350	0.000	0 1/3	0 378
		Intercent	0.200	110.554	0.202	1.000	0.000	17.010	452.089
	3	Intercept	217.535	119.554	• • <b></b>	1.820	0.070	-1/.918	452.988
		Intention T1 a	7.503	8.471	0.075	0.886	0.377	-9.180	24.187
		Action plan-	-1.372	8.164	-0.016	-0.168	0.867	-17.450	14.705
		ning 11 " Coping plan-	6 928	9 417	0.075	0 736	0 463	-11 617	25 473
		ning T1 <sup>a</sup>	0.920	).717	0.075	0.750	0.405	-11.017	23.775
		Action con-	4.864	8.517	0.057	0.571	0.568	-11.910	21.639
		trol T1 <sup>a</sup>							
		MVPA at T1	0.272	0.061	0.274	4.470	0.000	0.152	0.392
		age	0.121	1.458	0.005	0.083	0.934	-2.750	2.992
		gender	-29.882	13.614	-0.137	-2.195	0.029	-56.693	-3.071
		socioecstatus	10.994	12.715	0.056	0.865	0.388	-14.047	36.036
		healthstatus	-4.464	7.524	-0.040	-0.593	0.554	-19.282	10.354
		education	7.893	5.130	0.098	1.538	0.125	-2.211	17.997
Imputed	1	Intercept	304.177	6.235		48.78	0.000	291.900	316.454
data set 2						9			
		Intention T1 <sup>a</sup>	2.841	8.468	0.028	0.335	0.738	-13.835	19.517
		Action plan-	4.242	8.438	0.049	0.503	0.616	-12.374	20.858
		ning T1 <sup>a</sup>							

		Coping plan- ning T1 <sup>a</sup>	2.019	9.594	0.022	0.210	0.834	-16.874	20.912
		Action con- trol T1 <sup>a</sup>	6.339	7.886	0.074	0.804	0.422	-9.191	21.868
	2	Intercept	229.954	18.128		12.68	0.000	194.255	265.653
		-				5			
		Intention T1 <sup>a</sup>	4.717	8.201	0.047	0.575	0.566	-11.433	20.867
		Action plan-	0.144	8.215	0.002	0.018	0.986	-16.032	16.321
		ning T1 <sup>a</sup>							
		Coping plan-	5.051	9.305	0.054	0.543	0.588	-13.273	23.375
		ning T1 <sup>a</sup>							
		Action con-	4.723	7.636	0.055	0.619	0.537	-10.313	19.760
		trol T1 <sup>a</sup>	0.050	0.060	0.0(1	4 2 4 2	0.000	0.142	0.077
		MVPA at T1	0.259	0.060	0.261	4.342	0.000	0.142	0.377
	3	Intercept	248.798	119.304		2.085	0.038	13.838	483.758
		Intention T1 <sup>a</sup>	7.301	8.425	0.073	0.867	0.387	-9.290	23.893
		Action plan- ning T1 <sup>a</sup>	-1.481	8.292	-0.017	-0.179	0.858	-17.812	14.850
		Coping plan- ning T1 <sup>a</sup>	4.554	9.341	0.049	0.488	0.626	-13.841	22.949
		Action con-	8.627	7.954	0.101	1.085	0.279	-7.038	24.292
		MVPA at T1	0.269	0.061	0.271	4.432	0.000	0.150	0.389
		age	-0.234	1.456	-0.010	-0.160	0.873	-3.102	2.635
		gender	-27.793	13.638	-0.127	-2.038	0.043	-54.652	-0.934
		socioecstatus	12.676	12.716	0.065	0.997	0.320	-12.367	37.718
		healthstatus	-5.657	7.417	-0.051	-0.763	0.446	-20.264	8.949
		education	6.514	5.163	0.081	1.262	0.208	-3.654	16.682
Imputed	1	Intercept	304.143	6.243		48.71	0.000	291.849	316.437
data set 3						7			
		Intention T1 <sup>a</sup>	3.779	8.622	0.038	0.438	0.662	-13.199	20.757
		Action plan- ning T1 <sup>a</sup>	2.936	8.360	0.034	0.351	0.726	-13.526	19.398
		Coping plan- ning T1 <sup>a</sup>	2.204	9.351	0.024	0.236	0.814	-16.209	20.617
		Action con- trol T1 <sup>a</sup>	6.166	8.448	0.071	0.730	0.466	-10.470	22.803

	2	Intercept	231.827	18.261		12.69	0.000	195.867	267.787
						5			
		Intention T1 <sup>a</sup>	5.734	8.370	0.057	0.685	0.494	-10.749	22.216
		Action plan-	-1.301	8.165	-0.015	-0.159	0.874	-17.380	14.779
		ning T1 ª							
		Coping plan-	5.917	9.106	0.063	0.650	0.516	-12.015	23.850
		ning T1 <sup>a</sup>							
		Action con-	3.809	8.208	0.044	0.464	0.643	-12.355	19.972
		trol T1 <sup>a</sup>	0.252	0.060	0.254	4 107	0.000	0.124	0 271
		MVPA at 11	0.252	0.060	0.254	4.197	0.000	0.134	0.371
	3	Intercept	250.898	120.792		2.077	0.039	13.006	488.789
		Intention T1 <sup>a</sup>	7.437	8.531	0.074	0.872	0.384	-9.365	24.239
		Action plan-	-2.477	8.219	-0.029	-0.301	0.763	-18.664	13.710
		Coping plan- ning T1 <sup>a</sup>	4.694	9.173	0.050	0.512	0.609	-13.371	22.759
		Action con- trol T1 <sup>a</sup>	8.411	8.686	0.097	0.968	0.334	-8.695	25.518
		MVPA at T1	0.262	0.061	0.264	4.278	0.000	0.141	0.382
		age	-0.219	1.468	-0.009	-0.149	0.882	-3.111	2.673
		gender	-28.199	13.679	-0.129	-2.061	0.040	-55.139	-1.258
		socioecstatus	10.418	12.755	0.053	0.817	0.415	-14.702	35.537
		healthstatus	-5.845	7.624	-0.052	-0.767	0.444	-20.861	9.170
		education	7.515	5.153	0.093	1.459	0.146	-2.632	17.663
Imputed	1	Intercept	303.560	6.246		48.59	0.000	291.260	315.861
data set 4						8			
		Intention T1 <sup>a</sup>	5.382	8.337	0.054	0.646	0.519	-11.036	21.800
		Action plan-	3.618	8.506	0.042	0.425	0.671	-13.132	20.368
		ning T1 <sup>a</sup>							
		Coping plan-	0.393	9.635	0.004	0.041	0.967	-18.580	19.367
		ning T1 <sup>a</sup>			<b></b>				
		Action con-	4.696	8.038	0.055	0.584	0.560	-11.133	20.524
		Intercent	220 260	10 120		12.50	0.000	102 640	264.000
	2	intercept	220.308	10.139		12.39	0.000	172.049	204.000
		Intention T1 <sup>a</sup>	7.274	8.068	0.073	0.902	0.368	-8.613	23.161
		Action plan- ning T1 <sup>a</sup>	-0.228	8.266	-0.003	-0.028	0.978	-16.505	16.049

