Towards sustained employability and quality of life: Findings on single and multiple health behaviour change from four studies in lifestyle-related disease prevention and rehabilitation

by

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Abstract

Lifestyle-related diseases such as cardiovascular diseases and musculoskeletal diseases are the leading cause of work disability and death worldwide. As regular physical activity and sufficient intake of fruit and vegetables play a key role in the prevention and treatment of such diseases, the promotion of these behaviours constitutes a major topic in health psychology. Yet approaches for multiple health behaviour change, as well as the incorporation of work-related outcomes, and quality of life warrant further research.

The overarching goal of this present thesis is to unveil mechanisms of both successful single and multiple health behaviour change and to derive recommendations for future research as well as practical implications for public health, workplace health promotion, and medical rehabilitation. In particular, the *first* aim of this thesis was to research behaviour change (physical activity) with respect to improvement of quality of life, sickness absence, and subjective employability. The *second* aim of this thesis was to shed light on the processes that are involved in single health behaviour change (fruit and vegetable consumption) on the basis of well-established models in health psychology. *Finally*, this thesis deals with explanatory factors for the development and promotion of habit strength of multiple behaviours (both physical activity and fruit and vegetable consumption) and the effectiveness of an Internet-based computer-tailored intervention.

This thesis focuses on three major research areas that are introduced in *Chapter 1*: The *first* focus area deals with health behaviour change and functioning in everyday life, and describes how a healthy lifestyle interrelates with quality of life and employability. The *second* focus area introduces the theory behind intending, motivating and planning for health behaviours and will discuss approaches for single and multiple health behaviour change used in this thesis. *Finally*, the last focus area will draw upon improving health via development and promotion of habit strength and provides an overview of behaviour change techniques that ground

on the introduced concepts. The research questions (*Chapter 2*) were examined in one observational and three experimental studies in various settings (*Chapter 3* to *6*; medical rehabilitation; primary prevention) and across different health behaviours (physical activity; fruit and vegetable consumption).

The results of this thesis highlight the importance of incorporating quality of life and vocational outcomes in activity-based treatment programmes because of the relationship between physical activity and improved quality of life and employability, as well as reduced sick leave (*Chapter 3* and *4*). The findings of this thesis further suggest that improving a person's confidence in their abilities may not only set the stage for successful behaviour change by strengthening intentions, but may also diminish the negative effects of compensatory health beliefs (*Chapter 5*). Finally, especially if accompanied by self-regulatory strategies such as self-efficacy and planning, increases in desired behaviour for even more than one behaviour may be reached. The findings show that web-based computer-tailored interventions for multiple health behaviours can be an effective means to improve habit strength for physical activity and fruit and vegetable consumption if they make use of such self-regulatory strategies (*Chapter 6*).

This thesis outlines suggestions how to proceed in the future: We may consider utilising the findings of the empirical studies and employ the theoretical and statistical evaluation strategies introduced as a basis for further development of approaches for single and multiple health behaviour change. Prospective research might also benefit from the suggested innovative strategies to recruit and motivate candidates who are hard to reach and optimise follow-up and thus adherence rates. The practical implications for public health, medical rehabilitation, and workplace health promotion on changing employee's health behaviours given may provide a promising basis for disease prevention, sustaining quality of life and employability, and reintegration of already sick-listed employees.

Zusammenfassung

Lebensstilbedingte Erkrankungen wie Herz-Kreislauf-Erkrankungen und Muskel-Skelett-Erkrankungen gelten als häufigste Ursache für Arbeitsunfähigkeit und Sterblichkeit weltweit. Da regelmäßige körperliche Aktivität und ausreichender Obst- und Gemüsekonsum eine wichtige Rolle in der Prävention und der Rehabilitation dieser Erkrankungen spielen, nimmt die Förderung dieser Verhaltensweisen eine zentrale Aufgabe in der Gesundheitspsychologie ein. Allerdings bedarf es weiterer Forschung in Bezug auf multiple Gesundheitsverhaltensänderung sowie der Ergänzung von Lebensqualitäts- und Arbeitsfähigkeitsindikatoren.

Das übergeordnete Ziel dieser Dissertation ist es, Mechanismen der singulären und multiplen Gesundheitsverhaltensänderung zu enthüllen und Empfehlungen für sowohl Forschung als auch angewandte Gesundheitsförderung wie in der medizinischen Rehabilitation oder am Arbeitsplatz abzuleiten. Diese Dissertation fokussiert drei Forschungsbereiche, die in *Kapitel 1* eingeleitet werden: den *erste*n Schwerpunkt bildet der Zusammenhang zwischen Gesundheitsverhalten und der allgemeinen Funktionsfähigkeit und zeigt auf, wie ein gesunder Lebensstil mit erhöhter Lebensqualität und Arbeitsfähigkeit einhergeht. Der *zweite* Teil der Einleitung gibt einen Überblick über Theorien zur singulären und multiplen Verhaltensänderung, auf denen die theoretischen Annahmen dieser Dissertation fußen. Der *dritte* Teil der Einleitung zielt auf die Entwicklung und Förderung von Verhaltensgewohnheiten ab und informiert über Techniken der Verhaltensänderung, die sich in innovativer Umsetzung der zuvor vorgestellten theoretischen Grundlagen bedienen.

Die Forschungsfragen dieser Dissertation (*Kapitel 2*) wurden in einer längsschnittlichen Beobachtungsstudie sowie drei experimentellen Studien innerhalb verschiedener Settings (*Kapitel 3* bis *6*; Medizinische Rehabilitation, Primärprävention) und über verschiedene Verhaltensweisen hinweg (körperliche Aktivität, Obst- und Gemüsekonsum) untersucht.

Die Ergebnisse dieser Dissertation zeigen die Relevanz von Lebensqualitäts- und Arbeitsfähigkeitsindikatoren bei der Begutachtung von Veränderungen körperlicher Aktivität. Ein höheres Aktivitätslevel ging mit besserer Lebensqualität (*Kapitel 3)* sowie subjektiv höherer Arbeitsfähigkeit und weniger krankheitsbezogenen Fehlzeiten im Längsschnitt einher (*Kapitel 4*). Des Weiteren weisen die Ergebnisse darauf hin, dass gesteigertes Vertrauen in die eigenen Fähigkeiten nicht nur hilfreich im Aufbau von Verhaltensabsichten ist, sondern auch negative Einflüsse von kompensatorischen Kognitionen abschwächen kann. Außerdem kann insbesondere das Planen von Verhalten dazu beisteuern, intendiertes Verhalten umzusetzen (*Kapitel 5*). Schließlich zeigen die Ergebnisse, dass mithilfe von gestärkter Selbstwirksamkeit und Planung Veränderungen in mehreren Verhaltensweisen gleichzeitig erreicht werden können. Internetbasierte maßgeschneiderte Interventionen erwiesen sich als eine vielversprechende Möglichkeit, die Gewohnheitsbildung für körperliche Aktivität und Obst- und Gemüsekonsum parallel zu stärken (*Kapitel 6*).

Zukünftiger Forschung sollen die Ergebnisse der empirischen Studien helfen, die Empfehlungen als Basis für die theoretische (Weiter-)Entwicklung von singulären und multiplen Gesundheitsverhaltensmodellen zu nutzen. Die methodischen Ableitungen dienen der Verbesserung der Analyse von komplexen Zusammenhängen zwischen psychologischen und verhaltensbezogenen Faktoren und der Entwicklung von theoriegestützten Interventionen. Die praktischen Implikationen zur Gesundheitsförderung, ob in der medizinischen Rehabilitation, im öffentlichen Gesundheitswesen oder am Arbeitsplatz stellen eine Möglichkeit dar, das Verhalten von Beschäftigten zur Prävention und Rehabilitation lebensstilbedingter Erkrankungen zu verändern, Arbeitsfähigkeit beizubehalten oder wiederherzustellen.

Chapter 1: General introduction

Lifestyle-related diseases (LRD) such as heart disease, diabetes, obesity, and bone diseases are, nowadays, the most common, costly, and preventable of all health problems and they will continue to impose an even greater burden in the future (Mathers & Loncar, 2006; Nichols et al., 2014). Within high-income countries, poor as well as young and middle-aged people are affected by such conditions (Gerteis et al., 2014; World Health Organisation, 2016). The economic implications of such diseases are also serious. LRDs not only negatively impact wages, workforce participation, and labour productivity, but they also increase early retirement rates, job turnover, and disability (Busse, Blümel, Scheller-Kreinsen, & Zentner, 2010).

Regular physical activity and sufficient intake of fruit and vegetables both play a key role in the prevention and treatment of LRDs (Boeing et al., 2012; Hagen et al., 2012; Oyebode, Gordon-Dseagu, Walker, & Mindell, 2014; Langsetmo et al.; 2012). However, while many practitioners and people know a great deal of *what* should be done, people generally know very little about *how* to act effectively act to achieve health goals. Yet, why is it that changing health behaviours and maintaining good health habits can be so difficult when the behaviours themselves are often quite simple?

Health psychology is concerned with understanding how psychological, behavioural, and cultural factors contribute to physical health and illnesses such as LRDs (Brennon & Feist, 2010). While research concerned with the change of more than one behaviour at a time is scarce, the need to explore *multiple health behaviour change* has been identified as an important means to prevent diseases that are prone to more than one risk behaviour (e.g. smoking and poor diet in heart disease, cancer, and stroke) (Spring, Moller, & Coons, 2012).

There is consistent evidence that behavioural risk factors cluster in individuals and in populations (Lakshman et al., 2010; Schneider, Huy, Schüssler, Diehl, & Schwarz, 2009) and that disease risks and healthcare costs are greatest for people with multiple health problems (Lehnert et al., 2011). The role of multiple health behaviour change and its implication for sustained functioning, will hold greater importance in upcoming research. It is important to examine patterns of health behaviours in a holistic approach to health in both health promotion and illness prevention strategies.

Therefore, the main objective of this thesis is to shed light on the processes that are involved in health behaviour change and adherence to a healthy lifestyle. The assessment of quality of life and employability will be used as additional outcome measures complementing the traditional "hard outcomes" for evaluating benefits of health behaviour change.

Chapter 1 starts by *(a)* describing the relationship between health behaviours and the prevention of LRD to portray the need to investigate the determinants of health behaviour change and the shortcomings of traditional medical outcomes. *Chapter 1* then continues with *(b)* a subsequent description of the theoretical framework behind intending, motivating, and planning for health behaviours, and comprises the rationale for the investigation of the theoretical assumptions. Finally, *Chapter 1* closes with *(c)* an overview of behaviour change techniques for the promotion of behaviour maintainance that innovatively use the concepts introduced before. In particular, the rationale behind and the effectiveness of newer interventions (e.g. computer-tailored Internet-based intervention) will be discussed.

In *Chapter 2*, the overall goal of dissertation, the research questions, and related hypotheses are introduced. An outline of the empirical chapters is given to embed the research questions that are addressed from *Chapter 3* to *Chapter 6*.

Chapter 7 closes with a summary of the findings of the empirical studies (*Chapter 3* to *Chapter 6*) followed by methodological, theoretical, and practical implications, as well as an overall conclusion of the present thesis.

1.1 Understanding health behaviour change and functioning in everyday life

During the last two decades, a wealth of epidemiologic studies has documented the health benefits of regular physical activity in the prevention and treatment of *cardiovascular diseases (CVDs)* and *musculoskeletal diseases (MSDs)*. For example, based upon a meta-analysis of 48 randomised controlled trials, Taylor et al. (2004) report that exercise-based treatment was associated with reduced all-cause mortality and cardiac mortality, greater reductions in total cholesterol level, triglyceride level, and systolic blood pressure. The effect of exercise treatment on total mortality was independent of disease diagnosis and dose of exercise intervention that was given to the participants. Studies by Langsetmo et al. (2012) show that an increase in physical activity is beneficial for health as it is associated with several health benefits such as an increase in bone mineral density and a reduction of body weight. Similar health effects are found in studies where physical activity is an effective treatment for sub-acute and chronic non-specific low back pain (Liddle, Baxter, & Gracey, 2004). In general, there is empirical evidence that exercise therapy for bone and muscle health has beneficial clinical effects for the prevention and treatment of most MSDs such as neck pain and shoulder pain, fibromyalgia, rheumatoid arthritis, and osteoarthritis (Hagen et al., 2012).

Healthy nutrition like a reduced intake of saturated fat, a high fibre, fruit and vegetable consumption has been shown to be beneficial for health and is thus advocated for in the prevention and treatment of lifestyle-related diseases (LRD). There is accumulating evidence that especially the consumption of fruit and vegetables plays an especially important role in the prevention of LRDs, such as diabetes mellitus (Carter, Gray, Troughton, Khunti, & Davies, 2010; Muraki et al., 2013), CVDs (Boeing et al., 2012; Lauchet, Amouyel, Hercberg, & Dallongeville, 2006), bone diseases (Boeing et al., 2012) and even certain kinds of cancer

(Oyebode et al., 2014; Pavia, Pileggi, Nobile, & Angelillo, 2006). In addition, evidence suggests that a lower risk of all-cause mortality is associated with a higher consumption of fruit and vegetables (Oyebode et al., 2014; Wang et al., 2014).

Recommendations for physical activity ad fruit and vegetable consumption

Currently there are no “one-size-fits-all” recommendations for physical activity and fruit and vegetable consumption that people should complete to improve overall functioning. However, one can summarise from the associations like the American Heart Association (2014), National Health Society (2015), American College of Sports Medicine (Garber et al., 2011), Deutsche Gesellschaft für Prävention und Rehabilitation von Herz-Kreislauf-Erkrankungen (Bjarnason-Wehrens et al., 2009) or the Dutch Hartstichting (2015) that one should be as physically active "as their abilities and conditions allow". Surely, recommendations also depend on the target group; for example, physical activity guidelines for people who are recovering from a musculoskeletal condition, would need to consider factors such as pain, fatigue, fear of falling, and feeling unwell. These factors themselves may make it more difficult to be physically active.

Whereas previous reviews have used qualitative estimates such as low, moderate, and high physical activity, Sattelmair et al. (2011) showed that individuals who engaged in the equivalent of 150 min/week of moderate-intensity leisure-time physical activity had a 14% lower risk for coronary heart disease, compared to those reporting no leisure-time physical activity. Those engaging in the equivalent of 300 min/week of moderate-intensity leisure-time physical activity even had a 20% lower risk. The recommendations upon which the questionnaires and the intervention content of this thesis are based are thus geared towards these findings (*Chapter 3*, *Chapter 4*, and *Chapter 6*).

Concerning the consumption of fruit and vegetables, Wang et al. (2014) conclude that there is a threshold around five servings a day, after which the risk of all-cause mortality does not further reduce. This assumption is reflected in national prevention campaigns such as 5 a day" by the Deutsche Gesellschaft für Ernährung e.V. (2012) or the Dutch Voedingscentrum (2011) and will be the recommendation for fruit and vegetable consumption in the dietary-related studies of this thesis (*Chapter 5* and *Chapter 6*).

Assessment of quality of life to complement morbidity and mortality statistics

Despite the rich body of research on health behaviours, morbidity and mortality rates are incomplete measures of outcome, since they do not necessarily reflect all aspects of health. The main drawback of these statistics is that they do not directly relate to subjective health and quality of life. The assessment of *quality of life* should therefore be an important and useful outcome measure complementing the traditional "hard outcomes" for evaluating benefits of physical activity. Many researchers have attempted to define exactly what constitutes quality of life, although their conceptualisations are approachable at varying levels of generality. This is due to the perspective - which may be either societal or individualistic - the study populations used as well as range of theoretical models or academic orientation (Felce & Perry, 1995). Despite a lack of universal agreement on what constitutes quality of life, current assessment usually focuses on the domains of physical functioning, psychological functioning, social functioning, and environmental functioning.

Changes in the people's perceptions of their health status may not be perceptible to the clinician. In response, assessment of quality of life should be increasingly integrated as a source of information not only in medical and psychological research but also in daily clinical practice. When quality of life is being measured, it is important to have an understanding of the different quality of life concepts and important properties of measurement instruments, such as reliability, validity, responsiveness, and sensitivity.

Quality of life research strongly remains focused on given conditions of life such as sociodemographic variables (Lubetkin, Jia, Franks, & Gold, 2005) and medical condition

(Bentsen, Rokne, & Klopstad Wahl, 2013; Dickens, Cherrington, & McGowan, 2012; Matcham et al., 2014), rather than aspects that one can choose such as engaging in regular physical activity.

Self-perception concerning the benefits of regular physical activity reflects a central motivational strategy in many exercise-promotion interventions (Greaves et al., 2011). Accordingly, it is necessary to study whether – and to what degree – the self-perception of quality of life varies across the different motivational stages through which an individual progresses when he or she changes his or her behaviour. Therefore, the relationship between readiness to be physically active and the self-reported quality of life will be researched in this thesis (*Chapter 3)*.

Labor participation and employability as timely and important concepts

From a prevention perspective, screening for predictive factors and obstacles associated with long-term employability appear to offer a promising avenue for prolonged labor participation. *Employability* can be defined as the capability to gain initial employment, maintain employment, and obtain new employment if this is required (Rump & Eilers, 2006). Labor participation and feeling able to work in the ageing population are timely and important concepts. In particular, in a study by Leist et al. (2013), unemployment and sickness absence were associated with higher risk of cognitive impairment in older age. In addition, keeping the older members in the workforce for longer may partly compensate for the shrinking of younger generations as a by-product of the demographic change.

It is not only the individual worker who can benefit from long-term employability. Sustained employability and fewer sick days also provide benefits to the employer, such as lower presentism and absenteeism, reduced staff attrition, and training costs by retaining experienced employees and maintaining improved productivity (Norrefalk, Ekholm, Linder, Borg, & Ekholm, 2008).

Employability and sickness absence are multi-determined outcomes that cannot be accurately predicted simply from knowledge of the physical health status. Characteristics of the worker, physical, and psychosocial job characteristics, workplace factors, the insurance or worker's compensation scheme have all been shown to have some role to play in influencing work-related outcomes independently of the underlying physical health status (Clay, Newstead & McClure, 2010).

Bevan (2015) highlights that LRDs account for half of all European absences from work and 60% of permanent work incapacity. For MSD patients, the reported rates of people who *return to work* may vary from 15% to 85% during the first year after treatment (Bontoux et al., 2009; Øyeflaten Atle Lie, Ihlebæk, & Eriksen, 2014), although interpretation is complicated; for instance, this range is even broader in persons who recover from CVDs (Fonager et al., 2014; Samkange-Zeeb et al., 2006). Return to work rates are very much influenced by the pool of persons being studied (Hubertsson et al., 2014; Øyeflaten et al., 2014), as well as different follow-up periods, the definition of return to work that is used, and generic outcomes where return to work is grouped together with return to education or home duties (Biering, Hjøllund, & Lund, 2013; Wasiak et al., 2007).