		Coping plan-	3.392	9.335	0.037	0.363	0.717	-14.991	21.775
		ning T1 <sup>a</sup>							
		Action con-	2.455	7.784	0.029	0.315	0.753	-12.873	17.783
		MVPA at T1	0.263	0.060	0.265	4.396	0.000	0.145	0.381
	3	Intercept	259.429	119.589		2.169	0.031	23.908	494.951
		Intention T1 <sup>a</sup>	9.469	8.296	0.095	1.141	0.255	-6.870	25.807
		Action plan-	-1.846	8.335	-0.021	-0.221	0.825	-18.261	14.569
		ning T1 <sup>a</sup>							
		Coping plan- ning T1 <sup>a</sup>	3.371	9.393	0.036	0.359	0.720	-15.127	21.868
		Action con-	6.043	8.144	0.071	0.742	0.459	-9.995	22.081
		MVPA at T1	0.273	0.061	0.275	4.480	0.000	0.153	0.393
		age	-0.409	1.461	-0.017	-0.280	0.780	-3.287	2.469
		gender	-28.744	13.649	-0.132	-2.106	0.036	-55.624	-1.864
		socioecstatus	11.373	12.777	0.058	0.890	0.374	-13.790	36.536
		healthstatus	-5.427	7.489	-0.049	-0.725	0.469	-20.176	9.322
		education	7.113	5.149	0.088	1.381	0.168	-3.028	17.254
Imputed	1	Intercept	302.919	6.238		48.55	0.000	290.635	315.204
data set 5						8			
		Intention T1 <sup>a</sup>	0.869	8.943	0.009	0.097	0.923	-16.741	18.480
		Action plan-	2.882	8.154	0.033	0.353	0.724	-13.176	18.939
		ning T1 <sup>a</sup>							
		$C \cdot 1$	2 407	0.422	0.020	0.270	0.712	15 000	
		Coping plan- ning T1 <sup>a</sup>	3.487	9.433	0.038	0.370	0.712	-15.088	22.062
		Coping plan- ning T1 <sup>a</sup> Action con-	3.487 7.554	9.433 7.940	0.038 0.088	0.370 0.951	0.712 0.342	-15.088 -8.081	22.062 23.188
		Coping plan- ning T1 <sup>a</sup> Action con- trol T1 <sup>a</sup>	3.487 7.554	9.433 7.940	0.038 0.088	0.370 0.951	0.712 0.342	-15.088 -8.081	22.062 23.188
	2	Coping plan- ning T1 <sup>a</sup> Action con- trol T1 <sup>a</sup> Intercept	3.487 7.554 228.049	9.433 7.940 18.167	0.038	0.370 0.951 12.55	0.712 0.342	-15.088 -8.081 192.273	22.062 23.188 263.825
	2	Coping plan- ning T1 <sup>a</sup> Action con- trol T1 <sup>a</sup> Intercept	3.487 7.554 228.049	9.433 7.940 18.167	0.038	0.370 0.951 12.55 3	0.712 0.342	-15.088 -8.081 192.273	22.062 23.188 263.825
	2	Coping plan- ning T1 <sup>a</sup> Action con- trol T1 <sup>a</sup> Intercept	3.487 7.554 228.049 3.110	9.433 7.940 18.167 8.660	0.038 0.088 0.031	0.370 0.951 12.55 3 0.359	0.712 0.342 0.000 0.720	-15.088 -8.081 192.273 -13.944	22.062 23.188 263.825 20.164
	2	Coping plan- ning T1 <sup>a</sup> Action con- trol T1 <sup>a</sup> Intercept Intention T1 <sup>a</sup> Action plan-	3.487 7.554 228.049 3.110 -0.896	9.433 7.940 18.167 8.660 7.930	0.038 0.088 0.031 -0.010	0.370 0.951 12.55 3 0.359 -0.113	0.712 0.342 0.000 0.720 0.910	-15.088 -8.081 192.273 -13.944 -16.512	22.062 23.188 263.825 20.164 14.720
	2	Coping plan- ning T1 <sup>a</sup> Action con- trol T1 <sup>a</sup> Intercept Intention T1 <sup>a</sup> Action plan- ning T1 <sup>a</sup>	3.487 7.554 228.049 3.110 -0.896	9.433 7.940 18.167 8.660 7.930	0.038 0.088 0.031 -0.010	0.370 0.951 12.55 3 0.359 -0.113	0.712 0.342 0.000 0.720 0.910	-15.088 -8.081 192.273 -13.944 -16.512	22.062 23.188 263.825 20.164 14.720
	2	Coping plan- ning T1 <sup>a</sup> Action con- trol T1 <sup>a</sup> Intercept Intention T1 <sup>a</sup> Action plan- ning T1 <sup>a</sup> Coping plan- ning T1 <sup>a</sup>	3.487 7.554 228.049 3.110 -0.896 5.826	9.433 7.940 18.167 8.660 7.930 9.134	0.038 0.088 0.031 -0.010 0.063	0.370 0.951 12.55 3 0.359 -0.113 0.638	0.712 0.342 0.000 0.720 0.910 0.524	-15.088 -8.081 192.273 -13.944 -16.512 -12.161	22.062 23.188 263.825 20.164 14.720 23.814
	2	Coping plan- ning T1 <sup>a</sup> Action con- trol T1 <sup>a</sup> Intercept Intention T1 <sup>a</sup> Action plan- ning T1 <sup>a</sup> Coping plan- ning T1 <sup>a</sup> Action con-	3.487 7.554 228.049 3.110 -0.896 5.826 5.621	9.433 7.940 18.167 8.660 7.930 9.134 7.688	0.038 0.088 0.031 -0.010 0.063 0.065	0.370 0.951 12.55 3 0.359 -0.113 0.638 0.731	0.712 0.342 0.000 0.720 0.910 0.524 0.465	-15.088 -8.081 192.273 -13.944 -16.512 -12.161 -9.519	22.062 23.188 263.825 20.164 14.720 23.814 20.760
	2	Coping plan- ning T1 <sup>a</sup> Action con- trol T1 <sup>a</sup> Intercept Intention T1 <sup>a</sup> Action plan- ning T1 <sup>a</sup> Coping plan- ning T1 <sup>a</sup> Action con- trol T1 <sup>a</sup> MVPA at T1	3.487 7.554 228.049 3.110 -0.896 5.826 5.621 0.261	9.433 7.940 18.167 8.660 7.930 9.134 7.688 0.060	0.038 0.088 0.031 -0.010 0.063 0.065 0.263	0.370 0.951 12.55 3 0.359 -0.113 0.638 0.731 4 369	0.712 0.342 0.000 0.720 0.910 0.524 0.465 0.000	-15.088 -8.081 192.273 -13.944 -16.512 -12.161 -9.519 0.143	22.062 23.188 263.825 20.164 14.720 23.814 20.760 0.378

	3	(Konstante)	247.830	119.406		2.076	0.039	12.669	482.991
		Intention T1 <sup>a</sup>	5.273	8.838	0.053	0.597	0.551	-12.134	22.679
		Action plan-	-2.474	8.009	-0.029	-0.309	0.758	-18.246	13.299
		ning T1 <sup>a</sup>							
		Coping plan-	5.505	9.174	0.059	0.600	0.549	-12.561	23.572
		ning T1 <sup>a</sup>	0 5 4 5	0.051	0.110	1 0 1 1	0.005	( 110	05 (00
		Action con-	9.747	8.051	0.113	1.211	0.227	-6.110	25.603
		MVPA at T1	0 269	0.061	0 272	4 432	0.000	0 150	0 389
		2000	-0.267	1 456	-0.011	_0.183	0.855	-3 134	2 601
		age	-0.207	12 (2)	-0.011	-0.105	0.035	-5.154	1 5 9 1
		gender	-28.437	13.030	-0.130	-2.085	0.038	-55.292	-1.381
		socioecstatus	12.636	12.693	0.064	0.996	0.320	-12.361	37.634
		healthstatus	-5.774	7.519	-0.052	-0.768	0.443	-20.582	9.034
		education	7.224	5.126	0.090	1.409	0.160	-2.870	17.319
Combined	1	Intercept	303.689	6.264		48.48	0.000***	291.411	315.967
imputed						0			
data $(n-2(2))$		Intention T1 <sup>a</sup>	3.234	8.766		0.369	0.712	-13.955	20.423
(n-203)		Action plan-	3 624	8 398		0.431	0.666	-12 836	20.083
		ning T1 <sup>a</sup>	5.021	0.570		0.151	0.000	12.050	20.005
		Coping plan-	2.346	9.641		0.243	0.808	-16.553	21.244
		ning T1 <sup>a</sup>							
		Action con-	5.832	8.248		0.707	0.480	-10.339	22.002
		trol T1 <sup>a</sup>							
	2	Intercept	229.439	18.253		12.57	0.000***	193.664	265.215
		Intention T1 a	5 222	0 102		0	0.520	11 212	21.059
			5.525	8.483		0.627	0.530	-11.512	21.958
		Action plan-	-0.303	8.188		-0.037	0.970	-16.351	15.745
		Coping plan-	5.417	9.359		0.579	0.563	-12.930	23.764
		ning T1 <sup>a</sup>							
		Action con-	3.568	8.109		0.440	0.660	-12.341	19.478
		trol T1 <sup>a</sup>							
		MVPA at T1	0.259	0.060		4.319	0.000***	0.142	0.377
	3	(Konstante)	244.898	121.001		2.024	0.043*	7.709	482.087
		Intention T1 <sup>a</sup>	7.396	8.668		0.853	0.394	-9.600	24.392
		Action plan-	-1.930	8.225		-0.235	0.814	-18.051	14.190
		ning T1 <sup>a</sup>							

Coping plan- ning T1 ª	5.010	9.411	0.532	0.594	-13.437	23.458
Action con- trol T1 <sup>a</sup>	7.539	8.564	0.880	0.379	-9.269	24.346
MVPA at T1	0.269	0.061	4.404	0.000***	0.149	0.389
age	-0.202	1.476	-0.137	0.891	-3.094	2.691
gender	-28.611	13.671	-2.093	0.036*	-55.405	-1.817
socioecstatus	11.619	12.779	0.909	0.363	-13.427	36.665
healthstatus	-5.434	7.540	-0.721	0.471	-20.212	9.345
education	7.252	5.175	1.401	0.161	-2.890	17.394

Notes. B, unstandardized regression coefficient; SE, standard error;  $\beta$ , standardised regression coefficient, all predictors were grand-mean-centered, \*p < .05; \*\*p <0.01; \*\*\*p < .001.

#### Table S9c

#### Regression Analysis of Volitional Factors at T1 on Total Physical Activity at T2

								95%	CI
			В	SE	β	Т	р	LL	UL
Original	1	Intercept				17.115	0.000	396.984	501.545
Data ( <i>n</i> = 81)		intention T1	-7.863	50.891	-0.029	-0.155	0.878	-109.221	93.495
		action planning T1	10.689	33.146	0.051	0.322	0.748	-55.327	76.704
		coping planning T1	12.491	42.031	0.060	0.297	0.767	-71.221	96.203
		action control T1	5.457	36.052	0.029	0.151	0.880	-66.347	77.262
	2	Intercept	241.202	53.660		4.495	0.000	134.307	348.097
		intention T1	0.581	45.885	0.002	0.013	0.990	-90.826	91.988
		action planning T1	10.450	29.858	0.050	0.350	0.727	-49.030	69.931
		coping planning T1	-3.102	38.034	-0.015	-0.082	0.935	-78.869	72.664
		action control T1	5.025	32.477	0.027	0.155	0.877	-59.672	69.722
		Total PA T1	0.495	0.115	0.448	4.319	0.000	0.267	0.723
	3	Intercept	-106.667	396.692		-0.269	0.789	-897.845	684.510
		intention T1	13.513	47.430	0.050	0.285	0.777	-81.084	108.109
		action planning T1	4.486	30.613	0.021	0.147	0.884	-56.569	65.542
		coping planning T1	-0.726	39.382	-0.004	-0.018	0.985	-79.270	77.819
		action control T1	4.025	33.008	0.021	0.122	0.903	-61.807	69.857
		Total PA T1	0.500	0.116	0.453	4.311	0.000	0.269	0.732
		Age	3.160	4.865	0.072	0.650	0.518	-6.542	12.862
		Gender	-51.899	46.652	-0.128	-1.112	0.270	-144.943	41.146
		Socioecomonic Status	72.613	47.987	0.166	1.513	0.135	-23.094	168.321
		Health status	2.773	30.774	0.010	0.090	0.928	-58.604	64.149
		Education	10.021	20.023	0.058	0.500	0.618	-29.912	49.955
Imputed	1	Intercept	442.898	8.348		53.051	0.000	426.459	459.338
uata set 1		intention T1	9.800	11.419	0.073	0.858	0.392	-12.686	32.285

		action planning T1	10.748	11.174	0.093	0.962	0.337	-11.256	32.752
		coping planning	-3.281	12.927	-0.026	-0.254	0.800	-28.736	22.174
		T1							
		action control T1	1.907	11.123	0.017	0.171	0.864	-19.996	23.811
	2	Intercept	298.409	24.578		12.141	0.000	250.009	346.809
		intention T1	8.665	10.672	0.065	0.812	0.418	-12.351	29.681
		action planning T1	10.073	10.443	0.087	0.965	0.336	-10.491	30.638
		coping planning T1	-2.947	12.080	-0.024	-0.244	0.807	-26.736	20.841
		action control T1	-1.764	10.411	-0.015	-0.169	0.866	-22.267	18.739
		Total PA T1	0.334	0.054	0.359	6.199	0.000	0.228	0.440
	3	Intercept	181.491	153.412		1.183	0.238	-120.642	483.624
		intention T1	9.850	10.972	0.074	0.898	0.370	-11.758	31.458
		action planning T1	7.907	10.515	0.069	0.752	0.453	-12.802	28.615
		coping planning T1	-2.626	12.159	-0.021	-0.216	0.829	-26.573	21.321
		action control T1	1.981	11.025	0.017	0.180	0.858	-19.732	23.695
		Total PA T1	0.340	0.054	0.366	6.275	0.000	0.233	0.447
		Age	1.045	1.883	0.033	0.555	0.580	-2.664	4.754
		Gender	-32.047	17.664	-0.110	-1.814	0.071	-66.835	2.741
		Socioecomonic Status	24.800	16.502	0.095	1.503	0.134	-7.699	57.299
		Health status	0.503	9.762	0.003	0.052	0.959	-18.723	19.729
		Education	7.624	6.598	0.071	1.156	0.249	-5.369	20.618
Imputed data set 2	1	Intercept	444.163	8.362		53.114	0.000	427.696	460.631
		intention T1	8.800	11.358	0.066	0.775	0.439	-13.567	31.167
		action planning T1	8.911	11.318	0.077	0.787	0.432	-13.376	31.198
		coping planning T1	-3.060	12.869	-0.025	-0.238	0.812	-28.402	22.281
		action control T1	4.574	10.578	0.040	0.432	0.666	-16.255	25.404
	2	Intercept	298.297	24.534		12.159	0.000	249.985	346.610
		intention T1	6.800	10.603	0.051	0.641	0.522	-14.080	27.681
		action planning T1	7.962	10.561	0.069	0.754	0.452	-12.836	28.760
		coping planning T1	-3.112	12.008	-0.025	-0.259	0.796	-26.758	20.534

		action control T1	2.752	9.874	0.024	0.279	0.781	-16.692	22.197
		Total PA T1	0.337	0.054	0.362	6.271	0.000	0.231	0.443
	3	Intercept	179.559	153.065		1.173	0.242	-121.891	481.008
		intention T1	9.135	10.900	0.068	0.838	0.403	-12.333	30.602
		action planning T1	6.072	10.643	0.053	0.571	0.569	-14.888	27.033
		coping planning T1	-3.425	12.047	-0.028	-0.284	0.776	-27.151	20.301
		action control T1	6.706	10.296	0.058	0.651	0.515	-13.571	26.984
		Total PA T1	0.345	0.054	0.370	6.370	0.000	0.238	0.451
		Age	1.133	1.880	0.036	0.603	0.547	-2.569	4.835
		Gender	-32.424	17.661	-0.111	-1.836	0.068	-67.205	2.358
		Socioecomonic	27.997	16.469	0.107	1.700	0.090	-4.437	60.432
		Status							
		Health status	-0.590	9.603	-0.004	-0.061	0.951	-19.502	18.322
		Education	6.350	6.623	0.059	0.959	0.339	-6.694	19.395
Imputed data set 3	1	Intercept	443.264	8.370		52.958	0.000	426.782	459.746
		intention T1	8.935	11.559	0.067	0.773	0.440	-13.827	31.698
		action planning T1	8.141	11.208	0.070	0.726	0.468	-13.929	30.212
		coping planning T1	-0.872	12.536	-0.007	-0.070	0.945	-25.559	23.814
		action control T1	3.320	11.327	0.029	0.293	0.770	-18.984	25.624
	2	Intercept	297.368	24.556		12.110	0.000	249.010	345.725
		intention T1	7.235	10.790	0.054	0.671	0.503	-14.013	28.483
		action planning T1	6.419	10.462	0.055	0.613	0.540	-14.184	27.022
		coping planning T1	0.566	11.701	0.005	0.048	0.961	-22.476	23.608
		action control T1	0.341	10.580	0.003	0.032	0.974	-20.494	21.177
		Total PA T1	0.337	0.054	0.363	6.267	0.000	0.231	0.443
	3	Intercept	198.992	154.603		1.287	0.199	-105.487	503.470
		intention T1	8.500	11.038	0.064	0.770	0.442	-13.238	30.238
		action planning T1	4.982	10.544	0.043	0.472	0.637	-15.783	25.747
		coping planning T1	-0.250	11.806	-0.002	-0.021	0.983	-23.501	23.001
		action control T1	4.631	11.232	0.040	0.412	0.680	-17.490	26.752
		Total PA T1	0.343	0.054	0.369	6.324	0.000	0.236	0.450

		Age	0.865	1.893	0.027	0.457	0.648	-2.862	4.593	
		Gender	-30.003	17.711	-0.102	-1.694	0.091	-64.885	4.878	
		Socioecomonic	23.429	16.519	0.089	1.418	0.157	-9.103	55.962	
		Status								
		Health status	-0.640	9.873	-0.004	-0.065	0.948	-20.084	18.804	
		Education	7.341	6.613	0.068	1.110	0.268	-5.683	20.366	
Imputed data set 4	1	Intercept	443.479	8.372		52.971	0.000	426.993	459.965	
		intention T1	11.837	11.175	0.089	1.059	0.290	-10.168	33.842	
		action planning T1	9.846	11.401	0.085	0.864	0.389	-12.605	32.296	
		coping planning T1	-3.075	12.914	-0.025	-0.238	0.812	-28.505	22.356	
		action control T1	-0.512	10.773	-0.004	-0.048	0.962	-21.727	20.703	
	2	Intercept	298.995	24.546		12.181	0.000	250.659	347.332	
		intention T1	9.689	10.446	0.073	0.928	0.355	-10.881	30.260	
		action planning T1	9.531	10.652	0.082	0.895	0.372	-11.445	30.507	
		coping planning T1	-3.188	12.066	-0.026	-0.264	0.792	-26.948	20.571	
		action control T1	-3.094	10.074	-0.027	-0.307	0.759	-22.932	16.745	
		Total PA T1	0.335	0.054	0.360	6.210	0.000	0.229	0.441	
	3	Intercept	220.923	153.662		1.438	0.152	-81.702	523.547	
		intention T1	11.267	10.777	0.084	1.046	0.297	-9.956	32.491	
		action planning T1	7.636	10.752	0.066	0.710	0.478	-13.540	28.812	
		coping planning T1	-3.207	12.158	-0.026	-0.264	0.792	-27.152	20.737	
		action control T1	0.799	10.574	0.007	0.076	0.940	-20.025	21.623	
		Total PA T1	0.340	0.054	0.366	6.261	0.000	0.233	0.447	
		Age	0.618	1.890	0.020	0.327	0.744	-3.105	4.340	
		Gender	-31.723	17.742	-0.108	-1.788	0.075	-66.664	3.219	
		Socioecomonic	23.727	16.617	0.090	1.428	0.155	-9.000	56.453	
		Status								
		Health status	-0.160	9.735	-0.001	-0.016	0.987	-19.332	19.012	
		Education	6.642	6.632	0.061	1.002	0.318	-6.419	19.704	
Imputed data set 5	1	Intercept	442.864	8.353		53.018	0.000	426.415	459.312	
		intention T1	5.087	11.974	0.038	0.425	0.671	-18.493	28.667	