The studies that investigated the effect of physical activity on sickness absence are promising (Dugmore, et al., 1999; Kool et al., 2004). Dugmore and colleges (2006) found that regularly aerobic exercise training not only improved cardiorespiratory fitness, psychological status, and quality of life. The trained population also showed a significant improvement in vocational status over a five-year follow-up period. Since long-term benefits of regular physical activity hold importance to the individual, the employer, and society, one of the main research aims in this thesis will be the contribution of physical activity to sickness absence and subjective employability over a period of several years after rehabilitation treatment (*Chapter 4*).

1.2 Modelling behaviour change: the theory behind intending, motivating, and planning for health behaviours

Models and theories in health psychology typically postulate certain factors that are assumed to underlie health behaviours and influence the process of single and multiple health behaviour change. In the following, some of the key processes investigated in single and multiple health behaviour change will be outlined.

Single behaviour change: Transtheoretical Model of Change

Models in health psychology usually postulate some form of intention that is seen to be central of the initiation of health behaviour. In the Transtheoretical Model (TTM; Prochaska, DiClemente, & Norcross, 1992; *Chapter 3*) see Figure 1) Prochaska, DiClement, and Norcross (1992) claim that individuals typically progress through a series of stages of change in each of which intention comprises different roles. Stage models like the TTM share the assumption that during the process of change, people face different needs that have to be met to reach the next stage.

Figure 1 provides a pictorial display of how the progression from one stage to the other is related to these and other predictors according to recent literature. Marshall and Biddle (2001) suggest that the most difficult part of making lifestyle changes that are aimed at prevention (e.g. increasing physical activity) might be the transition from pre-contemplation to contemplation. This is because in the pre-contemplation stage people tend to underestimate the benefits of changing, overestimate the downsides, and are not particularly aware that they are making such evaluations (Hall & Rossi, 2008; Prochaska, 1994).

It may not be possible to generalise across behaviours and apply the same TTM intervention components for various behaviours and various people. A promising way to optimise these processes is to tailor the information content to a person's expectations and needs to set the stage for behaviour change.

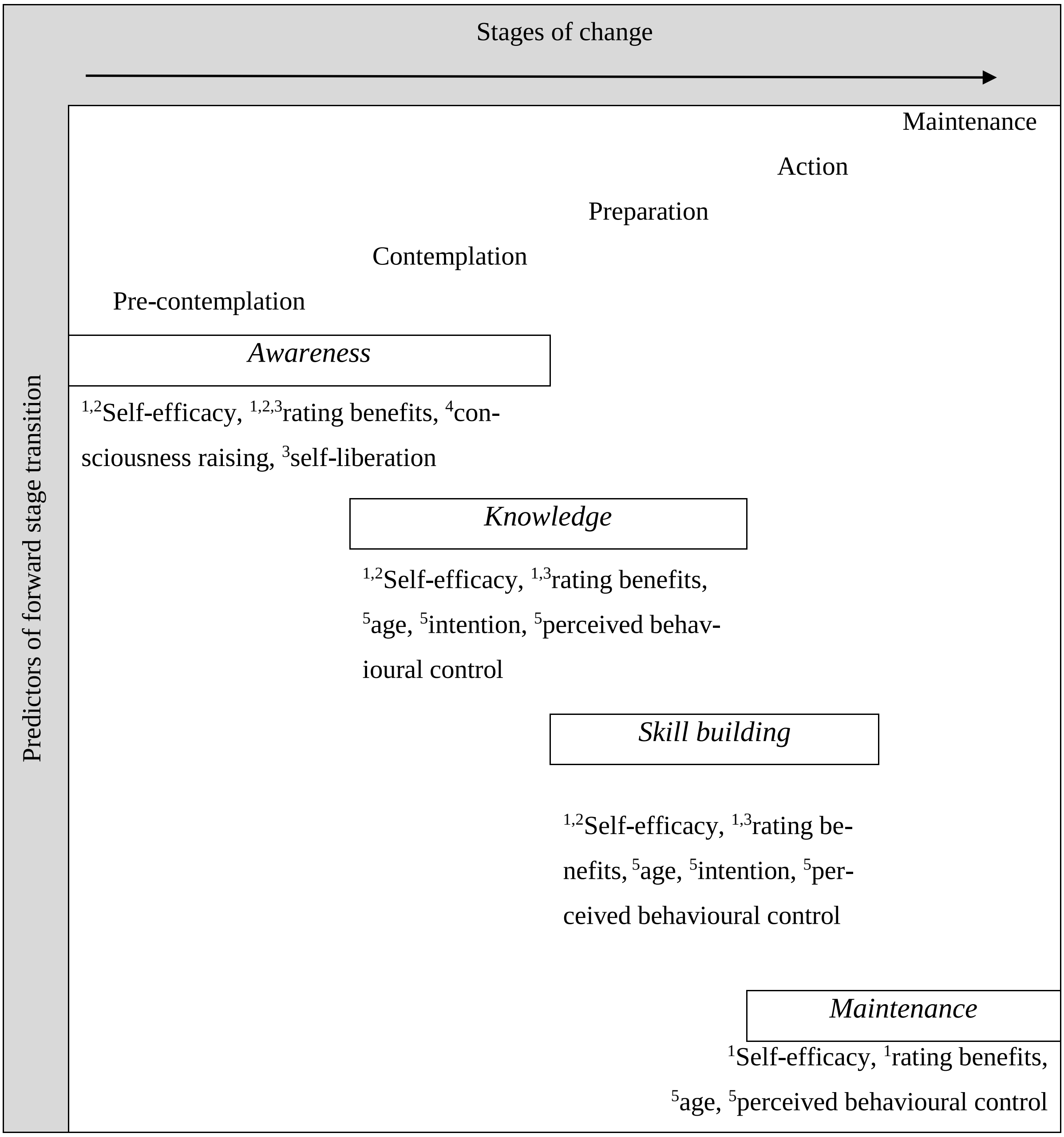

Figure 1. Predictors of forward stage transition in the Transtheoretical Model for fruit and vegetable consumption and physical activity.

[1] Plotnikoff et al., 2001

[2] De Vet et al., 2006

[3] Marshall & Biddle, 2001

[4] Horwarth et al., 2013

[5] Armitage et al., 2004

Single behaviour change: Health Action Process Approach

A second approach for single health behaviour change is the *Health Action Process Approach* (HAPA; Schwarzer, 1992; Schwarzer, Lippke, & Luszczynska, 2011*; Chapter 5* and *Chapter 6;* Figure 2). Schwarzer divides the health behaviour change process into two phases: He distinguishes the motivational phase in which the intention is formed and the volitional phase in which planning, the maintenance of goals, and the realisation of behaviour are the central components. According to HAPA (Schwarzer, 1992; Schwarzer, Lippke, & Luszczynska, 2011), the three factors that are essential for the development of an intention to perform or stop (e.g. in case of smoking) a certain behaviour are outcome expectancies, risk perceptions and self-efficacy.

Outcome expectations are beliefs about certain outcomes of a performed behaviour. They can be positive or negative (e.g. losing weight, reducing CVD risk, waste of time). *Risk perceptions* describe the subjective judgement that people make about their susceptibility for a certain risk (e.g. lung cancer). *Self-efficacy* can be defined as the sense that one is capable of performing the behaviours necessary to achieve a particular outcome, even in case of difficulties.

In the HAPA (Schwarzer, 1992; Schwarzer, Lippke, & Luszczynska, 2011; Figure 2; *Chapter 5* and *Chapter 6*), Schwarzer integrates *planning* as an intermediate step between intention and subsequent behaviour to overcome the so-called *intention-behaviour gap* (Sheeran & Orbell, 1998). The phenomenon describes that even if people hold strong intentions to act, they do not/may not translate them into behavior (Ajzen, 2011).

The results from Rhodes and de Bruijn (2013) even demonstrate that the discordance is not simply from extreme levels of intention or behaviour (e.g. intend to be physically active five times but are active on four days), but rather from levels that are relevant to health promotion: they employed analyses on intenders who were not successful at following through with their PA (36%), as well as successful intenders (42%). The overall intention-PA gap was 46%. This suggests that additional predictors seem to play a role if intention is transferred into behaviour.

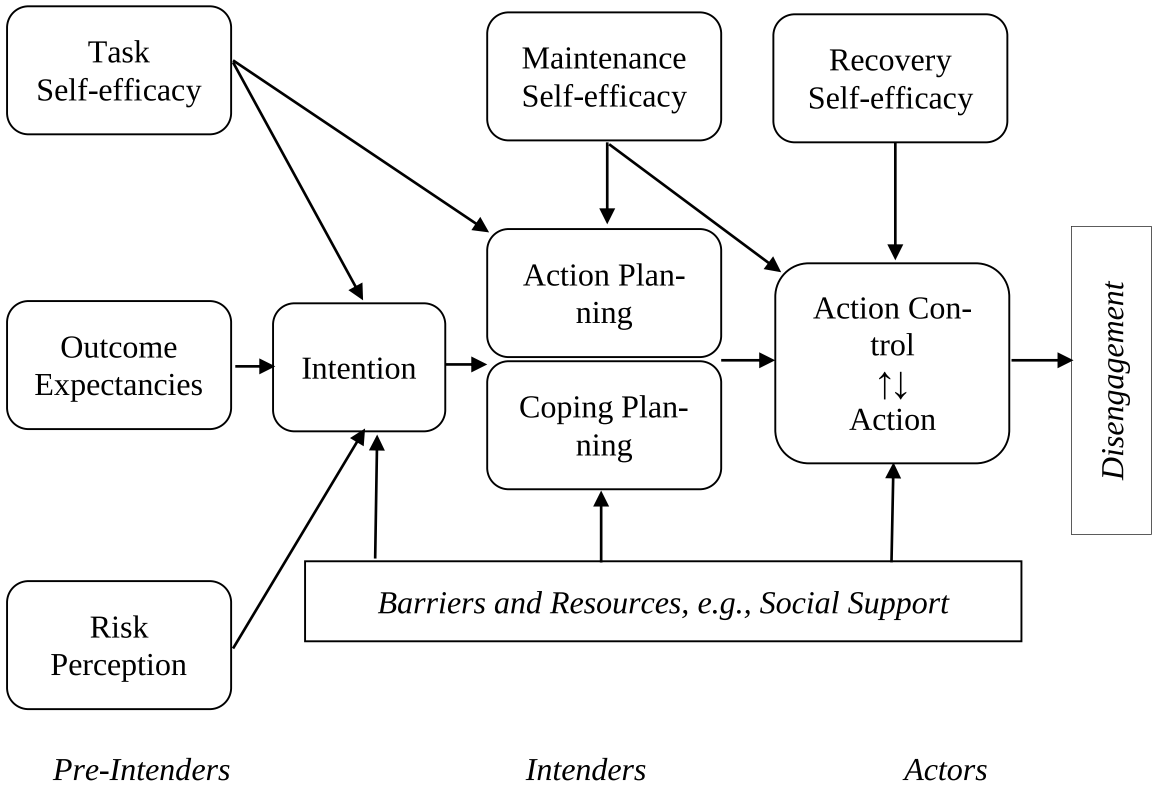

Figure 2. Health Action Process Approach (Schwarzer, 1992).

In the HAPA (Schwarzer, 1992; Schwarzer, Lippke, & Luszczynska, 2011; Figure 2; *Chapter 5 and Chapter 6*), planning refers to both *action planning* (when, how and when a behaviour will be performed) and *coping planning* (strategies to tackle anticipated barriers). As proposed by Schwarzer (1992), decisions regarding health behaviour change and maintenance are predicted to rely on these self-regulatory variables.

Planning has been repeatedly shown to increase physical activity (Carraro & Gaudreau, 2013) and fruit and vegetable consumption (Guillaume, Godin, Manderscheid, Spitz, & Muller, 2012), especially when accompanied with self-efficacy (Koring et al., 2012; Luszczynska, Triburcy, & Schwarzer, 2006).

Multiple behaviour change: Compensatory-Carry-Over Action Model (CCAM)

Thus far, most models in health psychology address only one behaviour at a time. However, the need to explore multiple health behavior change has been identified as an important means to the prevention of diseases that are prone to more than one risk behavior (e.g. smoking and poor diet in heart disease, cancer, and stroke) (Spring, Moller, & Coons, 2012).

There is evidence that health behaviours cluster in individuals and in populations (Lakshman et al., 2010; Schneider, Huy, Schüssler, Diehl, & Schwarz, 2009). Positive associations were reported for fruit and vegetable consumption and physical activity, as well as for harmful behaviors like smoking and binge drinking (Spring, Moller, & Coons, 2012).

Sometimes different behaviours are even interrelated in terms of compensation for the one over. So-called *compensatory health beliefs* (CHBs; *Chapter 5*) were initially addressed in a model by Rabiau, Knäuper, and Miquelon (2006), implying that the negative consequence of an unhealthy behaviour can be compensated by engaging in a healthy behaviour. For example, dieters may think to themselves "Eating unhealthy now can be compensated when I will be exercising later".

Lippke (2014) revised the initial CHB model for the use of multiple health behaviours and included planning and self-efficacy: the *Compensatory Carry-Over Action Model (CCAM)* combines the CHB model with different social-cognitive factors for single health behaviours as mentioned in the HAPA and extends this to the process of multiple health behaviours. The *first* main assumption is that within each behaviour domain, individuals translate their intentions into behaviour via planning. Self-efficacy moderates the relationship between planning and behaviour, and additionally affects behaviour directly. The *second* main assumption is that behaviour-specific processes for behaviour *A* (physical activity) and behaviour *B* (nutrition) interrelate via CHBs (here: *compensatory cognitions*).

The activation of the CHBs serves as a self-regulatory strategy to reduce the cognitive dissonance created by the temptation. They shift their focus of attention from the risk behaviour to the health behaviour that is selected for compensation. By these CHBs allow people to engage in the unhealthy behaviour without feeling guilty about it. In fact, CHBs are thought to be maladaptive because they are likely to be inaccurate and if they are accurate, the compensatory behaviour (e.g. exercising) may not be carried out (Miquelon, Knäuper, & Vallerand, 2012).

Radtke, Scholz, Keller, and Hornung (2012) investigated the role of CHBs for the formation of intention within the theoretical framework of the HAPA model. They showed that (in the case of smoking) CHBs were a significant predictor of intention to stop smoking and further social-cognitive variables such as risk perception, outcome expectancy, and self-efficacy. However, CHB could not predict smoking behaviour itself.

Although CHBs have been studied in the context of smoking (Radtke, Scholz, Keller, Knäuper, & Hornung, 2011) blood glucose control (Rabiau, Knäuper, Nguyen, Sufrategui, & Polychronakos, 2009), and caloric intake (Kronick, Auerbach, Stich, & Knäuper, 2011) there is still a lack of research in the context of fruit and vegetable consumption and longitudinal designs.

These findings underline the need to explicitly consider CHB regarding their influence on pre-intentional variables and actual behaviour. Therefore, in this thesis CHBs will be addressed to extend validation of the construct and assumptions of the CCAM and provide further insights of possible moderators of the effect of CHBs in the health behaviour change process (*Chapter 5*).

1.3 Improving health behaviour change via development and promotion of habit strength

To reduce risk for lifestyle-related diseases (LRD), one of the main goals is to adopt a healthy lifestyle (i.e., regular physical activity and sufficient intake of fruit and vegetables). The habituation of these behaviours is a desired goal in prevention, because once a behaviour has become habitual, it requires less conscious effort and relapses become less likely (Gardner & Lally, 2013; Lally, van Jaarsveld, Potts, & Wardle, 2010; Orbell & Verplanken, 2010). Nonetheless, the development of a habit - whether good or bad - is a complex process.

Use of self-regulation strategies for habituation of behaviours

In the literature, *self-regulation interventions* comprise techniques that aim to increase self-efficacy and planning, identifying barriers, and relapse prevention. Since one of the first investigations of self-efficacy in the health behaviour change process by Strecher, DeVellis, Becker, and Rosenstock in 1986, a rich body of research has shown that self-efficacy is related to better health behaviours. These include commitment to regular physical activity (Allison & Keller, 2004; Koring et al., 2012) and fruit and vegetable consumption (Luszczynska, Tryburcy, & Schwarzer, 2006), obesity-related weight loss (Linde, Rothman, Baldwin, & Jeffery, 2006; Shin et al., 2011), smoking cessation (Lindberg et al., 2015; Schnoll et al., 2011), and substance abuse treatments (Kadden & Litt, 2011) among the adult and older adult population.

In 1986, Albert Bandura proposed four specific sources for an individual's self-efficacy (see Table 1): (i) *past experience in performing specific behaviours*; (ii) *vicarious experiences* (e.g. watching others who are similar to oneself successfully perform behaviours); (iii) *verbal persuasion* (e.g. being told that one is capable); and (vi) *the experience of physiological arousal*. According to Bandura (1986), people with a high sense of self-efficacy are more likely to initiate a behaviour, and self-efficacy influences the degree of effort that is expended and sustained over time.

Bandura's (1986) sources of self-efficacy can be reflected in a host of specific *behaviour change techniques (BCTs)*. The popular taxonomy by Abraham & Michie (2008) specifies 26 BCTs commonly used to change physical activity and dietary behaviours that are used in the empirical studies of this thesis (*Chapter 6*).

Based on the meta-analyses by Williams and French (2011) and Prestwich et al. (2014) Table 1 forms an evidence base on which psychological BCTs are most effective in increasing self-efficacy for physical activity and healthy nutrition, respectively. Williams and French (2011) found a small but significant overall summary effect of interventions on self-efficacy (d = 0.16) for physical activity. The overall summary intervention effect for self-efficacy for diet was g = 0.24 (Prestwich et al., 2014). According to Cohen (1988), effect sizes ranging from .00 to .20 are considered small; those from .20 to .33 are considered medium; and those bigger than .33 are referred to as large.

Significantly higher effect sizes were produced when interventions included planning, provided instruction, and time management techniques: intervention studies, including detailed planning of when, where, and how the specific behaviour would be performed, led to significantly higher self-efficacy scores than simply providing information on behavioural benefits (Ashford, Edmunds, & French, 2010; Williams & French, 2011). Considering that self-efficacy is seen as a predictor of planning the HAPA (Schwarzer, 1992; Schwarzer, Lippke, & Luszczynska, 2011; Figure 2; *Chapter 5* and *Chapter 6*), it thus seems that the association between self-efficacy and planning is mutually reinforcing. Whether changes in self-efficacy and planning can contribute additively to habituation of a certain behaviour, will therefore be researched in this thesis (*Chapter 6*).