		action planning T1	6.445	10.919	0.056	0.590	0.556	-15.056	27.946
		coping planning	1.167	12.631	0.009	0.092	0.926	-23.705	26.039
		T1							
		action control T1	5.228	10.631	0.046	0.492	0.623	-15.707	26.164
	2	Intercept	297.063	24.511		12.120	0.000	248.795	345.330
		intention T1	3.904	11.174	0.029	0.349	0.727	-18.101	25.908
		action planning T1	5.655	10.188	0.049	0.555	0.579	-14.408	25.718
		coping planning	0.328	11.785	0.003	0.028	0.978	-22.881	23.536
		action control T1	2.942	9.926	0.026	0.296	0.767	-16.605	22,489
		Total PA T1	0.337	0.054	0.363	6.274	0.000	0.231	0.442
	3	Intercept	191.859	152.839		1.255	0.211	-109.145	492.864
		intention T1	5.863	11.430	0.044	0.513	0.608	-16.648	28.374
		action planning T1	4.323	10.290	0.037	0.420	0.675	-15.942	24.589
		coping planning	-0.372	11.845	-0.003	-0.031	0.975	-23.699	22.955
		T1							
		action control T1	7.445	10.416	0.065	0.715	0.475	-13.068	27.959
		Total PA T1	0.343	0.054	0.370	6.344	0.000	0.236	0.449
		Age	0.876	1.876	0.028	0.467	0.641	-2.819	4.571
		Gender	-30.132	17.658	-0.103	-1.706	0.089	-64.908	4.645
		Socioecomonic Status	28.341	16.440	0.108	1.724	0.086	-4.037	60.719
		Health status	-1.125	9.734	-0.008	-0.116	0.908	-20.294	18.045
		Education	7.082	6.580	0.066	1.076	0.283	-5.876	20.041
Combined	1	Intercept	443.334	8.381		52.895	0.000	426.906	459.761
imputed		intention T1	8.892	11.809		0.753	0.452	-14.272	32.056
data (n=263)		action planning T1	8.818	11.350		0.777	0.437	-13.431	31.068
		coping planning T1	-1.824	12.952		-0.141	0.888	-27.215	23.567
		action control T1	2.904	11.176		0.260	0.795	-19.018	24.825
	2	Intercept	298.026	24.560		12.134	0.000	249.889	346.164
		intention T1	7.259	11.007		0.659	0.510	-14.330	28.847
		action planning T1	7.928	10.670		0.743	0.458	-12.994	28.850

	coping planning	-1.671	12.116	-0.138	0.890	-25.425	22.083
	T1						
	action control T1	0.236	10.592	0.022	0.982	-20.562	21.033
	Total PA T1	0.336	0.054	6.241	0.000	0.231	0.442
3	Intercept	194.565	154.606	1.258	0.208	-108.475	497.604
	intention T1	8.923	11.240	0.794	0.427	-13.117	30.963
	action planning T1	6.184	10.691	0.578	0.563	-14.775	27.143
	coping planning	-1.976	12.123	-0.163	0.871	-25.740	21.788
	T1						
	action control T1	4.313	11.173	0.386	0.700	-17.629	26.254
	Total PA T1	0.342	0.054	6.310	0.000	0.236	0.448
	Age	0.907	1.897	0.478	0.632	-2.811	4.625
	Gender	-31.266	17.730	-1.763	0.078	-66.016	3.485
	Socioecomonic	25.659	16.709	1.536	0.125	-7.096	58.414
	Status						
	Health status	-0.402	9.765	-0.041	0.967	-19.541	18.736
	Education	7.008	6.633	1.056	0.291	-5.993	20.010

Notes. B, unstandardized regression coefficient; SE, standard error;  $\beta$ , standardised regression coefficient, all predictors were grand-mean-centered, \*p < .05; \*\*p <0.01; \*\*\*p < .001.

Appendix II: Supplementary information: What do older adults think about when formulating implementation intentions for physical activity? Evidence from a qualitative study

## **Implementation Intention Task**

#### Empfehlungen für körperliche Aktivität ab 65 Jahren

Die Bundeszentrale für gesundheitliche Aufklärung veröffentliche die Nationale Empfehlungen für Bewegung und Bewegungsförderung. In einem gesonderten Kapitel werden Bewegungsempfehlungen für ältere Erwachsene ab 65 Jahren gegeben. Hier heißt es unter anderem, dass regelmäßige körperliche Aktivität bedeutsame Gesundheitseffekte erzielen und die Risiken der Entstehung chronischer Erkrankungen reduzieren kann. Hierfür gelten folgende Mindestempfehlungen:

 mindestens 150 Minuten pro Woche ausdauerorientierte Bewegung mit moderater Intensität durchführen (z. B. 5 x 30 Minuten/Woche)

oder

 mindestens 75 Minuten/Woche ausdauerorientierte Bewegung mit höherer Intensität durchführen.

Dabei soll die Gesamtaktivität in mindestens 10-minütigen einzelnen Einheiten verteilt über Tag und Woche gebündelt werden (z.B. mindestens 3 x 10 Minuten/Tag bzw. 5 x 30 Minuten/Woche).

#### Zu beachten:

**Bewegung mit moderater Intensität** meint Aktivitäten, welche moderate körperliche Anstrengung benötigen. Bei diesen Aktivitäten atmen Sie etwas schwerer als im Ruhezustand, wie z.B. beim Laufen, Fahrrad fahren oder Einkaufen.

**Bewegung mit höherer Intensität** meint Aktivitäten, welche starke körperliche Anstrengung benötigen. Bei diesen Aktivitäten atmen Sie deutlich schwerer als im Ruhezustand, wie z.B. beim Fußball spielen, Tanzen, Schwimmen.

#### Planungsaufgabe

Jetzt würde ich Sie gerne darum bitten, sich Gedanken zu machen, wie sie Ihre körperliche Aktivität über die nächsten 28 Tage steigern können, so dass Sie den Empfehlungen der Bundeszentrale für gesundheitliche Aufklärung entsprechen.

Bitte beachten Sie hierbei folgende Fragen:

- a) Welche körperlichen Aktivitäten würde ich gerne durchführen?
- b) Überlegen Sie sich einen **Plan** für die kommenden 4 Wochen. Welche Aktivitäten könnten Sie täglich durchführen?
- c) Wann haben Sie am Tag Zeit, um die körperliche Aktivität durchführen? Für wie lang würden oder könnten Sie diese jedes Mal durchführen? Würden Sie diese körperlichen Aktivitäten lieber allein oder zusammen mit einer Person/en durchführen?

Jetzt haben Sie die Möglichkeit "**Wenn-Dann-Sätze**" zu formulieren, denn wissenschaftliche Studien zeigen, dass diese konkreten Pläne am besten erinnert werden, wenn Sie diesem Schema folgen. Zum Beispiel:

- "Wenn ich die Nachrichten im Fernsehen sehe, dann mache ich 10 Kniebeugen."
   Oder:
- "Wenn ich meine/n Freund/in zum Essen treffe, dann mache ich im Anschluss einen flotten Spaziergang."

Diese Art von "Auslösern" oder Hinweisen für körperliche Aktivität können bestimmte Situationen (z.B. Tageszeit), Dinge oder Personen beinhalten.

Jetzt denken Sie über die kommenden 4 Wochen nach und formulieren Sie zusammen mit dem Interviewer bis zu 3 Pläne, wie Sie Ihre körperliche Aktivität im Vergleich zu Ihrer derzeitigen steigern können.

Wichtig: Sie sollten diesen Plan bzw. diese Pläne täglich durchführen können.

Bitte beachten Sie bei der Formulierung der Sätze, dass diese realistisch gleichzeitig aber auch fordernd sind.

# Ihre Planung:

Plan	Wenn	Dann
1	Wenn	Dann
2	Wenn	Dann
3	Wenn	Dann

## Zum Schluss ein paar Fragen über Sie:

1.	Bitte geben Sie Ihr Alter an: Jahre				
2.	Bitte kreuzen Sie Ihr Geschlecht an: [] Mann [] Frau [] Anderes				
3.	Bitte kreuzen Sie Ihren Familienstand an:[] alleinstehend[] nie verheiratet[] verheiratet[] geschieden[] verwitwet[] Partnerschaft[] getrennte Partnerschaft				
4.	Bitte geben Sie Ihren höchsten Bildungsabschluss an:[] Grundschule[] Hauptschule[] Mittelschule[] Gymnasium[] Praktikum[] Universität[] andere Bezeichnung				
5.	<ul> <li>Sind Sie derzeit Berufstätig oder in Ruhestand?</li> <li>[] Arbeitstätig [] Ruhestand</li> </ul>				
	a. Wenn in Ruhestand: Mit welchem Alter gingen Sie in Ruhestand? Jahre				
6.	Leben Sie in Ihrem eigenen Haushalt (nicht in einer Pflegeeinrichtung)? [] ja [] nein				
7.	Mit wie vielen Menschen leben Sie zusammen?Menschen a. Wenn Sie mit anderen zusammenwohnen: Mit wem leben Sie zusammen? [] Partner /Partnerin [] Familie [] Andere				

## **Implementation Intention Task**

#### Practice task

We all know that what we eat is important to our health. Think about what you have for dinner in a typical week. Would you describe this as healthy? How much planning do you do to eat healthy meals each week?

#### Physical activity recommendation

In September 2019, the UK Chief Medical Officer updated the physical activity guidelines for the UK population. This included separate guidelines for older people. It recommends that older people carry out at least 150 minutes of moderate physical activity every week. Alternatively, those that can carry out vigorous physical activity are recommended to do at least 75 minutes of this activity every week. Daily, this equates to around 20 minutes moderate physical activity, or 12 minutes vigorous physical activity.

Remember:

**Moderate physical activity** refers to activities that require moderate physical effort where you breathe somewhat more heavily than normal (e.g. walking, cycling, shopping). **Vigorous physical activity** refers to activities that require strong physical effort where you breathe markedly more heavily than normal (e.g. playing football, dancing, swimming).

#### **Planning task**

Now we would like to ask you to think about increasing your physical activity over the next 28 days so that you meet the above physical activity recommendations.

To this end, please think about the following questions:

a) What **physical activities** would you like to carry out?

b) Think about your plans for the coming 4 weeks. Which activities could you do daily?

c) When do you have **time** each day to carry out physical activity? For how long would you like or could you do physical activity each time? Would you like to be active alone or together with another person / other persons?

Now, you have the opportunity to formulate **"if-then" sentences**, because scientific studies have found that these concrete plans are best remembered when they are formulated as "if-then" sentences. In doing so, it is particularly important to note the trigger for the activity. For example:

"<u>If</u> I am standing in the kitchen cleaning the dishes, <u>then</u> I will stand on one leg to improve my balance".