Table 1

Overview of Sources of Self-efficacy and Self-efficacy Related Behaviour Change Techniques

Sources of self-efficacy	Behaviour change technique (BCT)	Empirical evidence (effect size of intervention effect when BCT included)	
(Bandura, 1986)	(Abraham & Michie, 2008)	Physical activity	Diet
(i) past experience in performing specific behaviours	#7. Prompt practice	*d* = .23 (Ashford et al., 2010) *d* = .13 (Williams & French, 2011)	
	#12. prompt self-monitoring of behaviour	*d* = .14 (Ashford et al., 2010) *d* = .06 (Williams & French, 2011)	*g* = .14 (Prestwich et al., 2014)
	#11. prompt review of behavioural goals	*d* = .12 (Williams & French, 2011)	*g* = .20 (Prestwich et al., 2014)
(ii) vicarious experiences	#9. model or demonstrate the behaviour	*d* = .32 (Ashford et al., 2010)	
	#19. provide opportunities for social comparison	*d* = .44 (Ashford et al., 2010) *d* = .34 (Williams & French, 2011)	
	#8. provide instruction	*d* = .21 (Williams & French, 2011)	
(iii) verbal persuasion	#6. provide general encouragement	*d* = .31 (Williams & French, 2011)	*g* = .16 (Prestwich et al., 2014)
	#13. provide feedback on performance	*d* = .43 (Ashford et al., 2010) *d* = .18 (Williams & French, 2011)	*g* = .13 (Prestwich et al., 2014)
(iv) the experience of physiological arousal	#24. stress management	*d* = .18 (Williams & French, 2011)	*g* = .39 (Prestwich et al., 2014)

Matching people's needs: use of computer-tailored interventions

It remains popular in various healthcare settings to find "one-size-fits-all" informational pamphlets that provide the individual with general information about a disease condition and some helpful strategies to combat it. However, they are often too general to provide much help. People might reject this type of communication because they perceive it as a "mass-product" that is not really designed for their individual characteristics, motivation, and needs (Kreuter, Stretcher, & Glassman, 1999).

As mentioned before, research suggests that the most difficult part of making lifestyle changes might be the transition from not intending to change one's behaviour at all (pre-contemplation) to intending to change in near future (contemplation). In these early stages, verbal communication, self-efficacy and discussion of benefits are of special importance (De Vet, de Nooijer, de Vries, & Brug, 2006; Prochaska, DiClimente, & Norcross, 1992). A promising way to optimise these processes is to tailor the information content to a person's expectations and needs (Martin, Haskard-Zolnierek, & DiMatteo, 2010).

Today's technology makes it relatively simple to create such information sheets, directives, and other health-relevant behaviour plans. Research shows that people take tailored information more seriously than general information. They are more likely to read the information put together based upon their personal needs, they find it more interesting and remember it better, while they are also even more likely to save the material for future reference (De Vries & Brug, 1999; Hawkins, Kreuter, Resnicow, Fishbein, & Dijkstra, 2008; Noar, Grant Harrington, van Stee, & Shemanski Aldrich, 2011).

The Internet is increasingly used as a medium for the delivery of such tailored interventions designed to promote health behavior change (Webb, Joseph, Yardley, & Michie, 2010; Lustria et al., 2013). This is also due to the overall increase in Internet use. Data from the D21-

Digital-Index (2015) show that in 2015, 77.6% of the total German population are regular Internet users and that the numbers in the 60+ age group are increasing the most. For many people, the Internet serves as an omnipresent source of access to health information and that health information is largely trusted (Bennet & Glasgow, 2009).

There is a variety of reasons for delivering health care interventions through the Internet: Participants can access and respond to intervention content in a manner that can feel largely anonymous. Most importantly, Internet-delivered interventions can be used at individual's convenience, meaning at any time and anywhere there is Internet access (Griffiths et al., 2006). Internet interventions are also chosen because of their cost-effectiveness. For little more than the development of the intervention, Internet interventions can be made available to a variety of populations (Yardley, 2011).

When evaluating such interventions, it is, of course, necessary to know *whether* and *for whom* interventions work in terms of adopting a healthy lifestyle (i.e., regular physical activity and healthy diet). Notwithstanding, in order to conclude what online interventions should address in the future, it is also essential to test the mechanisms of *how* the intervention exhibits an effect on health behaviour change. Mediation analysis might unfold the underlying working mechanisms of such an intervention by providing more information about theories upon which intervention programmes are based. Therefore, both the effectiveness and the working mechanisms of a computer-tailored Internet-based intervention will be investigated in this thesis (*Chapter 6*) to provide implications for further research and Internet-based practice.

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Chapter 2: Overall goal of dissertation, research questions, and related hypotheses

The present thesis aims to add to the description and promotion of single and multiple health behaviour changes relevant to the prevention and rehabilitation of LRDs. In particular, health behaviour change will not only be researched regarding improvement of people's quality of life but also regarding sickness absence and subjective employability. Processes involved in intention formation and translation into intended behaviour will be investigated to unveil mechanisms of successful health behaviour change. Moreover, explanatory factors for the effectiveness of newer interventions (e.g. computer-tailored Internet-based intervention) will be investigated. Figure 3 visualises the foci of the empirical studies (*Chapter 3* to *Chapter 6*) within the previously introduced framework (*Chapter 1*).

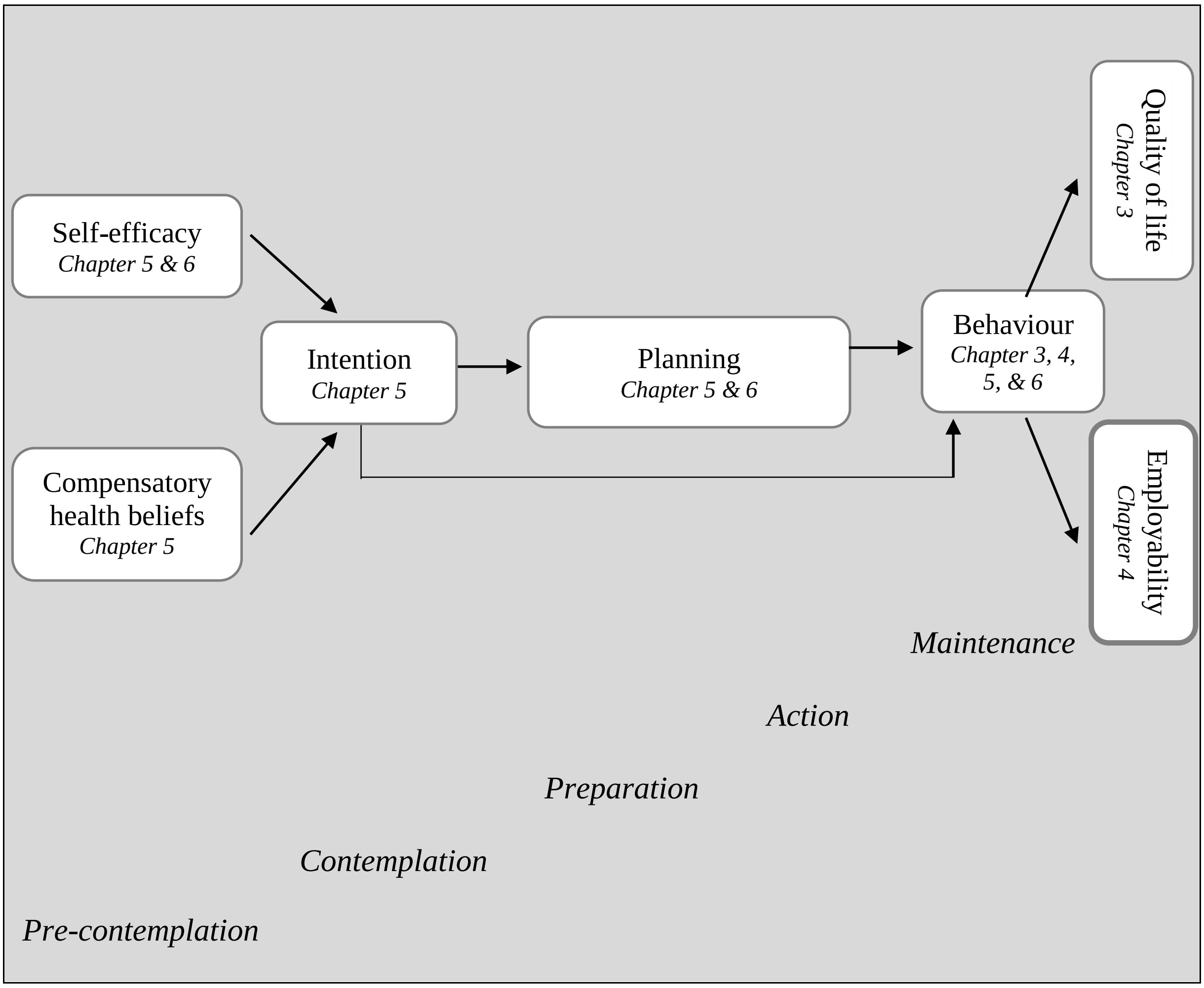

Figure 3. Overview of the research foci for each empirical chapter within this thesis.

Note: ⟶ indicates studied associations between variables

2.1 Research questions of the three main focus areas

a) Understanding health behaviour change and functioning in everyday life

i. How do differences in motivational readiness for physical activity interrelate with quality of life (*Chapter 3)?*

ii. What are the short-term and long-term relations between physical activity and sickness absence? (*Chapter 4*)?

iii. What are the short-term and long-term relations between physical activity and subjective employability? (*Chapter 4*)?

b) Modelling behaviour change: the theory behind intending, motivating and planning for health behaviours

i. What role does self-efficacy play in the intention formation process for regular fruit and vegetable consumption (*Chapter 5*)?

ii. What role do compensatory health beliefs play in the intention formation process for regular fruit and vegetable consumption (*Chapter 5*)?

iii. How can planning add to the translation of intentions into behaviour (*Chapter 5*)?

c) Improving health behaviour change via development and promotion of habit strength

i. What mechanisms are associated with habit strength (*Chapter 6*)?

ii. How effective is an Internet-based computer-tailored intervention with self-regulation booster sessions in increasing habit strength of regular fruit and vegetable consumption and physical activity (*Chapter 6*)?

iii. What mechanisms account for the intervention effects in promoting the habit strength of regular fruit and vegetable consumption and physical activity (*Chapter 6)*?

2.2 Studies in this thesis

Table 2

Overview of Included Empirical Studies

					Follow-ups after baseline						
					Months			Years			
	Behaviour	Design	Setting	Baseline	2	3	6	1	3	8	Primary outcomes
Chapter 3	Physical activity	Experimental	Cardiac rehabilitation, primary prevention	M							Quality of life
Chapter 4	Physical activity	Observational	Orthopaedic rehabilitation	M			M	M	M	M	Subj. employab., sickness absence
Chapter 5	FVC	Experimental	Cardiac rehabilitation, primary prevention	M	M						Intention, FVC
Chapter 6	Physical activity, FVC	Experimental	Cardiac rehabilitation, primary prevention	M & I	M	M					Habit strength (physical activity, FVC)

Note: Research questions of chapter 3, chapter 5, and chapter 6 were analysed with the same data; M = measurement point; I = eight-week intervention treatment; FVC = fruit and vegetable consumption; subj. employab. = subjective employability

This thesis includes *four* empirical studies with different study designs, health behaviours and samples. The structures of the experimental studies (*Chapter 3, Chapter 5, and Chapter 6*) and the prospective observational study (*Chapter 4*) are outlined in Table 2.

Baseline assessments were taken either before and after orthopaedic rehabilitation treatment (*Chapter 4*) or after cardiac rehabilitation treatment and in primary prevention (*Chapter 3, Chapter* 5, and *Chapter 6*). The follow-up measures were employed up to eight years after baseline to capture short-term (*Chapter 4, Chapter* 5, and *Chapter 6*) and long-term changes (*Chapter* 4, and *Chapter 6*) in behavioural outcomes, social-cognitive variables and habit strength.

Besides paper-pencil questionnaires (*Chapter 4*), Internet-based communication techniques were used to deliver the web-based questionnaires (*Chapter 3, Chapter 5*, and *Chapter 6*), and the web-based computer-tailored intervention (*Chapter 6*).

Physical activity was the behavioural target in *Chapter 3* and *Chapter 4. Chapter 5* focused on fruit and vegetable intake and *Chapter 6* focused on both physical activity and fruit and vegetable intake. Further information about the study design, recruitment and procedures is provided in the empirical chapters *(Chapter 3* to *Chapter 6).*

Chapter 3: Quality of life and stages of behavioural change for physical activity in people motivated to reduce their cardiovascular risk

Storm, V., Reinwand, D.A., Wienert, J., & Lippke, S. (under re-review). Quality of life and stages of behavioural change for physical activity in people motivated to reduce their cardiovascular risk. *Quality of Life Research*.

Abstract

Purpose: Regular physical activity has been shown to be associated with improved quality of life (QoL). However, systematic investigations of the association between motivational stages of change for physical activity and different domains of QoL are lacking.

Methods: A randomized controlled trial was conducted to improve physical activity and fruit and vegetable consumption in Germany and the Netherlands (N = 790) participants. The mean age was 50.9 years (SD = 12.2, Range: 20-84), 62.9% (n = 497) of the participants were female. Besides sociodemographic information, QoL, physical activity, the stage of change for exercise, and body mass index (BMI) were obtained via a web-based self-report.

Results: There were significant interrelations of stages of change for activity with the different domains of physical, psychological, social relations, and environment QoL (Wilks λ = .94, df = 12, $p < .001$). Study participants of the maintenance group showed highest QoL levels across all domains, while the pre-contemplators/contemplators showed the lowest QoL values. The relationship between the stage of change and QoL was different among BMI groups.

Conclusion: Healthcare providers should individually encourage people to attain higher stages of change for physical activity due to the association with both, a higher QoL and lower BMI and should give personalised feedback on physical activity levels. However, there is a need for further longitudinal studies to acquire a more complete understanding of long-term mechanisms of stage of change for physical activity, BMI and QoL.

Introduction

Regular physical exercise is well known to have a positive effect in the primary and secondary prevention of cardiovascular diseases such as high blood pressure (Hamer, Tailor, & Steptoe, 2006; Pal, Radavelli-Bagatini, & Ho, 2013), diabetes mellitus (Dagfinn, Norat, Leitzmann, Tonstad, & Vatten, 2015; Cooper et al, 2014) and coronary heart disease (Gielen, Laughlin, O'Conner, & Ducker, 2015; Sattelmair et al., 2011). While morbidity and mortality benefits have been carefully examined, quality of life (QoL) has attracted less attention when evaluating the effects of physical activity programs, although the results are promising (Gielen et al., 2015).

A promoted line of research seeks to extend beyond the straightforward division between physically active and sedentary individuals, striving to explore the determinants of motivational readiness based upon underlying continuum of stages of change. In the Transtheoretical Model of Change (TTM), Prochaska and DiClimente (1983) suggest that individuals typically progress through a series of five stages in terms of behaviour change. Here, the readiness to change one's behaviour spans from pre-contemplation (not intending to change), contemplation (intending to change in the next 6 months), preparation (intending to take action in the immediate future), action (having recently changed one's behaviour, defined as within the last 6 months) to maintenance (sustaining one's behaviour change for a while, defined as more than 6 months).

Given that adapting the self-perception concerning the benefits of regular physical activity reflects a central motivational strategy in many activity-promotion interventions (Greaves et al., 2011), studying whether – and to what degree – the self-perception of QoL varies across the different behaviour change stages through which an individual progresses holds strong importance.

One possible barrier to regular physical activity is that sedentary individuals may be unaware of their inactivity. Rising levels of inactivity over the last years may have worsened peoples' ability to distinguish low from sufficient physical activity levels creating the perception that sedentary lifestyles are socially accepted.

Evidence from studies that compare self-report with objective physical activity data indicates that between 48% and 61% of adults, who do not currently meet recommended guidelines, overestimate their levels of physical activity and refer to themselves as actor or maintainer within the TTM (Ronda, van Assema, & Brug, 2001; van Sluijs, Griffin, & van Poppel, 2007; Watkinson et al., 2010).

Thus far, no studies have examined the relationship between physical activity and QoL in motivated people who want to reduce their cardiovascular risk. One related study was conducted in the general population (Laforge et al., 1999), one involved lung cancer survivors (Clark et al., 2008), and two involved only overweight and obese adults (Romain et al., 2012; Lee, Chang, Liou, & Chang, 2006). They all concluded that people who reported exercising on a regular basis also had better QoL, with a peak occurring in the action stage.

In addition, as being overweight has been found to be an independent risk factor for both cardiovascular diseases (Bastien, Poirier, Lemieux, & Després, 2014) and limited QoL (Renzaho, Wooden, & Houng, 2010), it is important to consider the relationship between physical activity and QoL across different BMI groups.

The present study aims to expand on the literature on physical activity and QoL by examining the relationship between stages of physical activity and the self-reported QoL among people who are motivated to reduce their cardiovascular risk. We hypothesize that the higher people are according to the stage of change for physical activity, the higher their reported

reported QoL in all domains (*hypothesis 1*). In addition, we suggest that the relationship between stage of change and QoL domains is significantly different according to BMI groups (*hypothesis 2*).

Methods

Study Design

This study was designed as a randomized control trial (RCT) to investigate whether a web-based computer-tailored intervention is effective in increasing self-reported physical activity and fruit and vegetable consumption. Specific information on the study design can be found in Reinwand, Kuhlmann, Wienert, de Vries, and Lippke (2013).

The baseline questionnaire (T0) was the same for the intervention and waiting control group; thus, we expect no differences in results due to group condition. Indeed, we are interested in differences in self-reported QoL according to stages of change for physical activity; the effectiveness of the behaviour change intervention does not hold interest in this study. We therefore do not analyse the behaviour changes over time.

Ethical Approal

The study was registered at ClinicalTrials.gov (Identifier: NCT01909349) and received ethical approval by the Deutsche Gesellschaft für Psychologie in Germany (EK-A-SL022013) and the Medical Ethics Committee of Atrium Medical Centre Heerlen in the Netherlands (12-N-124).

Participants and Procedure

Data collection took place from July 2014 until February 2015 in Germany and the Netherlands. In total, N = 1,010 study participants were recruited by the researcher team in cardiac rehabilitation facilities, heart training groups, online panels and Internet platforms in

Germany and the Netherlands. Participation in the study was voluntary and data were anonymized.