I'll leave my yoga mat by the lounge door. <u>If</u> I see my yoga mat in the morning, <u>then</u> I will do 15 minutes yoga exercise before breakfast".

"<u>If</u> I dropped my grandson off at my daughter's, <u>then</u> I will do a brisk walk home instead of taking the bus".

These kinds of triggers or cues to activity can comprise of situations (time of day, for example), things or persons.

Now think about the next 4 weeks, and together with the researcher, formulate up to three plans of how to be more physically active than previously.

**Important**: You should be able to perform the plan / plans **daily**.

Please pay attention to formulating the plans specifically so that they are realistic but still challenging.

Your pl Plan	anning: If	then
	If	then
1		
	If	then
2		
2	If	then
3		

#### **Demographics**

Lastly some questions about you please:

- 1. Please tell me your age
- 2. Write down their gender (male/female/other)
- 3. Please tell me your marital status (single or never married/married/divorced/widowed/civil union/dissolved union)
- 4. What is your highest educational degree? (primary school/secondary school/vocational qualification or apprenticeship/college/university/other professional)
- 5. Are you still in paid employment or retired? (yes/no)
  - a. If retired, at what age did you retire?
- 6. Do you live in your own home? (independent flat or house/sheltered housing or assisted living/residential home/other)
- 7. How many other people do you live with?
  - a. If live with others, who with? (partner/family/other)

## **Implementation Intention Task**

#### Bewegungsempfehlung BAG und BASPO

Gemäss der **Bewegungsempfehlung** des Bundesamts für Gesundheit (BAG) und des Bundesamts für Sport (BASPO) sollten ältere Menschen wöchentlich entweder 2½ Stunden moderat oder 1¼ Stunden anstrengend körperlich aktiv sein. Täglich ergibt dies etwa eine 12minütige anstrengende oder eine 20minütige moderate körperliche Aktivität. Zur Erinnerung:

Anstrengende Aktivitäten bezeichnen Aktivitäten, die starke körperliche Anstrengungen erfordern und bei denen Sie deutlich stärker atmen als normal.

**Moderate Aktivitäten** bezeichnen Aktivitäten mit moderater körperlicher Anstrengung bei denen Sie ein wenig stärker atmen als normal.

#### Planungsaufgabe

Nun möchten wir Sie bitten, darüber nachzudenken, Ihre körperliche Aktivität für die nächsten 28 Tage so zu steigern, dass Sie mindestens die Bewegungsempfehlung des BAG und des BASPO erreichen.

Bitte überlegen Sie sich dazu folgende Fragen:

a) Welche körperliche Aktivität(en) würden Sie gerne ausführen?

b) Denken Sie nun bitte an Ihre **Pläne** in den kommenden 4 Wochen. Welche Aktivitäten könnten Sie täglich ausüben?

c) Wann haben Sie **Zeitfenster**, in denen Sie eine körperliche Aktivität ausführen könnten? Wie lange möchten und können Sie diese jeweils ausführen? Möchten Sie diese alleine oder zusammen mit einer anderen Person/ anderen Personen machen?

Da wissenschaftliche Studien herausgefunden haben, dass sich solche konkreten Pläne am besten erinnern lassen, wenn man sie in **"wenn – dann" Sätzen** zusammenfasst, haben Sie nun die Möglichkeit "wenn-dann" Sätze zu formulieren. Dabei ist es besonders wichtig, den **Anstoss zur Aktivität** zu notieren, also zum Beispiel: Wenn ich gefrühstückt habe, dann packe ich meine Tasche und gehe ins Schwimmbad. Oder: Wenn ich meine Enkel bei meiner Tochter abgesetzt habe, dann gehe ich in schnellem Tempo zurück nach Hause anstatt den Bus zu benutzen. Solche Anstösse oder Aktivitätshinweise können aus **Situationen (zum Beispiel auch Uhrzeiten), Dingen oder Personen** bestehen.

Denken Sie nun bitte an die nächsten 4 Wochen und formulieren Sie mit der Versuchsleiterin bis zu drei Pläne, wie sie in dieser Zeit körperlich aktiver sein werden als bisher.

Wichtig: Sie sollten den Plan/ die Pläne täglich ausführen können. Achten Sie bitte darauf, dass Sie die Pläne spezifisch formulieren und dass diese zwar realistisch, dennoch herausfordernd sind.

## Ihre Planung:

Plan	Wenn	dann
1	Wenn	dann
2	Wenn	dann

#### Qualitative interview questions

#### Qualitative interview questions for participants after the think aloud is complete

Some people find completing these kinds of planning tasks to be helpful for doing the activities they want to do more of, such as physical activity. However other people find them not to be helpful. We would like to ask you about your experience of doing this planning task to try to find out more about why this is.

[Notes to interviewer: Each numbered question is to be asked at some point during the interview, the additional lettered questions underneath are probes to help get people talking to answer the question if they go quiet / don't appear to know how to respond]

- 1. Let's start by talking about physical activity: What was your first impression on reading on the physical activity guidelines at the beginning?
  - a. How much moderate physical activity would you say you do at the moment?
  - b. How do you feel about increasing it to 150mins per week?
- 2. What was it like for you completing this planning task?
  - a. How did it feel completing it?
    - i. What aspects did you like?
    - ii. What aspects did you not like?
  - b. Were there any aspects that felt easy and natural, or difficult and unnatural?
    - i. What aspects of your weekly routine follow a kind of plan like this?
  - c. What aspects that felt like they were motivating or demotivating?
  - d. What aspects that felt like your freedom of choice was being increased or restricted?
- 3. Now let's talk about your IF THEN plans: What was it like coming up with them?
  - a. In what ways would you say you think or feel differently about doing physical activity now that you have done the plans?
  - b. How motivated do you feel about following the plan each day?
  - c. How confident do you feel that you can do them?
    - i. What could make it difficult to do your IF THEN plans? (e.g. lack motivation or forget to do it)

- d. How do you feel about the "IF" part of the plans?
  - i. How easy was it to define this part?
  - ii. How helpful do you find defining the "IF" part, i.e. the situations?
- e. How do you feel about the "THEN" part of the plans?
  - i. How easy was it to define this part?
  - ii. How helpful do you find defining the "THEN" part, i.e. the different activities?

#### **Think Aloud Protocol**

- Set up the room and digital recording equipment
- Engage in conversation to build rapport and to help the participant feel at ease
- Thank them for participating
- Check that they understand the participant information sheet, answer any queries, and take informed consent
- Begin with the first set of instructions
- At the end turn to the post-think aloud questions (separate sheet)

#### Instructions for Think-Aloud (interviewer to read these aloud)

With your help we would like to find out more about how best to encourage older people to be physically active. One approach we are interested in is to ask people to develop a plan for being physically active. Therefore, I will provide you with a sheet that provides some information about the UK guidelines on physical activity, followed by a planning task. While reading the information and completing the task, I would like you to do this while thinking aloud. By "thinking aloud", I mean that you express everything that goes through your mind while reading and answering the questions. For example, when "thinking aloud" you might say how you understand the question or task. For some people it helps to summarize in their own words, what they have just read. If a question or task is difficult to understand, you can of course also say so.

For me, all things that go through your head while you read and answer the questions are important. Therefore, please say aloud everything you read and your possible answers and say, for example, whether the question or task is understandable, what you think it is asking for, and what you think about the possible answers. Especially if a question or task is difficult for you, it would be useful if you tell me.

I would like to ask you to "think aloud" the whole time. If possible, I would like you to talk constantly. Please do not think about what you tell me or how you say something. Just pretend to be alone in the room and talk to yourself.

If you are silent for a while, I will ask you to continue to think aloud. Of course, if you cannot think of any specific questions or find it difficult to answer, you can simply move on to the next part. After you have finished I will ask you some questions about how you found doing the planning task.

#### During the physical activity planning task:

If the participant is silent for about 10-15 seconds:

• "Please keep talking. Anything that goes through your mind when reading and an-

swering questions is an important piece of information for me."

If the participant keeps silent (5 times) longer than about 10-15 seconds:

• "Would you like me to read you the instructions again?"

If the participant queries about content and understanding:

• "How do you understand the question/task? Can you reproduce them in your own words?"

If the participant repeatedly asks about the same question:

• "This question is asking you about...".

Transcript in German
(Original Language)

# **English Translation**

Lack of necessity to plan	
DE7: Ich lasse meistens die Sachen auf mich zukommen und wenn Zeit ist, mache ich das, aber da sich das ganze schon zu einer gewis- sen Routine entwickelt hat, brauche ich da auch gar nicht gross zu planen.	I usually let things come to me and if there's time, I do it, but since everything already de- veloped into a certain routine, I don't need to do much planning.
DE4: Ich habs verstanden, aber ich weiss ehr- lich gesagt nicht, was ich, wie ich, was ich noch besser machen könnte, was ich schon mache. ich mach ja schon sehr viel.	I understood it, but honestly, I don't know what I, how I, what I could do better, what I'm already doing. I'm doing a lot already.
Planning feels too restrictive	
CH6: Eben, das ist dann nachher so irgend- wie ein Zwang.	Exactly, because afterwards this is somehow a restraint.
DE7: Also, ich denke mal eher einschrän- ken wie gesagt ich eigentlich nicht so sehr die Planerin bin und so in solchen Din- gen mehr so ein allgemeines Konzept habe, ich ich möchte mich möglichst viel bewegen und jetzt um welche Uhrzeit oder an welchem Tag oder so äh das ist für mich ein bisschen schwierig, das so einzugrenzen.	So, I think rather restraining like I said I'm actually not very much of a planner and such for such things I have more of a gen- eral concept, II want to exercise as much as possible and at which time of day or which day or so that is a bit difficult for me to narrow it down.