The inclusion criteria were as followed: being at least 20 years old, no contraindications for physical activity and fruit and vegetable consumption, having interest in reducing cardiovascular risk by improving physical activity and fruit and vegetable consumption, sufficient reading and writing skills in the relevant language, and Internet access. $N = 220$ data sets were excluded by the research team due to double registration ($n = 5$), missing gender information ($n = 86$), inadequate age ($n = 1$ younger than 20 years), and those who did not provide any self-report data ($n = 128$). Therefore, the final sample size comprised $N = 790$ participants at baseline (T0).

Measurement Instruments

Sociodemographic information. All sociodemographic information such as gender (1 = male, 2 = female), year of birth, country of birth (1 = Netherlands, 2 = Germany), employment status (1 = working part-time, 2 = working full-time, 3 = in training, 4 = unemployed, 5 = retired, 6 = housewife/houseman), marital status (1 = single, 2 = close relationship but not living together, 3 = close relationship and living together, 4 = marital partnership/common law marriage, 5 = divorced, 6 = widowed), and highest level of education (1 = no school graduation yet, 2 = primary school education, 3 = secondary school education, 4 = vocational school graduation, 5 = university entrance diploma, 6 = other) were measured via a web-based self-report. The same holds true for the following variables.

Quality of Life (QoL). QoL was determined by means of the short version of the World Health Organisation Quality of Life (WHOQOL-BREF) Questionnaire (Group WHOQOL, 1993; Hsiao, Wu, & Yao, 2014; Skevington, Lotfy, & O'Connell, 2004; Trompenaars, Masthoff, van Heck, Hodiamont, & de Vries, 2005). The WHOQOL-BREF was developed to assess QoL in a cross-culturally comparable way. Analyses of internal consistency, item–total correlations, discriminant validity and construct validity indicate that the WHOQOL-BREF has good to excellent psychometric properties of reliability and validity (Hsiao, Wu, & Yao, 2014; Skevington, Lotfy, & O'Connell, 2004; Trompenaars et al., 2005). The WHOQOL-BREF covers four domains of QoL: physical, psychological, social, and environment. These WHOQOL-BREF items all inquire "how much", "how completely", "how often", "how good" or "how satisfied" the respondent felt in the last two weeks.

Physical QoL was assessed via the use of seven items (Cronbachs α = .81) such as "To what extent do you feel that physical pain prevents you from doing what you need to do?". *Psychological* quality of life was measured with six items (Cronbachs α = .81) such as "To what extent do you feel your life to be meaningful?". QoL regarding *social relations* was assessed by three items (Cronbachs α = .64) such as "How satisfied are you with the support you get from your friends?". Eight items (Cronbachs α = .79) such as "To what extent do you have the opportunity for leisure activities?" were used to measure *environment* QoL. Study participants indicated their answers on different five-point-scales ranging from not at all (1) to completely (5), very dissatisfied (1) to very satisfied, not at all (1) to an extreme amount (5), not at all (1) to extremely (1), very poor (1) to very well (5) and never (1) to always (5). Three of the items were reversed before scoring. According to the WHOQOL-BREF scoring protocol, the four domains are subsequently scored, labeled and transformed to a 0 to 100 scale used to interpret and compare to other validated instrument tools such as the WHOQOL-100. The four domain scores are scaled in a positive direction, with higher scores indicating a higher quality of life.

Body Mass Index (BMI). Weight (in kg) and height (in cm) were assessed to calculate participants' BMI. According to the World Health Organisation (2006), a BMI of 18.5 to 24.9 is considered normal weight, 25.0 to 29.9 falls within the overweight range, and a BMI of 30 or higher or higher falls within the obese I (30 to 34.9) or obese II (35 to 39.99) category. To obtain equal sample sizes per BMI group we merged those with a BMI higher than 30 into one group.

Stage of Change. The stage of change for physical activity was assessed with the item: “Please think about your typical week: Do you engage in physical activity at least 5 days per week for at least 30 minutes?” (Lippke, Ziegelmann, Schwarzer, & Velicier, 2009). Participants indicated their answer on a rating scale with verbal anchors “No, and I do not intend to start” (*Pre-contemplation stage*); “No, but I am considering it” (*Contemplation stage*); “No, but I seriously intend to start” (*Preparation stage*); “Yes, but only for a brief period of time” (*Action stage*); “Yes, for a long period of time” (*Maintenance stage*).

Due to the small number of participants in the pre-contemplation stage (n = 19), pre-contemplators and contemplators were merged into one group to have equal sample sizes per stage group.

Physical activity. Physical activity was assessed with the short form of the International Physical Activity Questionnaire (IPAQ; Mäder, Martin, Schutz, & Marti, 2006; Craig et al., 2003). The IPAQ short form has been developed and tested for use in adults aged 15 to 69 years and show cross cultural validity and reliability (Craig et al., 2003). The IPAQ short form covers the domains walking, moderate and vigorous intensity activities. Participants indicated the duration (in hours and minutes) and frequency (in days) of each activity domain per week. Minutes per week were multiplied with days per week for a sum score per activity domain and then added for total activity per week.

Data Analysis

Preliminary analysis. Data analysis was conducted with SPSS 22. Correlation analyses and χ^2-tests were performed to detect country differences between the categorical variables stages of change for physical activity, and BMI groups. T^2-tests were undertaken to compare country differences regarding age and QoL.

Main analysis. As indicated by the Levene test, homogeneity of variances was not given for the dependent variables physical ($F(4, 785) = 6.62$, $p < .001$), psychological ($F(4, 785) = 9.43$, $p < .001$), social relations ($F(4, 785) = 8.40$, $p < .001$), and environment ($F(4, 785) = 12.76$, $p < .001$) QoL. We used a one-way MANCOVA, ANCOVA and the Games-Howell post-hoc comparisons to analyze variations on the QoL scores for the different stages of change for physical activity (*hypothesis 1*) and whether the relationship between stage of change and QoL is different according to BMI groups (*hypothesis 2*).

The Games-Howell test is recommended if the homogeneity of variances assumption is violated (Games & Howell, 1976; Jaccard, Becker, & Wood, 1984). As we simultaneously compared four sub-scales across stages of change, the Bonferroni adjustment for multiple comparisons was performed and a significance level of $p = .01$ was used. Age, gender, country, employment status, marital status and highest level of education were included as covariates in all analyses. Furthermore, a p value of .05 was defined as level of significance for all analyses besides of the Games-Howell post-hoc analyses were a p value of .01 was defined as level of significance.

Polynomial contrast analyses were used to test for nonlinear trends, i.e., quadratic and cubic terms. The trends were tested with adjustment (weighted terms) for unequal sample sizes. Trends and planned contrasts were computed in line with Winer, Brown, and Michels (1991). Reported contrast effect sizes are presented as r. According to Cohen (1988) effect sizes ranging from .00 to .20 are considered small, those from .20 to .33 are considered medium and those bigger than .33 are referred to as large.

Results

Descriptive Information

Sample Characteristics. The final sample comprised N = 790 participants. All descriptive results including baseline equivalency are portrayed in Table 1.

Table 1

Descriptive Information on Main Study Variables (N = 790)

	Total (N = 790)	German (n = 371)	Dutch (n = 419)		
	n (%)	n (%)	n (%)	χ^2	p
Stages of change				24.21	< .001
PC / C	155 (19.6)	59 (15.9)	96 (22.9)		
P	308 (39.0)	164 (44.2)	144 (34.4)		
A	125 (15.8)	73 (19.7)	52 (12.4)		
M	202 (25.6)	75 (20.2)	127 (30.3)		
BMI				7.66	.022
Normal weight	231 (29.2)	99 (26.7)	132 (31.5)		
Overweight	370 (46.9)	167 (45.0)	203 (48.4)		
Obese I - III	189 (23.9)	105 (28.3)	84 (20.0)		
Age	50.85 (12.15)	52.18 (11.18)	49.67 (12.85)	8.51	.004
Physical Activity	576.43 (568.04)	699.17 (636.78)	467.75 (474.28)	34.03	< .001
QoL					
Physical	68.44 (16.14)	71.44 (15.50)	65.79 (16.24)	24.79	< .001
Psychological	63.21 (15.11)	64.11 (16.13)	62.42 (14.11)	2.45	.118
Social Relations	60.38 (18.21)	58.89 (18.84)	61.69 (17.54)	4.67	.031
Environment	73.62 (12.24)	76.10 (12.61)	71.44 (11.48)	29.56	< .001

Note: [1]N = 766; PC = Pre-contemplation stage; C = Contemplation stage; P = Preparation stage; A = Action stage; M = Maintenance stage; QoL = Quality of Life;

Preliminary Analysis

Age was positively associated with psychological QoL ($r = .12$, $p = .001$) and environment QoL ($r = .12$, $p = .001$). This means that in this sample, older people tend to have higher psychological and environment QoL. BMI was negatively associated with physical QoL ($r = -.14$, $p < .001$), psychological QoL ($r = -.16$, $p < .001$), social relations QoL ($r = -.13$, $p < .001$), and environment QoL ($r = -.13$, $p < .001$). QoL scores were lower among people with higher BMI. In addition, all QoL domains were positively correlated with each other ($r > .41$, $p < .001$), indicating that high values in one QoL domain are associated with high values in another QoL domain.

Main Analysis

To test our *hypothesis 1*, we analyzed variations on the QoL scores for the different stages of change. The MANCOVA results revealed significant effects with stages of change for physical activity in relation to the four domains of the WHOQOL-BREF questionnaire (Wilks $\lambda = .94$, df = 12, $p < .001$). Games-Howell post-hoc comparisons, p values for all ANCOVA results as well as linear, quadratic, and cubic terms are shown in Table 2.

Overall, study participants of the maintenance group showed the highest QoL levels across all domains, while the pre-contemplators/contemplators showed the lowest QoL values across all domains. Significant differences occurred when comparing pre-contemplators/contemplators with the maintainers regarding physical, psychological, social and environment QoL. In addition, preparers scored higher on physical, psychological and social relations QoL, but not environment QoL.

There were significant linear trends for all of the QoL domains, indicating that the higher the stage of change, QoL increased proportionately. For environment QoL there was also a significant cubic trend, with high QoL levels in both preparers and maintainers.

Table 2

Analysis of Mean Values and Standard Deviations According to Stages of Change (N = 790)

	PC / C	P	A	M			Linear term	Quadratic term	Cubic term
	n = 155	n = 308	n = 125	n = 202	p	GH[1]			
	M (SD)	*M* (SD)	*M* (SD)	*M* (SD)			*F* (*r*)	*F* (*r*)	*F* (*r*)
Physical QoL	65.12 (16.31)	67.34 (14.40)	68.40 (18.42)	72.72 (16.23)	< .001	PC / C < M, P < M	21.83** (0.61)	0.48 (0.01)	0.41 (0.01)
Psychol. QoL	59.65 (17.00)	61.28 (12.65)	63.70 (15.79)	68.59 (15.22)	< .001	PC / C < M, P < M	39.07** (0.81)	2.03 (0.07)	0.12 (< .01)
Social relations QoL	57.20 (20.48)	58.47 (15.27)	60.47 (18.84)	65.68 (19.06)	< .001	PC / C < M, P < M	23.81** (0.65)	1.97 (0.07)	0.17 (< .01)
Environment QoL	70.83 (11.59)	74.29 (10.00)	72.30 (15.79)	75.63 (12.92)	.003	PC / C < M	9.27* (0.33)	< 0.01 (< .01)	6.84* (0.24)

Note: QoL = Quality of life; PC = Pre-contemplation stage; C = Contemplation stage; P = Preparation stage; A = Action stage; M = Maintenance stage; psychol. = psychological; [1]Games-Howell post-hoc test, with significance at .01; r = contrast effect size; * $p < .05$, ** $p < .001$

To test our *hypothesis 2*, we investigated whether the differences in QoL according to stage of change might also depend on people's BMI group (Table 3).

Table 3

Analysis of Quality of Life Mean Values and Standard Deviations per Quality of Life Dimension According to Stages of Change per BMI Group (N = 790)

	PC/C	P	A	M	p	GH[1]
Normal weight:	*n* = 52	*n* = 68	*n* = 35	*n* = 76		
18.0 – 25.0, *n* = 231						
Physical QoL	57.51	69.49	66.33	73.45	.096	
Psychological QoL	64.34	62.19	63.45	68.97	.036	
Social Relations QoL	63.14	59.07	59.05	66.01	.107	
Environment QoL	72.90	74.13	72.68	76.48	.255	
Overweight:	*n* = 66	*n* = 166	*n* = 48	*n* = 90		
25.1 – 30.0, *n* = 370						
Physical QoL	67.21	68.35	70.24	72.14	.090	
Psychological QoL	60.35	62.58	62.41	70.14	< .001	PC / C < M, P < M
Social Relations QoL	56.19	59.29	61.28	68.06	< .001	PC / C < M, P < M
Environment QoL	71.50	75.55	72.92	75.45	.028	
Obese I to III:	*n* = 37	*n* = 74	*n* = 42	*n* = 36		
30.1 – max, *n* = 189						
Physical QoL	58.01	63.08	68.03	72.62	.007	PC / C < M
Psychological QoL	51.81	57.55	63.38	63.89	.005	
Social Relations QoL	50.68	56.08	59.71	60.02	.175	
Environment QoL	66.72	71.45	71.28	74.31	.211	

Note: QoL = Quality of life; PC = Pre-contemplation stage; C = Contemplation stage; P = Preparation stage; A = Action stage; M = Maintenance stage; [1]Games-Howell post-hoc test, with significance at $p < .01$.

Maintainers showed highest levels of QoL across all QoL dimensions, irrespective of BMI group. There were no significant associations between QoL and stage of change in normal weight people. However, we found significant differences in the association of QoL and the stage of change among overweight and obese people: Overweight pre-contemplators and contemplators showed lower levels of psychological and social relations QoL than those in the maintenance group. In addition, the overweight preparers also showed lower levels of psychological and social relations QoL than those in the maintenance group. Obese pre-contemplators and contemplators showed lower levels of physical QoL. There were no weight-specific differences in the association between environment QoL and stage of change.

Discussion

The main aim of this study was to examine the relationship between motivational stage of change for physical activity and the self-reported QoL among people who were motivated to reduce their cardiovascular risk. In this study, we proceeded beyond the simple distinction between physically active and inactive individuals. We rather made an attempt to understand the determinants of motivational readiness to change along an underlying continuum of stages of change of the TTM (Prochaska & DiClimente, 1983), ranging from pre-contemplation (not intending to change) to maintenance (regular physical activity over time).

In our sample, more than half of the adults were not physically active regularly and were not even considering starting to do so. Therefore, a markedly high percentage were not in the stage of being physically active for at least five days a week for 30 minutes. Similar results are found in an other study that investigates physical activity behaviour in the adult population (Monette, Baird, & Jackson, 2014). However, they had a fairly strong intention to be physically active, with 39.0% of them in the preparation stage (having the intention to start being physically active within the next 30 days) and a further 17.2% in the contemplation stage (having the intention to start being physically active within the next 6 months). This finding is in line with the data from Lee et al. (2006) and shows that it is essential to focus on how to provide appropriate guidance to people who are motivated to reduce their cardiovascular risk through regular physical activity.

Older people reported higher levels of QoL. Although older age is often associated with lower levels of cognitive function (Monette, Baird, & Jackson, 2014; Knopman et al., 2001), slight improvement in mental health in older subjects is possible, especially when supported by physical activity training (Kelly et al., 2013). However, it would be assumable that physical domains of QoL deteriorated in older individuals, although our results did not replicate this.

Like in the investigations conducted by Korhonen et al. (2014) and Renzaho, Wooden, and Houng (17) we discovered that QoL and BMI were negatively related, whereby the greater the BMI, the lower the physical, psychological, social relations, and environment QoL. In fact, Cameron et al. (2012) suggest that the relationship between obesity and QoL is bi-directional: in a longitudinal study, they found that QoL was also a predictor of weight gain over the course of the years. Future studies should attempt to further investigate the direction of the effect of physical activity by using randomized controlled trials.

Four previous studies have examined the effects of stage of change on QoL among the general population (Laforge et al. 1999), among lung cancer survivors (Clark et al., 2008) and overweight and obese adults (Romain et al., 2012; Lee et al., 2006). They all concluded that people who reported being physically active on a regular basis also had better self-reported QoL, with a peak occurring in the maintenance stage. However, to our knowledge, no studies to date have used the TTM with the WHOQOL-BREF questionnaire as a reliable instrument that tends to produce fewer ceiling and floor effects (Hsiao, Wu, & Yao, 2014; Skevington, Lorfy, & O'Connell, 2004; Trompenaars et al., 2005). In line with the aforementioned studies, we could show that progression through the physical activity stages is related to higher physical, psychological, social relations and environment QoL. We found statistically significant differences in all QoL domains when comparing inactive people (pre-contemplators/contemplators) with people with sustained physical activity (maintainers).

So far, the relationship between QoL and stage of change among different weight groups has been unattended. Among our sample, the association between QoL and stage of change was different for normal weight, overweight and obese people: Overweight people who were already exercising on a regular basis (maintainers) showed higher levels of psychological and social relations QoL than both those who did not consider to start doing so (pre-contemplators/contemplators) and those who were preparing to do so (preparers).

In obese people, stage of chance was associated with QoL in the physical domain only. Obese but regularly active people (maintainers) reported significantly higher physical QoL than obese people who did not intend to start exercising (pre-contemplators/contemplators). QoL was not associated with stage of change among people with normal weight. One could assume that the obesity group could profit from regular physical activity in a two-fold manner: *first*, in terms of reducing their risk of future cardiovascular diseases through weight management; and *second*, regarding their psychological and social relations QoL levels.

Since environment QoL did not yield significant differences with regard to motivational stages among the three BMI grousps and only marginally significant differences between motivational stages alone. While the relationship between physical activity and physical QoL, psychological QoL and social relations QoL is well documented (Bize, Johnson, & Poltnikoff, 2007), environment QoL might be influenced by other factors than physical activity.

Our study has some limitations; for instance, the small percentage in the pre-contemplation stage prompted us to merge them with those in the contemplation stage, which precludes any specific interpretation for each of these groups.

Furthermore, our study participants form a rather heterogeneous group. Although baseline intentions and sociodemographic data was controlled for in all analyses, a physician rating, medical diagnosis or objective index of medical severity should be included to control for in future studies.

Finally, as our study is cross-sectional, the presence of an association between physical activity and QoL does not allow an interpretation of a potential causal relationship. We suggest an experimental design for future studies, investigating the effect of physical activity on QoL, as evidence of causality can only be obtained from an interventional study. Indeed, it is possible that higher QoL positively influenced the motivation to change one's activity behaviour and not vice versa.