#### No reoccurring daily routine

CH3: Also der einzige fixe Ablauf, den wir haben, ist eigentlich am Morgen. Ja, am Morgen früh stehen wir auf, ziemlich früh, also (...) So spätestens um sieben Uhr stehen wir auf, machen... nehmen wir Frühstück, also dann könnte man eigentlich nach dem Frühstück (...) etwas einbauen.

CH11: Also, einen festgelegten Ding (Ablauf). also, mit Ausnahme vom Aufstehen, ins Bett gehen, vernünftig essen und so... aber sonst, zwischendurch (hab' ich keinen).

#### Only wanting to be active at certain times

CH11: Weil, wenn ich das am Morgen, Vormittag nach dem Frühstück mache, dann ähm, erstens habe ich es gemacht, zweitens bin ich am meisten motiviert, drittens stört mich niemand.

CH7: Das Zweite, das wüsste ich jetzt auch nicht gerade genau, dann müsste das einfach nach dem Mittagessen sein, am Abend möchte ich lieber nicht so anstrengende Sachen noch machen.

CH6: Jaja, ja, schon. Aber ich kann auch, am Morgen gelingt es mir irgendwie nicht so, und nach dem Mittag will ich jeweils gar nicht, aber vor dem Abendessen ist das irgendwie einfacher, und dann kann ich ja fernsehen und so. So, the only fixed routine we have is actually in the morning. Yes, early in the morning we get up, quite early, well (...) we get up at seven at the latest, we make... we have breakfast, so actually one could only integrate something after the breakfast.

So, a fixed thing (routine). So, with the exception of getting up, going to bed, eating reasonably and such..., but else, in between (I have none).

Because, when I do it in the morning, before noon after breakfast, then firstly I have done it, secondly, I'm the most motivated, thirdly nobody disrupts me.

The second, that I don't know exactly right now, then that would simply have to be after lunch. In the evening I would rather not do such strenuous things still.

Yes, yes, yes, I get it. But I can also, in the morning I somehow don't manage it, and after lunch I don't want at all, but before dinner it is somehow easier, and afterwards I can watch television or so.

#### The plan is a useful reminder

\*no German quotations\*

# The task encouraged resuming previous activities

CH8: Ähm und eines, das ich eine zeitlang öppe [= jeweils, ab und zu] praktiziert habe, und jetzt aber eigentlich eher in den Hintergrund ähm getreten ist, ist, wir haben oben einen Stepper.

CH4: Also einerseits, was ich wieder einführen möchte, das habe ich viele Jahre auch gemacht, ist jeden Morgen einfach so ein zehnminütiges Morgenturnen.

Planning triggers self-reflection about physical activity

\*no German citations\*

#### Spontaneous alternative activities

CH5: Ja. es wird ähm, eben jetzt gerade diese Woche wird es nicht imm... jetzt... ich habe noch ähm so einen fünfzehn bis Zwanzigprozent-Job...

CH13: Also in den nächsten vier Wochen würde ich mal, sofern ich nicht in der

Ehm, and something, which I practiced occasionally, which has now taken an ehm a backseat, is, we have a stepper upstairs.

So, on the one hand, what I would like to reinstate, I had done this for many years, is simply to do such a 10-minute morning gymnastics each morning.

Yes. It will ehm, but just this week it won't alw...now... I also have ehm a fifteen to twenty-percent job...

So, within the next four weeks, I would, provided I'm not in the holiday home, surely go to the gym once.
Ferienwohnung bin, sicher einmal ins Fitness gehen.

CH16: Ja, kann ich schon. ja, aber eben, ist einfach, dann kommt plötzlich Besuch, und dann kann ich dann nicht gehen (lacht).

CH12: Ja, das ist dann natürlich noch schwierig, wenn man dann irgendwie jetzt wie ich Besuch bekommt, die Woche wird das dann stattfinden, dann mache ich, ja, dann ist es halt dann schwer, dass ich es dann mache, gleich noch.

### Weather

CH1: Also ich sage jetzt so, wenn ich gehe, es kommt jetzt der Winter, also im Sommer ist man am Morgen früh gegangen, wenn es, dann hat man am Nachmittag gar nicht mehr «chönne go loufe» [= spazieren gehen können] eigentlich, oder.

DE9: Ah das plan ich ein, je nachdem, nach dem wetter, und was ich vorhabe.

#### health-related barriers

DE9: Es könnte mal im ganz seltenen Fall sein, dass ich erkältet bin. Da mache ich nichts, weil ich weiss, das kommt einen nicht gut an. aber ich bin ganz ganz selten mal erkältet, schon lange her. Und da habe ich also Yes, sure I can. Yes, but precisely, it is just, then some visitors are suddenly coming, and then I can't go (laughs).

Yes, that is quite difficult then, of course. When one gets a visitor, just like me, this week it will take place, then I will, well, then it's just difficult, that I do it then, on top.

So, I will say it this way, when I go, now the winter is coming. So, in summer one went in the early morning, when it, considering we couldn't go walking in the afternoon, actually, right.

Ah, I plan for that, depending, according to the weather and what I have planned.

It might occur on a very rare occasion that I have a cold. Then I do nothing, because I know, that isn't good for one. But it is very, very rare that I have a cold, long time ago. And so, I have no problems there. I don't need no make a plan.

keine Probleme. Ich brauche mir keinen Plan machen.

### **Covid-19-related barriers**

DE5: Mhm ne also schwimmen sind wir nicht gewesen. na das tun wir. Waren nämlich manchmal auch ähm, aber jetzt sind ja die Hallenbäder und alles geschlossen. wir erwägen natürlich, wenn jetzt einiges wieder eröffnet wird äh online sich dann die Berechtigungsscheine zu holen und dann auch äh äh auch Strandbad oder irgendwie zu gehen. Wissen wir jetzt aber jetzt noch nicht.

DE6: Ähm ja, dazu kann ich sagen, dass ich... gut in nicht-Corona- Zeiten eigentlich vier Stunden pro Woche im Schnitt ins Fitnessstudio gehe und da Kurse mache... Wirbelsäule und irgendwelche mittanzen und hüpfen und jetzt da das nicht möglich ist, ähm fahre ich mit dem Fahrrad zur Arbeit was fast zehn Kilometer sind. Mmmh, No, well we didn't go swimming. Well that we do. Went sometimes just as well ehm, but now the indoor swimming pools and everything are closed. We are of course considering, when many places are opened up again ehm, to get an authorization online, and then ehm ehm also to go to the public beach or else. But we don't know yet.

Ehm yes, about that I can say, that I... okay in non-Corona times I actually go four hours a week to the gym, on average, and do courses there... for the spine und some to dance to and jump up and down, and now that this isn't possible, ehm I ride my bike to work, which is nearly ten kilometres.

#### The task encouraged coping planning

CH5: Also, nein, wenn ich jetzt... Oder, wenn ich jetzt am Mittwoch und Donnerstag auf Luzern gehe, ähm, dann loufe [= gehe] ich dann eben zum Bahnhof und loufe [= gehe] wieder zurück.

CH6: Weil, es ist nicht immer gesagt, dass ich gleich nach dem Frühstück gehen kann

So, no, when I now... or when I go to Lucerne on Wednesday and Thursday, ehm, then I will walk to the train station and also back again.

Because, it is not always clear, that I can go right after breakfast, because I also have

(unverständlich), weil ich habe noch so verschiedene Ämtli [= aufgaben, Ämter], Pensionen am Machen für Leute im Kappelenring, oder dann habe ich ähm, noch Migrationsdienst, wo ich gehen muss.

some miscellaneous appointments, doing pensions for the people in the Kappelenring, or then I have ehm migration service, that I have to go to.

## Table S1

Sample	UK (N = 8)	DE (N=9)	CH (N=16)
	n	n	n
Gender			
Female	3	7	6
Male	5	10	3
Marital Status			
Single	1	2	0
Married	4	9	3
Divorced	2	4	1
Widowed	1	2	3
Relationship	0	1	0
<b>Highest Education</b>			
Not specified	1	0	0
Other professional	2	1	2
A-Levels	1	0	0
College	1	0	0
Apprenticeship	1	3	0
Secondary School	0	2	0
University	0	11	6
<b>Retirement Status</b>			
Retired	6	14	8
Not retired	2	3	1

Appendix III: Supplementary information: The Role of Self-Determination When Older Adults Talk About Their Physical Activity: An Interpretative-Phenomenological Study

## Interviewleitfaden für Self Act – Prätestung

<ul> <li>Leitfragen: <ol> <li>Was denken ältere Menschen was sie brauchen, um körperlich aktiv zu sein?</li> <li>Welche Rolle spielt die Selbstbestimmung, wenn Senioren über ihre körperliche Aktivität sprechen?</li> </ol> </li> </ul>			
	Frage	Weiterführende/ aufrechterhal- tende Fragen	Notizen
1.	Begrüssung/Einstieg	Liebe/r Frau/Herr Wir werden nun gemeinsam die- ses erste Interview durchführen. Dies wird ca. 30 Minuten dauern. Ich werde das Gespräch zu Stu- dienzwecken aufnehmen, natür- lich stehen diese Gespräche un- ter Datenschutz und werden auch in anonyme Transskripte verfasst. Nun werde ich mit der Aufnahme beginnen.	<ul> <li>Mit Name und Abteilung vorstellen</li> <li>Ziel: Vorstudie zur Er- fassung von Einstellun- gen zur Intervention.</li> <li>Betonen: Es gibt kein richtig/falsch</li> <li>Dauer: ca. 30 Minuten</li> <li>Datenschutz: Audioauf- nahme, pseudonymi- sierte Transkripte, Spei- chern auf passwortge- schützten Server</li> </ul>
1.1	Wieso wollen Sie an unse- rer Studie teilnehmen?		
1.2	Narratives Interview:         Schritt 1 (ohne nachfra- gen):         Erzählen Sie wie Sie zu         Ihren aktuellen körperli- chen Aktivitäten gekom- men sind? Erzählen Sie von Anfang an bis heute.         Nur bei Unklarheiten bzgl.         KA:         Mit körperlicher Aktivität ist Bewegung im Allgemeinen aber auch verschiedene Sportarten gemeint.         Erzählen Sie, wie Sie ak- tuell körperlich aktiv sind.	Schritt 2 (spezifisches Nachfra- gen):         Fokus auf Wieso, Weshalb, Wa- rum!         Wie hat es begonnen?         Welche Aktivitäten sind geblie- ben, welche sind über die Jahre hinweg verloren gegangen? In- wiefern?         Was hat sich verändert?         → Was ist KA für Sie (Definition)?         → Was bedeutet KA für Sie (per- sönl. Relevanz)?         Welche Rolle spielt körperliche Aktivität zurzeit in Ihrem Leben?         Gab es im Verlauf des Lebens längere Phasen mit regelmässi- ger, intensiver körperlicher Betäti- gung (bspw. Fussballtraining, Tanzunterricht etc.)?         Weshalb machen Sie das, was Sie jetzt machen? Was aufgehört und weshalb?	
2.	Motivation		
2.1	Wieso wollen Sie ihre kör- perliche Aktivität steigern?	Ist es eher eine Pflicht, Notwen- digkeit oder macht es auch Freude?	

2.2	Was motiviert Sie körper- lich aktiv zu sein?	Welche Aspekte sind besonders wichtig für Sie (Bessere Gesund- heit, mehr Leistungsfähigkeit, all- gemeine Fitness verbessern, per- sönliche Ziele und Herausforde- rungen angehen etc.)?	
2.3	Was sind Voraussetzun- gen, damit sie körperlich aktiver sein können?		
2.4	Möchten Sie sonst noch etwas sagen? Noch ein Anliegen? Anmerkung?		
3.	Verabschiedung	Danken für Ihre Geduld und Ihren Beitrag Aussicht auf die kommenden 5 Wochen geben → jeden Tag Tra- cker & Tagebücher + nach einer Woche Ziele und Pläne, welche Sie jeweils 1x wöchentlich ändern können. Danach Fragebogen & Tracker erklären Follow-up Termin ausmachen	

## Translated pre-intervention interview guideline

<ul><li>Key questions:</li><li>1. What do older people think they need to be physically active?</li><li>2. What role does self-determination play when seniors talk about their physical activity?</li></ul>				
	Question	continuing/sustaining questi- ons	Notes	
1.	Greeting/Introduction	Dear Mrs/Mr We will now conduct this first in- terview together. This will take about 30 minutes. I will record the interview for study purposes, of course these interviews are sub- ject to data protection and will also be transcribed anonymously. I will now start the recording.	<ul> <li>Introduce with name and department</li> <li>Aim: Preliminary study to record attitudes to- wards the intervention.</li> <li>Emphasize: There is no right/wrong</li> <li>Duration: approx. 30 minutes</li> <li>Data protection: Audio recording, pseudony- mized transcripts, stor- age on password-pro- tected server</li> </ul>	
1.1	Why do you want to take part in our study?			
1.2	Narrative Interview: Step 1 (without asking): Tell how you came to your current physical activities?	Step 2 (specific questions): Focus on why, wherefore, why! How did it start?		

	Tell us from the beginning until today. <u>Only if you are unclear</u> <u>about physical activity:</u> <i>Physical activity means</i> <i>exercise in general, but</i> <i>also various types of sport.</i>	Which activities have remained, which have been lost over the years? In what way? What has changed? → What is physical activity for you (definition)? → What does physical activity mean to you (personal rele-	
1.2		vance)?	
1.0	rently physically active.	currently play in your life? Have there been longer phases of regular, intensive physical activity (e.g. football training, dance les- sons, etc.) in the course of your life? Why do you do what you do now? What did you stop doing and why?	
2.	Motivation		
2.1	Why do you want to in- crease your physical activ- ity?	Is it more of a duty, a necessity or is it also fun?	
2.2	What motivates you to be physically active?	Which aspects are particularly im- portant to you (better health, more performance, improving general fitness, tackling personal goals and challenges, etc.)?	
2.3	What are the prerequisites for you for being more physically active?		
2.4	WMany other things you would like to say? Another request? A comment?		
3.	Goodbye	Thank you for your patience and your contribution Outlook for the next 5 weeks → every day tracker & diaries + after one week: goals and plans, which you can change once a week. Then explain questionnaire & tracker Make a follow-up appointment	

### Interviewleitfaden für Self Act - Posttestung

### Leitfragen:

- **1.** Hat die Intervention die Wahrnehmung älterer Menschen in Bezug auf ihre körperliche Aktivität verändert?
- **2.** Glauben SeniorInnen, dass Selbstbestimmung für Ihre körperliche Aktivität nach der Intervention wichtig ist?
- **3.** Waren SeniorInnen der Meinung, dass die Möglichkeit, ihre Pläne zu überprüfen und zu ändern hilfreich war, um ihre Motivation zur Aktivität zu fördern und zu mehr körperlicher Aktivität geführt haben?

	Frage	Weiterführende/ aufrechterhal- tende Fragen	Notizen
1.	Begrüssung/Einstieg	Liebe/r Frau/Herr Ehrlichkeit sehr wichtig, gibt kein richtig oder falsch. Es sind Ihre persönlichen Eindrücke der letzten Wochen. Dauer: ca. 30 Minuten. Gespräch wird aufgezeichnet, alles anonym und wird nur zu Studien- zwecken verwendet. Gerne beginne ich mit den ersten Fragen	<ul> <li>Mit Name und Abtei- lung vorstellen</li> <li>Betonen: Es gibt kein richtig/falsch</li> <li>Ziel: Erfassung der Wahrnehmung der Studie über die letzten 5 Wochen.</li> <li>Rechte/Pflichten: Je- derzeit ohne Begrün- dung abbrechen dür- fen. Betonen, dass für uns wichtig ist, was das eigene Erleben der Teilnehmenden ist.</li> <li>Datenschutz: Audio- aufnahme, pseudony- misierte Transkripte, Speichern auf pass- wortgeschützten Ser- ver</li> </ul>
1.1	Narratives Interview: <u>Schritt 1 (ohne nachfra-</u> <u>gen):</u> Sie haben das Ziel ge- habt, ihre KA zu steigern. Erzählen Sie mir von An- fang an bis heute, wie es Ihnen während der Studie ergangen ist. Haben Sie das Gefühl, dage die Studie Ibre KA	Schritt 2 (spezifisches Nachfragen): Zeichnen von persönlichem Zeit- strahl. Wie lief es generell ab mit ihrer kör- perlichen Aktivität? Wie war die erste Woche nur mit Tagebuch? Wie sind die Zielsetzung und das Erstellen der Pläne abgelaufen? Wie ist es Ihnen mit dem Wochen- rückblick ergangen? → Es geht um das grosse Ganze. → Zeitstrahl Ziel: Merkt Vp Unterschied zw. Prä	
	dass die Studie Ihre KA verändert hat?	und Post?	
1.3	Erzählen sie von der In- tervention. Was hat Ihnen gefallen und was weni- ger?	Fanden Sie das, was Ihnen gut ge- fallen hat auch nützlich, um Ihre KA zu steigern? Haben die Wochenrückblicke und die Möglichkeit Ihre Pläne bei Be- darf anzupassen Ihre Motivation ge- steigert, körperlich aktiv zu sein?	

			Wieso haben Sie die Gele ten, Ihre Pläne und Ziele ir chenrückblick anzupassen oder nicht genutzt?	genhei- n Wo- , genutzt	
1.4	Stateme «Bitte b folgende 'Die Inte mir daze	ent eenden Sie den en Satz» ervention hat bei u geführt, dass…'	bei		
2.	Motivat	ion			
2.1	2.1 <b>Statement</b> «Beenden Sie den fol- genden Satz» <i>Was mich während der</i> <i>Intervention am meisten</i> <i>motiviert hat, körperlich</i> Hat es Ihnen Spat perlich aktiver zu s dies im Verlauf ve Aufgaben, für die viert waren? Konn trotzdem ausführe		Hat es Ihnen Spass gemac perlich aktiver zu sein? Ha dies im Verlauf verändert? Aufgaben, für die Sie weni viert waren? Konnten Sie o trotzdem ausführen?	cht kör- t sich Gab es ger moti- diese	
2.2	Aufkläru Ihnen bo scheidu Ist uns o	ung: Wir wollten esonders viel Ent- ngsfreiheit geben. das gelungen?	Wenn ja: Inwiefern? Wenn nein: Inwiefern hat die Inter- vention sie in irgendeiner Weise in Ihrer Entscheidungsfreiheit einge- schränkt?		
2.3	Was ha gen, Ihr dern od	t Sie dazu bewo- e Pläne zu verän- er beizubehalten?	Haben Sie dazu ein bestim Beispiel?	nmtes	Extrinsische Motivation; Motivation aufgrund exter- ner Anreize.
			•		
5.	3. Feasability + Adherence Checkliste			Falls ma Person s hier noch uns so w man <u>nich</u> Falls Fra antworte gen unte den.	n das Gefühl hat, dass die tozial erwünscht antwortet, mals erklären, wieso es für richtig ist zu wissen, was <u>at</u> korrekt umsetzt. gen bereits genügend be- t wurden oben, können Fra- n weggelassen/gekürzt wer-
3.1	Be- reits       Konnten Sie alle Aufgaben vollständig aus- führen?         genü- gend- bear_ wor- tet:       wor- tet:		Wenn ne Erklären ist: «Sie Wochen wie gut h funktionie	ein; warum? was mit Aufgaben gemeint konnten Ihre KA während 4 planen und direkt umsetzen, nat dies Ihrer Meinung nach ert?»	
3.2	Be- reits genü- gend bear       Waren die Instruktionen für die Aufgaben gut verständlich und umsetzbar?         wor- tet:       wor- tet:		Glauben Aufgaber ben?	Sie, die Instruktionen der n korrekt umgesetzt zu ha-	
3.3	tet:       Inwieweit haben Sie das Gefühl, dass Sie         Be-       Inwieweit haben Sie das Gefühl, dass Sie         reits       Ihre Pläne, um Ihr Bewegungsziel zu errei-         genü-       chen, über die Wochen hin gut umsetzen         gend       konnten?         bear       wor-         tet:		Was war von abge auszufüh zu erreic	en Situationen, die Sie da- ehalten haben Ihre Pläne nren, um Ihr Bewegungsziele hen? Wie war das für Sie?	