Conclusion

The results of our study suggest that interventions aimed at increasing physical activity should be both aimed at increasing awareness of personal activity levels and matched to an individual's motivational change of change. Although the majority of the overweight and obese adults in the present study were not in the habit of exercising regularly, they showed motivation to be physically active.

The positive association between physical activity and QoL seems to be specifically relevant in overweight and obese individuals, and these could be target groups for preventive and therapeutic interventions that aim at improved QoL. The TTM highlights the role of verbal communication and cognitive processing in the early stage of changes (pre-contemplation and contemplation). Accordingly, health professionals must be properly trained to provide tailored advice to people at varying stages of change, with the benefits of effectively incorporating physical activity into their daily routines, reducing cardiovascular risk factors and enhancing the QoL. A causal effect of physical activity stage of change on QoL over time needs to be replicated in further studies considering longitudinal experimental designs.

Compliance with Ethical Standards

Funding

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Conflict of Interest

Vera Storm, Dominique Reinwand, Julian Wienert and Sonia Lippke all declare that they have no conflict of interest.

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent

Informed consent was obtained from all individual participants included in the study.

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Chapter 4: Physical exercise, sickness absence, and subjective employability: an 8-year longitudinal observational study among musculoskeletal patients

Storm, V., Paech, J., Ziegelmann, J., & Lippke, S. (in press). Physical exercise, sickness absence, and subjective employability: an 8-year longitudinal observational study among musculoskeletal patients. *Journal of Rehabilitation Medicine.*

Abstract

Objective: Physical exercise recommendations become particularly effective when embedded into medical rehabilitation. However, little is known about long-term behavior maintenance and its effect on sickness absence and subjective employability. The current longitudinal observational study investigated self-reported physical exercise, sickness absence and subjective employability over a period of 8 years.

Subjects: A total of 601 (T0) outpatients (mean age 45.14 years; standard deviation 10.73 years, age range 18–65 years) with different orthopaedic disorders were recruited during their 3-week medical rehabilitation in Germany. Of these, 61.7% (n = 371) were female. Follow-ups were carried out at 6 months (T1, n = 495), 12 months (T2, n = 340), 3 years (T3, n = 296) and 8 years (T4, n = 142) after baseline.

Methods: Patient characteristics, exercise status, social cognitive variables, sickness absence and subjective employability were obtained via self-report questionnaires. SPSS hierarchical regression models were used for data analysis, controlling for baseline measures and socio-demographic variables.

Results: Physical exercise status 6 months after rehabilitation treatment (T1) predicted sickness absence at 12 months (T2). Inactive people were 3.28 times more likely to be on sick leave at T2. In addition, physical exercise at T1 predicted subjective employability 12 months (T2) and 3 years (T3) later. Those who met the recommendations to be physically active for at least 40 min a week were more likely to feel able to work.

Conclusion: Exercise appears to play an important role in reducing sickness absence and subjective employability and should be promoted within and after rehabilitation treatment.

Introduction

Over the past several years, the demand for rehabilitation services has grown**.** Patients undergoing rehabilitation due to musculoskeletal diseases (MSD) make up the largest volume of rehabilitation patients in industrialized countries (Zheltoukhova, O'Dea, & Bevan, 2012). MSD such as joint or spine injuries as well as pain in the nerves and muscles are the most common cause of chronic severe pain, long-term physical disability, work limitations and unemployment (Zheltoukhova, O'Dea, & Bevan, 2012; Woolf, Vos, & March, 2010). The prevalence of many of these conditions increases markedly with age and is often affected by lifestyle factors such as physical inactivity (Woolf & Pfleger, 2003). Physical exercise, as one target health behaviour in MSD rehabilitation programs, is well known for its positive effects on physical and mental health (US Department of Health and Human Services, 2015). These physical exercise programs usually include the domains of muscle, strength and endurance training (Fransen, McConnell, & Bell, 2002).

So far, much research has been done on functional performances, the reported level of pain, or disability improvement after rehabilitation (Kool et al., 2004). Researchers, however, now increasingly recognize that successful return to work (RTW) and fewer sick days are also key outcomes in determining the effectiveness of rehabilitation.

MSD patients report multiple difficulties when trying to return to or remain at work. Difficulties include pain, its impact on work performance and fear of re-injury (Robert-Yates, 2003; Tveito, Shaw, Huang, Nicholas, & Wagner, 2010). It is likely that physical exercise not only improves people's functioning in terms of flexibility, strength, endurance and reduction of pain (van Middelkoop et al., 2010), but it might also have an indirect effect on feeling able to work by means of an improvement of health status (Rueda et al., 2012). In recent reviews regarding the long-term effects of rehabilitation exercise therapy, researchers found evidence for reduction of sick days (Kool et al., 2004) and faster RTW outcomes (Sullivan & Stanish, 2003; Sullivan et al., 2005).

After discharge from rehabilitation treatment, patients usually leave highly motivated to practice the intended behaviour. However, it is difficult for many patients to adopt and, in particular, to maintain the recommended behaviours even if they strongly intend to do so (Pisters et al., 2010; Reuter, Ziegelmann, Lippke, & Schwarzer, 2009). From a prevention perspective, screening for predictive factors and obstacles associated with long-term health behaviour change and employability offer a promising avenue for medical rehabilitation. Work resumption is an important goal, not only for economic reasons, but also because it benefits most patients' mental and physical health status (Rueda et al., 2012; van der Noordt, Uzelenberg, Droomers, & Proper, 2014). Since long-term outcomes are of importance to the individual and society, the authors of the longitudinal study presented here will assess the contribution of physical exercise to sickness absence and subjective employability up to eight years after discharge from rehabilitation treatment. Therefore, we hypothesize that physical exercise not only predict sickness absence at the different follow-ups (*hypothesis 1*) but that physical exercise also predicts subjective employability at the different follow-ups (*hypothesis 2*).

Method

Design

An eight-year prospective longitudinal design was used for the observational study that was done between 2001 and 2009 in Berlin, Germany.

Procedure and Participants

The first measurement point of the study (T0) was conducted in an outpatient orthopedic rehabilitation centre where participants underwent a daily exercise therapy for three weeks. All rehab patients who met the inclusion criteria such as *(i)* being at least 18 years old; *(ii)* no cognitive impairments; *(iii)* being capable of exercising on their own; *(iv)* German language proficiency were approached in a face-to-face meeting by their physicians to participate.

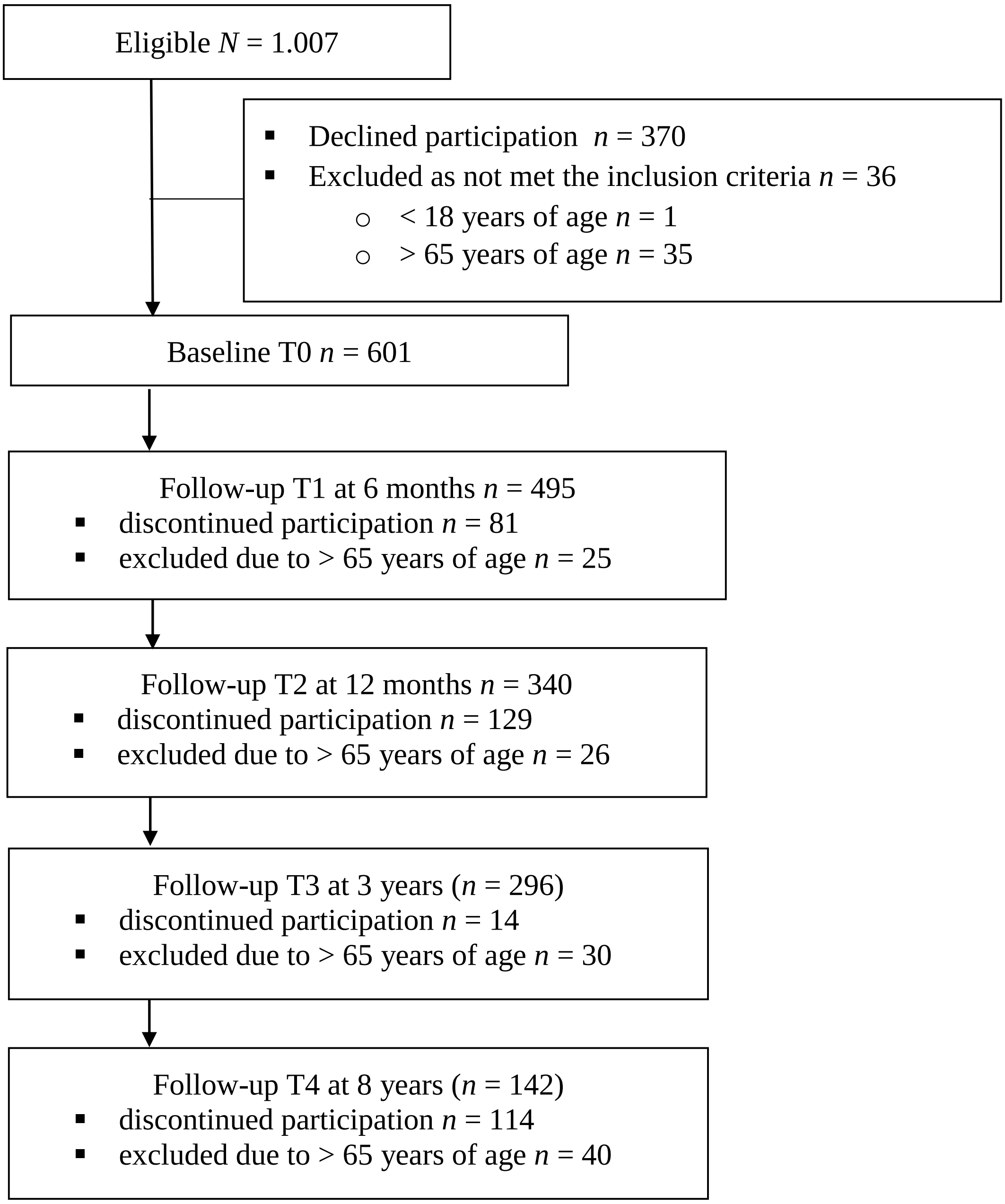

Figure 1. Participant flow through the study.

After obtaining informed consent, *N* = 637 persons were assessed by paper-and-pencil questionnaires. Physicians diagnosed patients with different musculoskeletal diseases, such as back pain, disc disorders, joint conditions and injuries. The goal of the rehabilitation programme was to improve their level of functioning, enhance their ability to work, and increase their chances of returning to work, i.e., feeling able to return to work.

We excluded n = 36 people that were either younger than 18 (n = 1) or older than 65 (n = 35) years at T0 to have a representative sample of the German working population. The final sample consisted of N = 601 people, had a mean age of 45.14 years at baseline (SD = 10.73, Range: 18-65), 61.7% (n = 371) of which were female. 68.7% (n = 413) of the participants were living with a partner and 71.5% were employed either fulltime, part-time or self-employed; 50.1% of those were on sick leave.

There were follow-ups at intervals of six months (T1, n = 495), twelve months (T2, n = 340), three years (T3, n = 269) and eight years (T4, n = 142) after baseline T0 (Figure 1). For each measurement point we included people up to the maximum age of 65 years only. The follow-up questionnaires (including prepaid reply envelopes) were sent by the project staff via mail. Those who did not respond after four weeks were sent a reminder letter along with another copy of the questionnaire and a prepaid envelope. The completion of each questionnaire took about 15 minutes. Participation in the study was voluntary and data were anonymised.

Measures

Demographic variables. Sociodemographic information such as gender, year of birth, partner status and highest level of education was assessed in the baseline questionnaire (T0). Height and body weight to calculate Body Mass Index (BMI) were additionally reported by the participants on all measurement points (T0, T1, T2, T3, T4). All item examples given below are translations from German.

Sick-leaves and return to work rates. At baseline T0, 50.1% of the participants (n = 301) reported currently being on sick leave. For each follow-up measurement point, we calculated the proportion who had returned to work after being on sick leave at the baseline. Percentages refer to the sample size at the respective follow-up. Six months after rehab (T1) n =

61 people (13%) had still not returned to work. Twelve months after rehab (T2) *n* = 35 participants (10.3%) had not resumed work, whereas after three years (T3) *n* = 32 (10.8%) and after eight years (T4) *n* = 14 people (9.9%) were on sick leave.

Subjective employability. Participants were requested to rate their subjective ability to work at T1, T2, T3, and T4 by answering whether they felt able to work fulltime or part-time, which they answered as either *not true* (1), *hardly true* (2), *rather true* (3) or *definitely true* (4).

Physical exercise. Physical exercise was assessed at T0, T1, T2, T3, and T4 with a modified version of the International Physical Activity Questionnaire (IPAQ, Mäder, Martin, Schutz, & Marti, 2006). The IPAQ has been shown to be a valid reliable instrument among rehab patients and beyond (Craig et al., 2003). We exclusively used targeted physical activity (endurance sports, muscle training, game sports) for data analysis because this subset constituted the best match with the exercise recommendations of the rehabilitation clinic. To compute exercise duration, we multiplied minutes of exercise per day with exercise days per week. This is a common routine in IPAQ research (Craig et al., 2003). Based on Tabachnick and Fidell's definition (2013), 18 values higher than 3 standard deviations were defined as outliers and were recoded to the closest non-outlying value in the data distribution. People who reported that they would exercise less than 40 minutes per week were categorised as inactive as this was the minimal recommendation by the doctors overseeing the rehabilitation (Löllgen & Löllgen, 2011).

Intention. Exercise intentions (Cronbach's α = .68) were assessed at T0, T1, T2, T3, and T4 with nine items such as "I intend to exercise for 20 minutes or longer on at least two days per week on a regular basis health." Participants rated all answers of the intention variable on a 4-point scale from *not at all true* (1), *not true* (2), *a little true* (3), to *exactly true* (4). Exercise intentions have shown validity within and beyond rehab samples (Schwarzer et al., 2007; Lippke, Ziegelmann, & Schwarzer, 2004). Table 1 provides a summary of all descriptions regarding the measured variables.

Data analysis

We analysed the data with SPSS version 22 software. Dropout analyses were done with *t*-tests for the continuous variables and χ^2 test for the categorical variable gender.

First, we used hierarchical logistic regression to investigate whether the dichotomised predictor physical exercise (0 = active, 1 = inactive) would predict sickness absence at the different follow-ups (*hypothesis 1*). As the participants showed their maximum levels of physical exercise at T1, we used exercise status at T1 as a predicting variable. The results of the logistic regression analyses are presented as an odds ratio (OR). The reliability of the OR is expressed as a 95% confidence interval (CI). Statistical significance was set at $p < .05$ for the multiple regression analyses.

Second, we used hierarchical linear regression to analyse the effect of the dichotomised predictor physical exercise (0 = active, 1 = inactive) and assumed that it would predict subjective employability at the different follow-ups (*hypothesis 2*).

In recent reviews, age and BMI were found to be strong predictors of the development and progression of certain musculoskeletal diseases such as osteoarthritis of the hand, knee and hip (Chapple, Nicholson, Baxter, & Abbott, 2011). Therefore, besides education, family status, T0 physical exercise, T0 intentions, and T0 subjective employability, age and T0 BMI were used as control variables.

We analysed the data with SPSS version 22 software. Dropout analyses were done with *t*-tests for the continuous variables and χ^2 test for the categorical variable gender.

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different follow-ups (*hypothesis 1*). As the participants showed their maximum levels of physical exercise at T1, we used exercise status at T1 as a predicting variable. The results of the logistic regression analyses are presented as an odds ratio (OR). The reliability of the OR is expressed as a 95% confidence interval (CI). Statistical significance was set at $p < .05$ for the multiple regression analyses.

Second, we used hierarchical linear regression to analyse the effect of the dichotomised predictor physical exercise (0 = active, 1 = inactive) and assumed that it would predict subjective employability at the different follow-ups (*hypothesis 2*).

Results

Preliminary Analysis

We found significant age differences between dropouts and those who participated in all follow-up questionnaires (T0: $t(600) = 7.52$, $p = .006$; T1: $t(494) = 7.58$, $p = .006$; T3: $t(339) = 4.62$, $p = .032$). The dropouts from after baseline were significantly older and the dropouts from after 6 months and after 3 years were significantly younger than those who completed all measurement points. Regarding gender, we found no differences in dropout rates after 6 months (T1), 12 months (T2) and 3 years (T3) (all *p*s > .248). In addition, participants who dropped out after 6 months (T1), 12 months (T2) or 3 years (T3) reported no significant differences regarding baseline exercise behaviour (all *p*s > .241). Those who dropped out after 6 months (T1) and 12 months (T2) did not differ in terms of subjective employability (T1) (all *p*s > .115) from those who completed all measurement points. However, those who dropped out after three years (T3) showed significantly lower levels of T1 subjective employability than those who also completed the T4 measurement point ($t(295) = 4.61$, $p = .032$).

Table 1

Summary of the Main Study Variables

	T0		T1		T2		T3		T4	
	n = 601		*n* = 495		*n* = 340		*n* = 296		*n* =1 42	
	M (SD)	Range	*M* (SD)	Range	*M* (SD)	Range	*M* (SD)	Range	*M* (SD)	Range
Intention	3.47 (0.48)	1.25-4.0	3.48 (0.51)	1.38-4	3.44 (0.55)	1-4	3.44 (0.52)	1.38-4	3.22 (0.56)	1.13-4
Subj. empl.	3.47 (0.48)	1-4	2.86 (1.22)	1-4	3.04 (1.17)	1-4	2.99 (1.20)	1-4	2.86 (1.27)	1-4
Age	45.14 (10.73)	18-65	46.24 (10.56)	20-65	47.22 (10.49)	21-65	48.56 (10.13)	23-65	52.03 (9.30)	26-65
	n	%	*n*	%	*n*	%	*n*	%	*n*	%
PA status[1]										
Inactive	308	51.2	121	25.8	92	27.1	100	33.8	54	38.0
Active	293	48.8	348	74.2	248	72.9	196	66.2	88	62.0

Note: Subj. empl.. = subjective employability; [1] inactive: < 40 min physical exercise/week, active: > 40 min physical exercise/week

Main Analysis

First, we ran multiple logistic regression to analyse the predictive value of physical exercise (0 = active, 1 = inactive) for sick leave absence (0=no sickness absence, 1=sickness absence). Results are depicted in Table 2. T1 physical exercise predicted sickness absence at T2 (OR: 3.28, 95% CI: 1.05-2.16, p = .002). The probability of being on sick leave at T2 was 3.28 times higher in people who were inactive at T1, irrespective of sociodemographic variables, baseline sickness absence, and baseline physical exercise (T0). There were no effects of physical exercise on sick leave at T3 nor on T4 absence.

Table 2

Hierarchical Regression Results on Sickness Absence

	Sick leave T2 (Ref: on sick leave) *n* = 340		Sick leave T3 (Ref: on sick leave) *n* = 296		Sick leave T4 (Ref: on sick leave) *n* = 142	
	OR (CI)	*p*	OR (CI)	*p*	OR (CI)	*p*
Step 1						
Control variables		.868		.630		.295
Nagelk. R^2	.02		.03		.19	
Step 2						
Physical activity T1 Ref: inactive[1]	3.28 (1.52-7.06)	.002	0.96 (0.35-2.64)	.939	1.18 (0.20-6.90)	.851
Nagelk. R^2	.07		.04		.20	
Step 3						
Physical activity T2 Ref: inactive[1]	3.13 (1.41-6.96)	.005	1.73 (0.65-4.64)	.274	1.79 (0.29-11.17)	.536
Nagelk. R^2	.12		.04		.21	

	Sick leave T2 (Ref: on sick leave) *n* = 340		Sick leave T3 (Ref: on sick leave) *n* = 296		Sick leave T4 (Ref: on sick leave) *n* = 142	
	OR (CI)	*p*	OR (CI)	*p*	OR (CI)	*p*
Step 4						
Physical activity T3 Ref: inactive[1]			0.81 (0.32-2.05)	.661	3.02 (0.53-17.31)	.216
Nagelk. R^2			.04		.25	
Step 5						
Physical activity T4 Ref: inactive[1]					0.65 (0.09-4.59)	.667
Nagelk. R^2					.26	

Note: Step 1 includes control variables gender, education, intention T0, BMI T0, sickness absence T0, physical exercise T0; [1] inactive: < 40 min physical exercise/week, active: > 40 min physical exercise/week; Nagelk. = Nagelkerkes R^2

Our *second* aim was to test the relationship between physical exercise and subjective employability. Therefore, we ran hierarchical regressions with physical exercise predicting subjective employability at the 12-month (T2), 3-year (T3) and 8-year (T4) follow-up. Results are depicted in Table 3.

Table 3

Hierarchical Regression Results of Physical Exercise on Subjective Employability

	T2 *n* = 340			T3 *n* = 296			T4 *n* = 142		
	ß	*p*	*F*	*ß*	*p*	*F*	*ß*	*p*	*F*
Step 1									
Control variables									
R^2	.33			.29			.15		
ΔR^2	.33	< .001		.29	< .001		.15	.049	
Step 2									
Physical activity T1[1]	-.10	.035	-2.12	-.18	.002	-3.07	-.06	.608	-0.52
R^2	.34			.32			.15		
ΔR^2	.01	.035		.03	.002		.< 01	.608	
Step 3									
Physical activity T2[1]	-.16	.001	-3.25	< .01	.962	-0.05	-.07	.597	-0.53
R^2	.37			.32			.15		
ΔR^2	.02	.001		< .01	.962		< .01	.597	
Step 4									
Physical activity T3[1]				-.04	.547	-0.60	< .01	.995	-0.01
R^2				.33			.15		
ΔR^2				< .01	.547		< .01	.995	
Step 5									
Physical activity T4[1]							-.16	.218	-1.24
R^2							.41		
ΔR^2							.02	.218	

Note: [1] inactive: < 40 min physical exercise/week, active: > 40 min physical exercise/week; control variables: gender, education, intention T0, BMI T0, subjective employability T0, physical exercise T0

T1 physical exercise significantly predicted subjective employability 12 months (*ß* = -.10, p = .035, R^2 = .34) and 3 years (*ß* = -.18, p = .002, R^2 = .32) after baseline when controlling for sociodemographic variables, baseline subjective employability and baseline physical exercise. T1 physical exercise was not predictive of subjective employability at T4.

Discussion

This study investigated the effect of physical exercise on sickness absence and subjective employability among former musculoskeletal rehabilitation patients and covered the durations of six months, one year, three years and eight years. Long-term follow-ups over extended periods of time after discharge from rehabilitation are scarce in the current literature. Therefore, the aim of this study was to enhance understanding of the longitudinal outcomes in the domain of employability and sickness absence.

We could show that being physically active for at least 40 minutes a week six months after rehabilitation treatment reduces sick leave during the first follow-up year. This is in line with Kool et al (2004), who investigated the effect of physical exercise treatment on sickness absence in a meta-analysis with 22 randomised controlled trials. However, in our study there was no effect of physical exercise status on sick leave in the longer run (e.g., three years and eight years later). It is possible that the effects of physical exercise decline with increasing follow-up duration. This might be due to the fact that other factors might influence sickness absence such as an individual's profession, stressors in the work and social environment (Nimiströ, Sarna, Lahtinen-Suopanki, Lindgren, & Hurri, 2004; Pfingsten, Hildebrandt, Leibing, Franz, & Saur, 1997) or non-changeable risk factors such as age, gender and genetic predispositions for certain health problems (Hubertsson et al., 2014). For future studies, a core set of confounding factors to describe participants in a standardised way would enable comparison of the effectiveness of physical exercise treatments for different working populations (Kool et al., 2004; Pfingsten et al., 1997).

We also found that being physically active for at least 40 minutes a week is positively associated with the subjective ability to work, consistent with Arvidson et al. (2013) also in the medical rehabilitation setting. Those people who had become regularly active since rehabilitation treatment were more likely to feel able to work not only in short term but also three years later, regardless of age, gender and baseline behaviour. It is well known that exercise not only improves muscle strength and endurance (Hunter, McCarty, & Bamman, 2004). Physical exercise might have also helped people to cope with stress, anxiety, and depression (Mammen & Faulkner, 2013), resulting in more work-related self-confidence. It is not only the individual worker can benefit from long-term rehabilitation effects on work-related outcomes. Sustained employability and less sick days also provide benefits to the employer, such as lower presentism and absenteeism, reduced staff attrition and training costs by retaining experienced employees and maintaining improved productivity (Norrefalk, Ekholm, Linder, Borg, & Ekholm, 2008).

Potential limitations of the study should be discussed. The *first* drawback is the measurement of patient's subjective employability. To measure subjective employability more elaborately, we recommend the use of the Work Ability Index by Ilmarinen (2009) or the Readiness To Return To Work Scale by Franche, Corbiére, Lee, Breslin, and Hepburn (2007). This enables the researcher to consider individual and social factors that influence an individual’s return to work after an injury and has been shown to have validity among musculoskeletal patients (Braathen, Brage, Tellnes, & Eftedal, 2013). Furthermore, not only a measure of ability but also of desire to work would be of interest in future studies, as desire may be influenced by job resources, physical job demands, certain personality characteristics or income (Halbesleben, 2010; Nahrgang, Morgesob, & Hofmann, 2011). Of course, changes in the labour market and social insurance system might also have an impact.

Secondly, the measurement of our criterion variable physical exercise needs to be discussed. Our exercise data are based on self-report only and might be prone to bias. However, there is evidence for the reliability and validity of physical activity self-reports such as the short version of the IPAQ (Craig et al., 2003). Future studies should consider more objective measures in addition to self-report such as pedometers which are already frequently applied in physical activity research (Mansi et al., 2014). In addition, physical activity at work might also be worth measuring to be included as a covariate.

Thirdly, our study participants form a rather heterogeneous group, as we included patients with different MSD, such as back pain, disc disorders, joint condition and injuries, and did not control for their conditions. The findings of Hubertsson et al. (2014) show that duration as well as age and sex distribution concerning sick leave vary considerably between different diagnostic codes within the group of MSDs. This underlines the importance of considering diagnosis in sick leave research. A physician rating or objective index of medical severity should therefore be included in future studies. Thus, the generalisability of our findings for a specific study group needs to be done with caution, and future researchers should aim at obtaining larger sample sizes and frequent follow-up participation.

Finally, the study results are based on a longitudinal but only observational design. The cause-and-effect relationships found are based on theory or time lag and not on experimental manipulation. From the results of our study, we conclude that active people need less sick leave. However, the exact direction of the effect remains uncertain. We do not know whether people are less physically active because they are sick more often, or whether physical activity has health effects that result in less sick leave. Although longitudinal analyses reflect the relationship between being active and decreased sick leave, the extent to which these associations are caused by a within-worker or a between-worker relation remains unclear. Intervention studies are needed that specifically address the impact of physical exercise on work-related outcomes, including yearly follow-up measurement points.

Conclusion

Identifying predictors for subjective employability and sickness absence is essential in order to direct correct individual rehabilitation. Our finding that physical exercise for 40 minutes a week may be effective at reducing sick leave is important information, not only for the individual but also from an economic perspective. Because rehabilitation patients show high motivation to exercise when they end their rehabilitation treatment, but then face a decrease in motivation over time, they need to be supported to maintain their motivation. Aftercare programs could be a promising tool to maintain rehabilitation outcomes and support people in changing their lifestyles by improving motivation, self-efficacy and planning strategies (Ströbl, Knisel, Landgraf, & Faller, 2013; Brouwer et al., 2009).

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Chapter 5: Compensatory health beliefs are negatively associated with intentions for regular fruit and vegetable consumption when self-efficacy is low

Storm, V., Reinwand, D.A., Wienert, J., Kuhlmann, T., de Vries, H., & Lippke, S. (2016). Brief report: Compensatory health beliefs are negatively associated with intentions for regular fruit and vegetable consumption when self-efficacy is low. *Journal of Health Psychology* [Epub ahead of print January 28, 2016, doi: 10.1177/1359105315625358].

Abstract

Compensatory health beliefs (the beliefs that an unhealthy behaviour can be compensated by a healthy behaviour) can interfere with adherence to fruit and vegetable consumption recommendations. Fruit and vegetable consumption, social cognitive variables and compensatory health beliefs were investigated via self-report at baseline (T0) and 8-week follow-up (T1) in N = 790 participants. Self-efficacy predicted fruit and vegetable consumption intentions. Planning mediated between intentions and T1 fruit and vegetable consumption. Compensatory health beliefs negatively predicted intentions at low self-efficacy levels only. The results propose the use of self-efficacy interventions to diminish the negative effects of compensatory health beliefs when forming fruit and vegetable consumption intentions and foster planning to translate intentions into behaviour.

Introduction

Coronary vascular diseases (CVD) are the main cause of mortality and morbidity in men aged over 45 years and women aged over 65 years in most developed European countries, including Germany and the Netherlands (Nichols et al., 2014). The prevalence of many of these conditions increases with age and is often affected by lifestyle factors such as physical inactivity and having an unhealthy diet (Mendis et al., 2011). There is accumulating evidence that especially fruit and vegetable consumption (FVC) plays an important role in preventing other chronic conditions associated with CVD, such as diabetes mellitus or (future) cardiovascular issues (Boeing et al., 2012). Despite the widely used recommendations to eat at least five portions of fruit and vegetable a day, few adults adhere to these guidelines (Organisation for Economy, Cooperation and Development (OECD, 2013).

Models and theories in health psychology are usually founded upon the common 'meta-theory' that some form of intention is central to initiating health behaviour or behaviour change. However, compensatory health beliefs (CHBs; Rabiau et al., 2006) can interfere with successful health behaviour change. CHBs implicate the belief that the negative consequences of an unhealthy behaviour (e.g. eating unhealthily) can be compensated by engaging in another, more healthy behaviour (e.g. exercising). In the Compensatory Carry-Over Action Model (CCAM; Lippke, 2014), CHBs are proposed to be disturbing in the motivational phase of behaviour change and they can be harmful if negatively related to behavioural intentions. Negative effects of CHBs on intentions have already been found in the context of physical activity (Berli et al., 2013) and dietary intake (Radtke et al., 2014). These negative effects imply that high CHBs are associated with low intentions to show the target behaviour. Nonetheless, the effects of CHBs on intention may also be influenced by certain motivational variables. However, moderation effects have been widely overlooked, with the exception of one study by Radtke et al. (2014), finding that CHBs were positively related to physical activity intentions in women with high levels of risk perception. This could imply that when people perceive high risks and observe possibilities to compensate low physical activity levels with other behaviours, they still have positive intentions, regardless of high CHBs.

In accordance with Rabiau et al. (2006), it is likely that the effect of CHBs on intentions also depends on self-efficacy beliefs, whereby individuals with low levels of self-efficacy are less likely to behave according to their intentions (Ochsner et al., 2013). Therefore, individuals low in self-efficacy might be more likely to subdue their temptations and show CHBs, which negatively influence intentions to undertake a health behaviour. Even if people have developed intentions to perform such a behaviour, they fail to translate them into action, which is commonly referred to as the intention-behaviour gap (Webb and Sheeran, 2006). Intervention research tries to bridge this gap with self-regulation strategies such as planning (Hagger and Luszczynska, 2014). Through specifying when and where a certain behaviour will be carried out or how potential barriers will be tackled, the goal behaviour is more likely to be shown. Indeed, this has already been found in the field of FVC (Adriaanse et al., 2011), especially when self-efficacy beliefs are high (Luszczynska and Haynes, 2009). However, research including intentions, CHBs and planning has been scarce to date.

Given the little research on CHBs thus far, the direction of the effect of CHBs on intentions and behaviour needs to be tested more systematically. Accordingly, this longitudinal study aims to examine the role of CHBs in predicting FVC intentions and actual FVC among people motivated to reduce their cardiovascular risk in a longitudinal randomised controlled trial (RCT). *First*, in accordance with Radtke et al. (2014) and Lippke (2014), we assume that CHBs negatively interrelate with FVC intentions (*hypothesis 1*). *Furthermor*e, as Rabiau et al. (2006) posit, people with low levels of self-efficacy lack the necessary self-control to realise health goals, which means that they are more likely to have CHBs and less likely to show intentions for regular FVC. Therefore, we hypothesise that the negative effect of CHBs on intentions is augmented by low levels of self-efficacy (*hypothesis 2*). *Finally*, we hypothesise that planning mediates between intentions and follow-up FVC (*hypothesis 3*), as already shown for various health behaviours besides FVC (De Vries et al., 2014; Hagger and Luszczynska, 2014; Reuter et al., 2010).

Method

Participants and procedure

In all, $N = 790$ study participants were recruited by the authors in cardiac rehabilitation facilities, heart training groups, online panels and different Internet platforms in Germany and the Netherlands. Participation in the study was voluntary and data were anonymised. No incentives for participation were provided. The inclusion criteria were as follows: being at least 20 years old, no contra-indications for physical activity and FVC, having an interest in reducing cardiovascular risk, sufficient reading and writing skills in the relevant language, and Internet access and Internet literacy. The follow-up (T1) with $n = 209$ took place eight weeks after the T0 baseline measurement. This study was designed as a RCT to investigate whether a computer-tailored intervention is effective in increasing self-reported physical activity and FVC. For the present analyses, the experimental longitudinal design does not hold interest. The T0 and T1 questionnaires were the same for the intervention and control group. *T*-tests revealed no baseline differences between the intervention and control group. Specific information on the study design has been published elsewhere (Reinwand et al., 2013).

Measures

Besides sociodemographic information (i.e., gender, year of birth), height (in cm) and body weight (in kg) were assessed to calculate body mass index (BMI). All mentioned measures were obtained via web-based self-report questionnaires.

CHBs. The CHB scale by Knäuper et al. (2004) proved valid regarding construct- and criterion-related validity. From the original CHB scale, items related to dieting were used and slightly revised in this study. Therefore, the scale comprised only four items (Cronbach's *a* = .72); for example, "If one is physically active, it's okay to eat as much as one wants to". Participants rated all answers of compensatory cognitions from *do not agree at all* (1) to *agree completely* (7) (Lippke et al., 2015).

Study participants indicated the following social cognitive items on Likert scales ranging from „not true (1)" to „exactly true (7)". All social cognitive measures had been validated in previous studies (Lippke et al., 2009; Luszczynska et al., 2007).

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FVC intentions. Intentions concerning FVC were assessed using the item: „I seriously intent to eat at least five portions of fruit and vegetable daily".

Self-efficacy. Self-efficacy towards eating fruit and vegetable (Cronbach's *a* = .92) was assessed with five items; for example, „I am certain that I can eat five portions of fruit and vegetable a day even it is difficult".

Planning. Planning was assessed with the use of six items (Cronbach's *a* = .92), such as, „For the next month I already planned in detail at which meals I will eat fruits and vegetables (e.g. additional salad)".

FVC. FVC on a typical day during the last 7 days was assessed using four items, whereby study participants reported their (1) daily consumption of portions of fruit, (2) cooked or steamed vegetables, (3) salad and raw vegetables, and (4) glasses of fruit and vegetable juice. Portions were added to a daily FVC sum score.

Statistical analysis

Data analysis was conducted with SPSS 22 and SPSS 22 AMOS, using structural equation modelling to explore the links between the mentioned constructs and validate the full model. Missing values (0%–19%) were estimated with full information maximum likelihood (FIML) methods. For moderation analysis (*hypothesis 2*), the independent variables self-efficacy and CHBs were z-standardised and multiplied for the interaction term. For the simple slopes analysis, we grouped self-efficacy into three categories (low, medium, high). Mediation analysis with bootstrapping (5.000 samples) according to Preacher and Hayes (2004) was undertaken to test *hypothesis 3*. For the analyses, gender, country of residence, age, BMI, marital status, employment status, group condition (intervention group vs. waiting control group), baseline FVC and baseline planning were included as covariates. Results of indicate BMI differences regarding the relationship between FVC and the health action process approach (HAPA)-based social cognitive variables.

Results

Sample characteristics

The sample had a mean age of 50.85 years (SD = 12.15, Range: 20–84), 62.9 per cent were females (n = 497), 71.8 per cent (n = 646) of the participants were married or in a relationship and 52.5 per cent (n = 415) were employed either full- or part-time. Table 1 provides an overview of all descriptive variables and baseline equivalency.

Preliminary analysis and missing values

There were no significant differences between those who participated in both measurement points and those who dropped out after T0 (n = 581) regarding gender ($\chi^2(1, N = 789) = 2.08$, $p = .149$), country ($\chi^2(1, N = 789) = 1.20$, $p = .274$), age ($F(1, 789) = 1.11$, $p = .293$), BMI

(F(1, 789) = 0.38, p = .535), baseline CHBs (F(1, 789) = 0.06, p = .812), baseline FVC intentions (F(1, 789) = 0.03, p = .776), baseline self-efficacy (F(1, 789) = 0.63, p = .430), baseline planning (F(1, 789) = 0.66, p = .417) and baseline FVC (F(1, 789) = 2.49, p = .131). T0–T1 attrition was 73.9% (n = 584).