3.4	Be- reits genü- gend beal wor- tet:	Womit hatten Sie Mühe diese während der Studie? Was ist Ihnen während der Studie gut gelungen?		
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### Translated post-intervention interview guideline

Key questions:

- 1. has the intervention changed older people's perception of their physical activity?
- 2. do older adults believe that self-determination is important for their physical activity after the intervention?
- 3. did older adults feel that the opportunity to review and change their plans was helpful in increasing their motivation to be active and led to more physical activity?

	Frage	Weiterführende/ aufrechterhal- tende Fragen	Notizen
1.	Greeting/Introduction	Dear Mrs/Mr Honesty is very important, there is no right or wrong. These are your personal impres- sions of the last few weeks. Dura- tion: approx. 30 minutes. Interview is recorded, all anony- mous and will only be used for study purposes. I would like to start with the first questions	<ul> <li>Introduce with name and department</li> <li>Emphasize: There is no right/wrong</li> <li>Aim: To record the per- ception of the study over the last 5 weeks.</li> <li>Rights/duties: To be able to stop at any time without giving rea- sons. Emphasize that what is important to us is the participants' own experience.</li> <li>Data protection: Audio recording, pseudony- mized transcripts, stor- age on password-pro- tected server</li> </ul>
1.1	Narrative Interview: <u>Step 1 (without asking):</u> <u>You have had the goal of</u> <u>increasing your physical</u> <u>activity. Tell me how you</u> <u>fared during the study.</u> <u>from the beginning until</u> <u>today.</u>	Step 2 (specific questions):         Drawing personal timeline.         How did your physical activity generally go?         How was the first week with just a diary?         How did the goal setting and creating the plans go?         How did you do with the weekly review?         → It's about the big picture.         → Timeline	
1.2	Do you feel that the study has changed your physi- cal activity?	Objective: Does the participant no- tice the difference between pre and post?	

1.3	Erzählen sie von der In- tervention. Was hat Ihnen gefallen und was weni- ger?	Did you find what you liked useful to increase your physical activity? Did the weekly reviews and the op- portunity to adjust your plans as needed increase your motivation to be physically active? Why did you use or not use the op- portunities to adjust your plans and goals in the weekly review?	
1.4	Statement "Please finish the follow- ing sentence" 'The intervention has led me to'		
2.	Motivation		
2.1	Statement "Finish the following sen-	Did you enjoy being more physically active? Did this change over time?	
	tence" 'What motivated me most to stay physically active during the intervention was'	were less motivated? Were you still able to carry them out?	
2.2	tence" 'What motivated me most to stay physically active during the intervention was' Clarification: We wanted to give you a lot of free- dom of choice. Did we succeed?	If yes: In what way? If no: To what extent did the inter- vention restrict your freedom of choice in any way? Suggestions for improvement?	

3.	Feasability Check list	+ Adherence	Depending on the assessment of the answers: If you have the feeling that the person is answering in a socially desirable way, explain here again why it is so important for us to know what is not being imple- mented correctly. If questions have already been well enough answered above, questions below can be omitted/shortened.
3.1	Already answered enough:	Konnten Sie alle Aufgaben vollständig aus- führen?	If no; why? Explain what is meant by tasks: "You were able to plan your physi- cal activity for 4 weeks and imple- ment it directly, how well do you think this worked?"
3.2	Already answered enough:	Were the instructions for the tasks easy to understand and implement?	Do you think you have followed the instructions correctly?
3.3	Already answered enough:	To what extent do you feel that you have been able to implement your plans to achieve your exercise goal well over the weeks?	Was waren Situationen, die Sie da- von abgehalten haben Ihre Pläne auszuführen, um Ihr Bewegungs- ziele zu erreichen? Wie war das für Sie?
3.4	Already answered enough:	What did you struggle with during the study? What did you do well during the study?	What were situations that pre- vented you from carrying out your plans to achieve your exercise goals? What was it like for you?

### Table S1

Themes of Motivation for Older Adults' Physical Activity sorted by Participants and their Self-

reported Physical Activity.

Partici-	Self-Reported PA per Week	Themes
pant		
P8	100 minutes	PA is a necessity to live
		PA as a basic need
		PA is also beneficial for the mind
		PA as a means to recharge
		PA as a tool for healthy aging
		PA as a tool to stay agile in older age
		PA as a tool for weight reduction
		Being inactive is boring
Р9	240 minutes	PA as a tool for healthy aging
		PA as a tool to stay agile in older age
		PA as a means for staying a part of society
P10	80 minutes	PA is a necessity to live
P11	0 minutes	PA as something recommended by others
		PA as a tool for healthy aging
		PA as a tool to stay agile in older age
		PA to keep up/compare with others
P12	275 minutes	PA as part of quality of life
		PA as a basic need
		PA is a necessity to live
		PA as a means to recharge
		PA out of enjoyment

		PA as a tool for healthy aging
P13	100 minutes	PA as a basic need
		PA as a tool for healthy aging
		PA as a tool to stay connected with the outside world
		Routines as a protective factor
P15	450 minutes	PA as a tool for healthy aging
		PA as part of quality of life /wellbeing
		PA is also beneficial for the mind
		PA out of enjoyment
P16	70 minutes	PA is a necessity to live
		Enjoyment for PA faded over the life course
		PA to keep up/compare with others
P17	120 minutes	PA as a tool for healthy aging
		PA as part of quality of life/wellbeing
		PA is also beneficial for the mind
P18	300 minutes	PA is a necessity to live
		PA is also beneficial for the mind
		Joy increases while being active
		PA as fall prevention
P20	180 minutes	PA as a tool for healthy aging
		PA as a tool for weight reduction
		PA to keep up/compare with others
P21	180 minutes	PA as a tool for healthy aging
		PA as a tool to stay agile in older age
		PA as a tool for weight reduction
		Routines as a protective factor
		Being inactive is boring

		PA to keep up/compare with others
P22	45 minutes	PA as a tool for healthy aging
		PA as a tool to stay agile in older age
		PA as a tool for weight reduction
P23	290 minutes	PA is a necessity to live
		PA as part of quality of life /wellbeing
		PA as a tool for healthy aging
		PA as a tool to stay independent
		PA as something recommended by others
		PA as something effortful/unenjoyable

Note. PA = physical activity. self-reported baseline physical activity per week was measured using the International Physical Activity Questionnaire (IPAQ; Craig et al., 2003). The themes were organized from more autonomous to controlled motivation for each participant.

## Table S2

Needs to be More Physically Active Sorted by Participants and their Self-reported Physical

Activity.

Participant	Self-Reported PA	Themes
	per Week	
P8	100 minutes	PA needs to be integrated in everyday life
		PA needs to be easily implemented
		Needs contact with other people
P9	240 minutes	PA needs to be integrated in everyday life
		Need to be monitored
		The setting is important
P10	80 minutes	PA needs to be integrated in everyday life
		The setting is important
		Needs to feel autonomous
		Having certain physical prerequisites
		Needs a certain pressure
		PA activities need to be affordable
P11	0 minutes	Needs to feel autonomous
P12	275 minutes	Needs to feel autonomous
		Needing realistic/attainable goals
		Knowing one's limit
		PA needs to be integrated in everyday life
		Needs a certain pressure
		Need to be monitored/feedback
P13	100 minutes	PA needs to be integrated in everyday life
		Finding motivation is necessary
		Knowing one's limit

	1	Wants to start gradually
		Wallts to start graduary
		Wants spontaneity
		Needs some incentives and rewards
P15	450 minutes	PA needs to be integrated in everyday life
		Finding motivation is necessary
		Knowing one's limit
		The setting is important
		Having certain physical prerequisites
P16	70 minutes	Needs to feel autonomous
P17	120 minutes	Having certain physical prerequisites
		Needs to feel autonomous
P18	300 minutes	PA needs to be integrated in everyday life
		Preference for certain PA
		Having certain physical prerequisites
P20	180 minutes	Having certain physical prerequisites
		Preference for certain PA
		Knowing one's limit
P21	180 minutes	Preference for certain PA
		PA needs to be integrated in everyday life
		Having certain physical prerequisites
		Knowing one's limit
P22	45 minutes	Needs to feel autonomous
P23	290 minutes	Having certain physical prerequisites
		Knowing one's limit

Note. PA = physical activity. self-reported baseline physical activity per week was measured using the International Physical Activity Questionnaire (IPAQ; Craig et al., 2003). The themes were organized from more autonomous to controlled motivation for each participant.