Specification of the conceptual model and testing of the hypotheses

The full proposed model is portrayed in Figure 1 and shows an acceptable model fit χ^2(27, N = 790) = 5.20, p < .001, comparative fit index (CFI) = .91, Tucker–Lewis index (TLI) = .72, root mean squared error of approximation (RMSEA) = .07 (.06; .08) to the data.

In contrast to *hypothesis 1*, CHBs did not interrelate with FVC intentions directly (b = -.05, p = .114). However, in line with *hypothesis 2*, the interaction between CHBs and self-efficacy predicted FVC intentions (b = .07, p = .020), thus indicating a moderation effect of self-efficacy with CHBs, whereby CHBs negatively influenced FVC intentions for those with low self-efficacy only. The simple slopes analyses demonstrated that the higher the CHBs, the lower the intentions for FVC in participants with low levels of self-efficacy (t(780) = -2.55, p = .011), but not those with medium (t(780) = -1.32, p = .187) nor high levels (t(780) = 0.87, p = .384).

In line with *hypothesis 3*, T1 planning mediated between T0 FVC intentions and T1 FVC: the effect of T0 FVC intention on T1 FVC was not significant (b = .09, p = .215). However, the effect of T0 FVC intentions on T1 planning was b = .14 (p = .031) and the effect of T1 planning on T1 FVC was b = .16 (p = .022). The bootstrapped standardised indirect effect of T0 FVC intentions on T1 FVC via T1 planning was b = .03 (95% confidence interval (CI): .01–.15). Self-efficacy significantly interrelates with intentions (b = .56, p < .001), indicating that high self-efficacy levels are associated with high intentions. In addition, baseline FVC significantly predicted follow-up behaviour FVC (b = .09, p = .002). The explained variances are portrayed in Figure 1.

Table 1

Overview of all Descriptive Variables and Baseline Equivalency

	Total (N = 790)	German (n = 371)	Dutch (n = 419)		
	M (SD)	M (SD)	M (SD)	T-test	p
Age	50.85 (12.51)	52.18 (11.18)	49.67 (12.85)	8.51	.004
BMI	27.55 (5.41)	28.02 (5.56)	27.13 (5.24)	5.38	.021
T0 FVC intention	4.75 (1.52)	4.56 (1.88)	4.92 (1.62)	8.37	.004
T0 CHBs	2.65 (1.00)	2.72 (1.14)	2.58 (0.86)	3.61	.058
T0 FVC self-efficacy	4.66 (1.46)	4.81 (1.45)	4.52 (1.44)	7.78	.005
T1 FVC planning	4.06 (2.17)	3.92 (1.73)	4.17 (1.39)	1.33	.251
T1 FVC	4.09 (2.17)	3.04 (1.28)	4.89 (2.37)	44.61	<.001
	N (%)	n (%)	n (%)	χ^2	p
Gender (female)	497 (62.9)	213 (57.4)	284 (67.8)	9.07	.004

Note: FVC = fruit and vegetable consumption, T0 = baseline; T1 = eight week follow-up

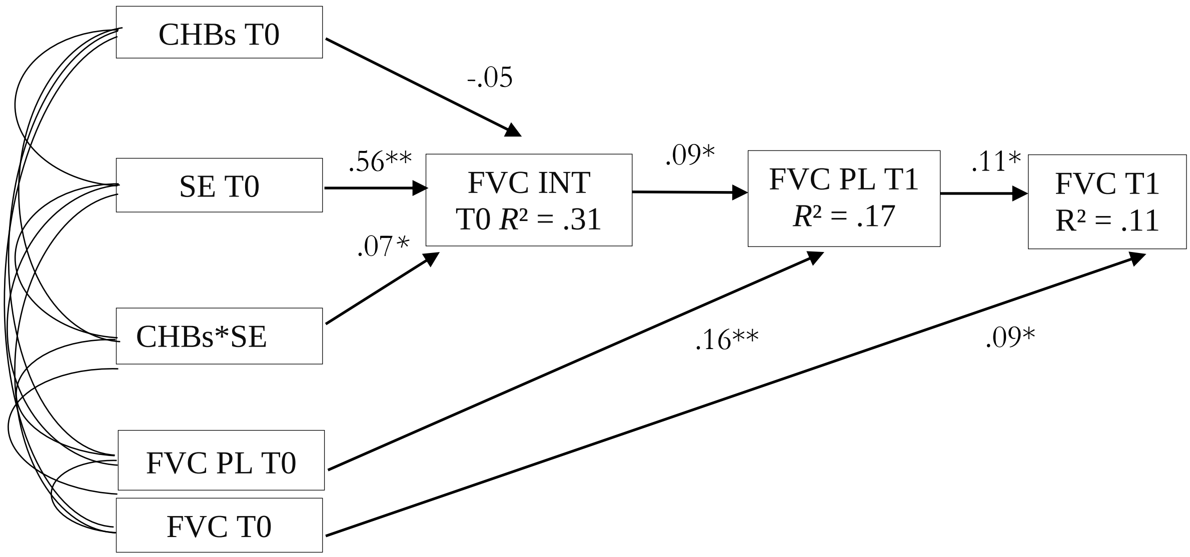

Figure 1. Conceptual model with standardised regression coefficients showing the longitudinal effect of CHBs in the health behaviour change process for fruit and vegetable consumption controlling for age, marital status, employment status, gender, group, country of residence, and BMI.

Note: T0 = baseline; T1 = follow-up at eight weeks; CHBs = compensatory health beliefs; SE = self-efficacy, FVC = fruit and vegetable consumption; PL = planning; INT = intention; N = 790; *p < .05, **p < .001.

Discussion

This longitudinal study aimed at examining the role of CHBs in predicting FVC intentions and actual FVC among people motivated to reduce their cardiovascular risk. CHBs within the health behaviour change process for FVC held special interest in this study. In contrast to Radtke et al. (2014), we found that CHBs did not directly interrelate with intentions to eat fruit and vegetables. Nonetheless, CHBs are negatively interrelated with intentions when self-efficacy levels were particularly low. One possible explanation might be that when self-efficacy exceeds a certain threshold, CHB cannot exhibit its conflicting effect on intentions. This is in line with Rabiau et al. (2006), given that individuals high in self-efficacy are more likely to resist temptations and practice barrier relapse management. Higher levels of self-efficacy were associated with higher intentions to eat fruit and vegetables, which is a typical finding in health behaviour research (Luszczynska et al., 2007; Luszczynska and Haynes, 2009). This suggests that improving a person's confidence in their ability (e.g. by mastery experience) to eat in a healthy way may set the stage for successful behaviour change by strengthening intentions and diminishing the negative effects of CHBs, for instance.

Higher intentions lead to more planning, which subsequently enables higher levels of FVC at a later stage. This is in accordance with previous findings on the effects of planning (Hagger & Luszczynska, 2014; Reuter et al., 2010) and suggests the further use of self-regulatory strategies in supporting people to change to healthier lifestyles.

Limitations and future research

This study is not without limitations; *first*, the high dropout needs to be addressed. Although there were no differences between dropouts and those who completed both waves of measurements, future studies should aim to obtain larger sample sizes, especially at follow-up.

Second, the dietary behaviour data here are based upon self-report only and might be prone to bias, such as recall bias. Future studies should consider more objective measures in addition to self-report such as biomarkers, which are already frequently applied in dietary research (Combs et al., 2013).

A *third* limitation refers to the measurement of subjects' CHBs, which were measured with four items for parsimonious reasons only. Despite showing good internal consistency among our sample, future researchers might want to measure CHBs with more sophisticated fruit- and vegetable-specific scales and investigate whether and how compensatory behaviour is actually carried out as "believed" earlier.

Finally, there were small yet significant differences between German and Dutch participants regarding the measures that we used. Nonetheless, we assume that such differences do not relate to the respective countries, as both countries have similar nutrition recommendations (WHO, 2003, 2006) and prevention campaigns (e.g. „5 a day“; Deutsche Gesellschaft für Ernährung e.V., 2012; Voedingscentrum Den Haag, 2011).

Conclusion

This study provides new insights into the concept of CHBs, with our results highlighting the negative effect of CHBs in the intention formation process for regular FVC, particularly at low levels of self-efficacy. Implications for theory development and practice could be as follows: future researchers might want to include extra self-efficacy modules (e.g. self-efficacy boosting exercises) to ensure diminishing the negative effect of CHBs when forming intentions to eat healthy or tailor an intervention to self-efficacy levels of participants, whereby people low in self-efficacy can profit equally in terms of intention formation. Moreover, planning components should be integrated to help translate people's good intentions into action. Especially people who are at risk of developing cardiovascular diseases should be made aware of the tendency to form CHBs (i.e., through discussions with medical professionals or eHealth programmes) and how to couple these maladaptive thoughts with goal-oriented planning strategies to stick to their health goals.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

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Chapter 6: Effectiveness of a web-based computer-tailored multiple-lifestyle intervention for people interested in reducing their cardiovascular risk

Storm, V., Dörenkämper, J., Reinwand, D.A., Wienert, J., de Vries, H., & Lippke, S. (2016). Effectiveness of a web-based computer-tailored multiple-lifestyle intervention for people interested in reducing their cardiovascular risk. A randomized controlled trial. *Journal of Medical Internet Research*, *18*(4):e78.

Abstract

Background: Web-based computer-tailored interventions for multiple health behaviours can improve the strength of behaviour habits in people who want to reduce their cardiovascular risk. Nonetheless, few randomized controlled trials have tested this assumption to date.

Objective: The study aim was to test an 8-week web-based computer-tailored intervention designed to improve habit strength for physical activity and fruit and vegetable consumption among people who want to reduce their cardiovascular risk. In a randomised controlled design, self-reported changes in perceived habit strength, self-efficacy, and planning across different domains of physical activity as well as fruit and vegetable consumption were evaluated.

Methods: This study was a randomized controlled trial involving an intervention group (n = 403) and a waiting control group (n = 387). Web-based data collection was performed in Germany and the Netherlands during 2013-2015. The intervention content was based on the Health Action Process Approach and involved personalized feedback on lifestyle behaviours, which indicated whether participants complied with behavioural guidelines for physical activity and fruit and vegetable consumption. There were three web-based assessments: baseline (T0, n = 790), a post-test 8 weeks after the baseline (T1, n = 206), and a follow-up 3 months after the baseline (T2, n = 121). Data analysis was conducted by analysing variances and structural equation analysis.

Results: Significant group by time interactions revealed superior treatment effects for the intervention group, with substantially higher increases in self-reported habit strength for physical activity ($F(1,199) = 7.71$, $p = .006$, Cohen's $d = 0.37$) and fruit and vegetable consumption ($F(1,199) = 7.71$, $p = .006$, Cohen's $d = 0.30$) at post-test T1 for the intervention group. Mediation analyses yielded behaviour-specific sequential mediator effects for T1 planning and T1 self-efficacy between the intervention and habit strength at follow-up T2 (fruit and vegetable

consumption: *ß* = .12, 95% CI 0.09-0.16, $p < .001$; physical activity: *ß* = .04, 95% CI 0.02-0.06, $p < .001$).

Conclusions: Our findings indicate the general effectiveness and practicality of web-based computer-tailored interventions in terms of increasing self-reported habit strength for physical activity and fruit and vegetable consumption. Self-efficacy and planning may play major roles in the mechanisms that facilitate the habit strength of these behaviours; therefore, they should be actively promoted in web-based interventions. Although the results need to take into account the high dropout rates and medium effect sizes, a large number of people were reached and changes in habit strength were achieved after 3 months.

Introduction

Cardiovascular diseases (CVD) are major causes of morbidity and mortality in men older than 45 years and women older than 65 years in most developed European countries, including Germany and the Netherlands (Gößwald, Schienkiewitz, Nowossadeck, & Busch, 2013; Leening et al., 2014; Mendis, Puska, & Norvving, 2011; Nichols, Townsend, Scarborough, & Rayner, 2014; OECD, 2013). Regular physical activity and a healthy diet play an important role in preventing CVD because of their wide range of beneficial effects on physical health. Results from different meta-analyses reveal that people who already suffer from CVD have a lower risk of reinfarction (Lawler, Filion, & Eisenberg, 2011), cardiac mortality (Lawler, Filion, & Eisenberg, 2011; Heran et al., 2011; Li & Sigriest, 2012), and overall mortality (Lawler, Filion, & Eisenberg, 2011; Heran et al., 2011; Taylor et al., 2004) if they improve their physical activity levels. Sufficient fruit and vegetable consumption is also recommended because it reduces the risk of further cardiovascular issues, such as coronary heart disease (Mente, de Koning, Shannon, & Anand, 2009; Wang et al., 2014) ischaemic heart disease (Crowe et al., 2011), cardiac mortality (Oyebode, Gordon-Dseagu, Walker, & Mindell, 2014), and overall mortality (Wang et al., 2014).

To reduce CVD risk, one of the main goals is to adopt a healthier lifestyle (i.e., regular physical activity and sufficient fruit and vegetable consumption). Changes that make these behaviours more habitual are a desired goal in primary and secondary prevention because once a behaviour has become habitual it requires less conscious effort and relapses become less likely (Gardner, Lally, & Wardle, 2012; Orbell & Verplanken, 2010). Habituation of the healthy behaviour may be the final phase in the health behaviour change chain, whereby the behaviour has stabilised and its strength has plateaued (Gardner, Lally, & Wardle, 2012).

People who are aware of their risk for CVD are usually highly motivated to practice recommended health behaviours and break old, unhealthy habits (Johnston, Johnston, Pollard, Kinmonth, & Mant, 2004). However, the process of health behaviour change involves motivational factors that extend beyond merely having knowledge about behaviour change benefits (DiMatteo, Haskard, & Williams, 2007) and good intentions (Judah, Gardner, & Aunger, 2012). Even when people successfully initiate recommended changes, the gains are often short term and, without intervention, behaviour change adherence declines over time (Froger-Bompas et al., 2009; Jackson, Leclerc, Erskine, & Linden, 2005). Thus, long-term studies investigating the underlying mechanisms of health behaviour maintenance are needed.

There is ample empirical support that intentions for behavioural change may best provoke behaviour initiation by increasing the use of self-regulation strategies (i.e.,, self-efficacy; Schwarzer, Lippke, & Luszczynska, 2011; Strecher, DeVellis, Becker, & Rosenstock, 1986; and planning; Carraro & Gaudreau, 2013; Hagger & Luszczynska, 2014; de Vries, Eggers, & Bolman, 2013). According to Bandura (2004), self-efficacy describes optimistic self-beliefs concerning the ability to cope with possible failure and recover from relapses. Perceived self-efficacy seems to be important at all points in the health behaviour change process (Schwarzer, Lippke, & Luszczynska, 2011) and is not only important for behaviour initiation, but also behaviour maintenance, recovery, and habituation. Evidence for the relevance of techniques that increase self-efficacy can be found in intervention studies, which found that experimentally induced changes in self-efficacy were positively associated with behaviour initiation at a later point (Allison & Keller, 2004; Kreausukon, Gellert, Lippke, & Schwarzer, 2012; Luszczynska, Triburcy, & Schwarzer, 2007). However, research on the direct effect on habit strength is limited.

In addition to self-efficacy, it is likely that planning promotes habit strength because habits are assumed to result from frequent behaviour enactment in stable settings (Lally, van Jaarsveld, Potts, & Wardle, 2009; Fleig, Pomp, Schwarzer, & Lippke, 2013; de Vries, Eggers, Lechner, van Osch, & van Stralen, 2014). For example, if a person plans to go swimming on

Fridays after dinner, the behaviour becomes closely tied to contextual cues such as the time and location for which he or she chose to perform the initial action plan, and the behaviour becomes automatised with minimal forethought (Orbell & Verplanken, 2010). Previous intervention studies using self-regulatory techniques have revealed effects on habit strength at short-term follow-up in the case of physical exercise (Fleig, Lippke, Pomp, & Schwarzer, 2011) and non-smoking (Webb, Sheeran, & Luszczynska, 2009), although no research is available addressing multiple behaviours.

Because habit strength is a relatively new concept in behavioural intervention research, it is not yet fully understood how planning and self-efficacy might interplay with habit strength. Interventions that make use of both self-efficacy and planning techniques may enhance social cognitions, thereby leading to increased habit strength. Thus, mediation analysis might unfold the underlying working mechanisms of such an intervention.

A growing area of research focuses on the incorporation of the Internet as a mode of delivery to allow for individualised behaviour change interventions (Webb, Joseph, Yardley, & Michie, 2010; Bennett & Glasgow, 2009; Griffiths, Lindenmeyer, Powell, Lowe, & Thorogood, 2006; Wantland, Portillo, Holzemer, Slaughter, & McGhee, 2004). Because interventions cannot fit all populations and circumstances in the same way, tailoring intervention content and offering personal behavioural and action feedback might increase the effectiveness of such programmes in comparison to generic interventions, or so-called “one-size-fits-all” approaches (Hawkins, Kreuter, Resnicow, Fishbein, & Dijkstra, 2008; de Vries & Brug, 1999). Specific tailored feedback for individuals based upon their perceptions about a given behaviour may be similar to feedback provided in face-to-face interactions, and thus hold a higher personal relevance for the participant (Krebs, Prochaska, & Rossi, 2010; Kreuter & Wray, 2003; Smeets, Kremers, Brug, & de Vries, 2007). In addition, compared to face-to-face interventions, tailored interventions are easily accessible when delivered via the Internet, and provide a cost-effective means to reach a wide population (Webb et al., 2010; Bennet & Glasgow, 2009). Previous studies on computer-tailored web-based health behaviour change interventions provided positive results for a variety of health behaviours, including physical activity (Peels et al., 2013; van Stralen, de Vries, Mudde, Bolman, & Lechner, 2011; Neville, O'Hara, & Milat, 2009; Bossen, Veenhof, Dekker, & de Bakker, 2014; Davies, Spence, Vandelanotte, Caperchione, & Mummery, 2012), fruit and vegetable consumption (Springvloet, Lechner, de Vries, Candel, & Oenema, 2015; Oenema, Tan, & Brug, 2005), and multiple health behaviours (Schulz et al., 2014; Broekhuizen, Kroeze, van Poppel, Oenema, & Brug, 2012; Lustria et al., 2013) among the general adult population, as well as people with cardiovascular risk profiles (Widmer et al., 2014; Kuhl, Sears, & Conti, 2006). Although these previous web-based computer-tailored studies focused on behavioural achievement, this study extended this topic by directly assessing its ability to enhance habit strength.

In this study, the *first* objective is to investigate the effectiveness of an eight-week web-based computer-tailored intervention on improvements of self-reported physical activity habit strength and fruit and vegetable habit strength among people who were interested in reducing their cardiovascular risk. *Moreover*, we also test the prediction that social cognitive variables targeted by the tailored intervention (i.e., self-efficacy and planning) increase more from the baseline in the intervention group than in the control group. *Finally*, we investigate whether changes in self-efficacy and action planning mediate the effect of the intervention on improvements in habit strength after two follow-up measurements. Testing the mechanisms of how the intervention exhibits an effect on proximal indicators of habit strength is the added value of our research. It is only when we know whether interventions work in terms of supporting habit formation by successfully targeting self-efficacy and planning by model learning and concrete planning tasks that we can conclude what online interventions should address in the future.

Methods

A detailed description of the study protocol has been published previously (Reinwand, Kuhlmann, Wienert, de Vries, & Lippke, 2013); therefore only a summary of the study methodology and procedures is provided.

Study Design, Procedure and Participants

This study was a randomised controlled trial involving one intervention group and one waiting control group. There were three assessments: baseline (T0, N = 790), a post-test at eight weeks after the baseline (T1, n =206), and a follow-up three months after the baseline (T2, n = 121). The waiting control group obtained access to the eight-week web-based computer-tailored intervention at T2 after the intervention group had finished the intervention. The study received ethical approval by the Deutsche Gesellschaft für Psychologie in Germany (EK-A-SL022013) and the Medical Ethics Committee of Atrium Medical Centre Heerlen in the Netherlands (12-N-124).

Enrollment and follow-up took place from July 2014 until February 2015 in Germany and the Netherlands. We used different recruitment strategies: participants were recruited face-to-face by the authors of this study in ten German and eight Dutch cardiac rehabilitation facilities and heart training groups. The authors of this study contacted the centres for acquisition and they were willing to participate. In addition, we called for participation via Internet platforms on diabetes and cardiovascular diseases as well as via an email invitation from two research agency online panels in Germany and the Netherlands. No data on how many participants were recruited through each strategy are available. The inclusion criteria were as follows: age between 20 to 85 years, no contraindications for physical activity and fruit and vegetable consumption, having an interest in improving physical activity and fruit and vegetable consumption, sufficient reading and writing skills in the relevant language (German or Dutch), computer literacy, and Internet access.

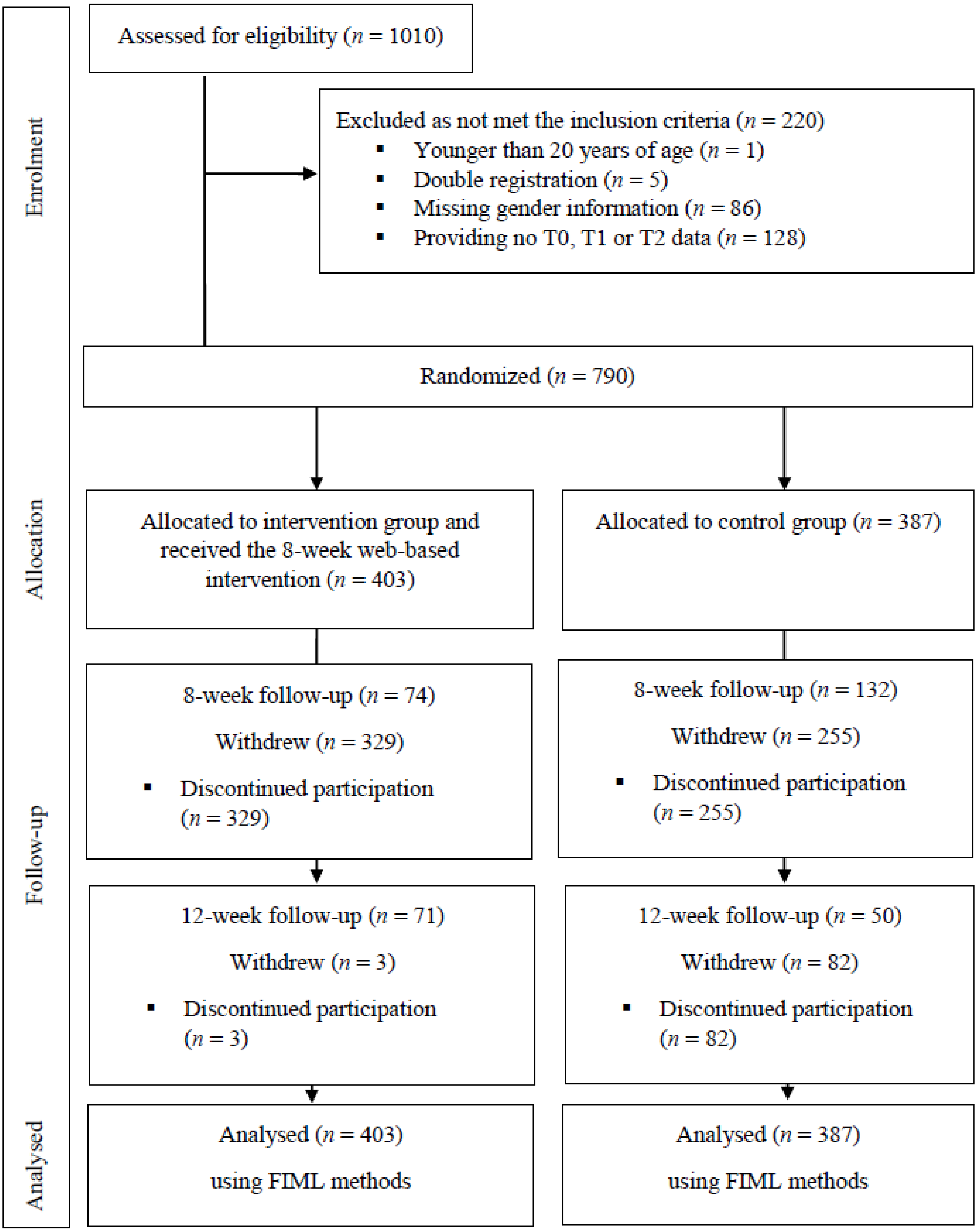

Figure 1. Participant flow through the trial.

Participation in the study was voluntary and data were anonymized. Figure 1 shows the flow of the respondents from enrollment in the study to allocation to the two conditions (intervention group and waiting control group), and follow-up visits after eight and twelve weeks. To obtain access to the web-based questionnaires, the participants registered on the Rehabilitation-Aftercare for an optimal Transfer into Autonomous daily life (RENATA) website with a self-chosen nickname and password. The website was also open to the general public and provided broad information on the inclusion criteria and the procedure of the eight-week intervention as well as the duration of the questionnaires. Participants were made aware of the two-group-design and the information provided was identical for all study participants, independent of the recruitment strategy.

After providing informed consent online, *N* = 1.010 participants were then randomly assigned to either the intervention group or the waiting control group. Both groups took part in the identical baseline measurement (T0). Randomisation into the intervention group and waiting control group was performed by the content management system, TailorBuilder, which was developed for web-based tailored interventions. No block or cluster randomisation was applied; rather, the randomisation was conducted at the individual level. Participants and the authors of this study were blinded to their allocation for the duration of the study. The experiment was double blind. Overall, *n* = 220 data sets were excluded by the research team because of double registration (*n* = 5), missing gender information (*n* = 86), inadequate age (*n* = 1 younger than 20 years), and no available T0, T1 or T2 data (*n* = 128).

Intervention Programme

After registration, the eight-week intervention was delivered to the intervention group via the Internet, addressing physical activity in the first four weeks and fruit and vegetable consumption in the following four weeks. Once a week, the study participants were reminded to participate in the weekly intervention sessions and the follow-up measurements by automatically generated emails containing a link to the respective questionnaire.

The intervention was a web-based computer-tailored intervention to increase physical activity and fruit and vegetable consumption among people who intended to change their physical activity and fruit and vegetable consumption. We used the Health Action Process Approach as a theoretical framework to develop the eight-week web-based intervention (Schwarzer, 2008; Schwarzer, Lippke, & Luszczynska, 2011). The eight weekly sessions in the intervention period targeted the concepts of the different stages (non-intender, intender, and actor) via the use of behaviour change techniques, such as providing information about behavioural risk, the benefits of behaviour change, intention formation, barrier identification, prompting specific goal setting, and reviewing behavioural goals (Abraham & Michie, 2008). These techniques have proven effective in other computer tailoring programmes (Schulz et al., 2014; Compernolle, Vandelanotte, Cardon, de Bourdeaudhij, & de Cocker, 2015).

Physical activity was discussed during the first four intervention sessions (sessions 1-4), and the last four sessions focused on fruit and vegetable consumption (session 5-8). In the following, we briefly describe the content of each session for both behaviours. In session 1 and 5, participants received tailored feedback about their risk perception, outcome expectancies, and their actual health behaviour regarding physical activity and fruit and vegetable consumption based upon their previous assessment. During the second and sixth sessions, participants were asked to determine personal goals and action plans for physical activity and fruit and vegetable consumption. During this session, participants received example plans and tailored feedback on how to structure a plan, and what elements such a plan should contain (where, when, who, how long, with whom). Subsequently, participants had the opportunity to adapt their plans. Self-efficacy was also addressed during this time and the following sessions and participants were provided with motivating feedback on how to perform the desired behaviour.

During the third and seventh sessions, participants were asked whether they had succeeded in performing the action plan and if they would like to adjust the plan. People who indicated having problems formulating plans received role-model examples. Thereafter, coping planning was addressed in the third and seventh session, whereby participants were asked to identify personal barriers and generate coping plans. Again, these coping plans were evaluated during the next session and could be adjusted by the participants. The fourth and eighth sessions focused on social support. Participants developed an overview about people in their environment who could support them in achieving their plans.

During the intervention, different types of feedback were provided. Ipsative feedback was used to provide participants with an overview of their development regarding physical activity and fruit and vegetable consumption during the intervention. This feedback was based on a short questionnaire that participants had to complete at the beginning of each session. Normative feedback was included to compare the participants' behaviour with the norm of the population. Bar charts were included in each session to present the progress of the participant's behaviour change.

In this study, feedback and behavioural recommendations referred to the goals of five portions of fruit and vegetable a day and physical activity five times a week for at least 30 minutes because this constituted the best match for the target group (Wang et al., 2014; Sattelmair et al., 2011). Bar charts were included to monitor the behaviour change progress and a personal tone was applied.

Measurement Instruments

Sociodemographic Variables. We assessed sociodemographic information such as gender (1 = male, 2 = female), year of birth, country (1 = Netherlands, 2 = Germany), employment status (1 = working part-time, 2 = working full-time, 3 = in training, 4 = unemployed, 5 = retired, 6 = housewife/-husband), marital status (1 = single, 2 = close relationship but not living together, 3 = close relationship and living together, 4 = marital partnership/common law marriage, 5 = divorced, 6 = widowed), and highest level of education (1 = no school graduation, 2 = primary school education, 3 = secondary school education, 4 = vocational school graduation, 5 = university entrance diploma, 6 = other) in the baseline questionnaire. The participants additionally reported body height and body weight to calculate their body mass index (BMI) at T0, T1, and T2.

Intentions. For physical activity, the three independent items used were "On 5 days a week for 30 minutes (or a minimum of 2.5 hours per week), I have the intention to perform…" (1) "strenous physical activity", (2) "moderate physical activity" or (3) "walking activity" (Lippke, Ziegelmann, Schwarzer, & Velicer, 2009). Intention about fruit and vegetable consumption was assessed using the item "I seriously intend to eat at least 5 portions of fruit and vegetable daily" (Lippke et al., 2009).

Self-efficacy. Physical activity self-efficacy (Luszczynska & Sutton, 2006) was assessed with five items (Cronbach's $\alpha = .88$), such as "I am certain that I can be physically active permanently at a minimum of 5 days a week for 30 minutes". Self-efficacy for fruit and vegetable consumption (Luczynska, Triburcy, & Schwarzer, 2007) was assessed by five items (Cronbach's $\alpha = .92$), such as "I am certain that I can eat 5 portions of fruit and vegetable a day even if it is sometimes difficult".

***Action Planning and Coping Planning*.** Action planning and coping planning were assessed using six items for physical activity (Cronbach's $\alpha = .91$) and six items for fruit and vegetable consumption (Cronbach's $\alpha = .92$). For both target behaviours, the question started with "For the next month, I have already planned in detail …" (1) "which physical activities I would like to do", (2) "when I have to be especially cautious not to stop being active" or (3) "what I can do in difficult situations to stick to my intentions" (Lippke, Schwarzer, Ziegelmann, Scholz, & Schüz, 2010).

Planning for fruit and vegetable consumption started with the same phrase, followed by the three items: (1) “when I will eat 5 portions fruit and vegetables”, (2) “which fruit and vegetables I will eat”, (3) “when I need to be especially cautious not to fall into my old eating habits” or (4) “what I can do in difficult situations to stick to my intentions” (Luszczynska, Triburcy, & Schwarzer, 2007).

Habit Strength. The strength of habit for physical activity (Cronbach’s α = .88) and fruit and vegetable consumption (Cronbach’s α = .93) was measured with an abbreviated version of the Self-Report Habit Index (SRHI; Verplanken & Orbell, 2003) and included the two items “Being physically active for at least 30 minutes on 5 days a week is something that…” and “Eating 5 portions of fruit and vegetable per day is something …” (1) “has become a confirmed habit” and (2) “I do without thinking about it”.

Statistical Analyses

Data analysis was conducted with SPSS version 22. Dropout analysis was performed using ANOVAs for the quantitative variables age, baseline intentions, baseline habit strength, and BMI. Chi^2-tests were performed for the categorical variables gender and country. Age, gender, country, employment status, marital status, highest level of education, and BMI were included as covariates in all analyses because at this point we were not interested in subgroup differences.

To investigate the effectiveness of the intervention, we *first* conducted separate ANCOVAs with repeated measures analyses for the four outcome measures for habit strength for regular physical activity, habit strength for fruit and vegetable consumption, self-efficacy, and planning. In each analysis, time, group, and a group by time interaction were entered as independent variables, and the group by time interactions were interpreted. Effect sizes for differences in means are presented as Cohen’s *d*. Those effect sizes less than 0.30 were considered small, whereas those between 0.30 and 0.80 were considered medium, and those larger than 0.80 were regarded as large (Cohen, 1988).

To examine whether intervention effects on habit resulted from changes in social cognitive variables, we used mediation analysis to test indirect effects of intervention on change in habit strength through changes in those cognitions that the intervention aimed to modify. The mediation analyses were performed using SPSS AMOS mediation models according to Preacher and Hayes (2004). The bootstrapping approach (5.000 bootstrap samples) was used to estimate 95% confidence intervals of the standardised effects of the intervention on habit strength through self-efficacy and planning.

Baseline habit strength and baseline levels of self-efficacy and planning were controlled for. The level of statistical significance was set at $p < .05$, while *p*-values between .05 and .10 were considered borderline significant. All reported *p*-values are two-tailed. We used no statistical measures to correct for multiple testing.

Across the sixteen variables used in the analyses, the missing data proportions were < 21% at T0, < 19% at T1, and < 17% at T2. Therefore, missing study variables were estimated with the full-information maximum likelihood (FIML) method. We exported the estimated data to SPSS to perform further analyses. FIML is based upon the maximum likelihood algorithm and compared with other options (i.e., list-/pair-wise deletion, regression imputation), maximum likelihood estimates exhibit the least bias (Enders, 2010). For example, Demirtas, Freels, and Yucel (2008) reported that parameters are estimated accurately with missing rates up to 25%.

Results

Participation and Sample Characteristics

The final sample consisted of $N = 790$ persons with a mean age of 50.9 years at baseline (SD = 12.2, Range: 20-84). In all, 62.9% ($n = 497$) of the participants were female, 71.8% (*n*

= 646) of the participants were married or in a relationship, and *n* = 569 participants (72.0%) were employed either full- or part-time. The mean BMI was 27.6 (SD = 5.5, Range: 15.0-60.8), indicating that the participants as a group were considered overweight. Table 1 provides an overview of the main baseline variables in this study.

Table 1

Sample Characteristics at Baseline T0 (N = 790)

Characteristics	Total (*N* = 790)	Waiting control group (*n* = 387)	Intervention group (*n* = 403)
Age (years), mean (SD)	50.8 (12.2)	50.8 (12.3)	50.9 (12.0)
Gender, *n* (%)			
Male	293 (73.1)	151 (51.5)	142 (48.5)
Female	497 (62.9)	236 (47.5)	261 (52.5)
BMI (kg/m²), mean (SD)	27.6 (5.4)	27.3 (5.2)	27.8 (5.6)
Physical activity, mean (SD)			
Intentions	3.9 (1.0)	3.9 (1.0)	4.0 (0.9)
Planning	4.3 (1.4)	4.3 (1.4)	4.3 (1.5)
Self-efficacy	4.6 (1.3)	4.5 (1.4)	4.7 (1.3)
Habit strength	3.5 (1.8)	3.4 (1.7)	3.6 (1.9)
Fruit and vegetable consumption, mean (SD)			
Intentions	4.5 (1.4)	4.5 (1.4)	4.6 (1.3)
Planning	3.8 (1.5)	3.7 (1.4)	3.8 (1.6)

Characteristics	Total (*N* = 790)	Waiting control group (*n* = 387)	Intervention group (*n* = 403)
Self-efficacy	4.7 (1.5)	4.6 (1.3)	4.7 (1.5)
Habit strength	3.7 (1.9)	3.6 (1.8)	3.8 (1.9)
Ethnicity, *n* (%)			
German	371 (47)	189 (49)	182 (45)
Dutch	419 (53)	198 (51)	221 (55)
Educational level, *n* (%)			
No school graduation	1 (0.1)	0 (0.0)	1 (100.0)
Primary school education	23 (2.9)	15 (65.2)	8 (34.8)
Secondary school education	86 (10.9)	40 (46.5)	46 (53.5)
Vocational school graduation	378 (47.8)	192 (50.8)	186 (49.2)
University entrance diploma	242 (30.6)	112 (46.3)	130 (53.7)
Other	60 (7.6)	28 (46.7)	32 (5.3)
Working situation, *n* (%)			
Working full-time	396 (50.1)	191 (48.2)	205 (51.8)
Working part-time	173 (21.9)	91 (52.6)	82 (47.4)
Schooling/vocational training	15 (1.9)	8 (53.3)	7 (46.7)
Unemployed	49 (6.2)	22 (44.9)	27 (55.1)
Retired	115 (14.6)	59 (51.3)	56 (48.7)
Housewife/-husband	42 (5.3)	16 (38.1)	26 (61.9)

Characteristics	Total (*N* = 790)	Waiting control group (*n* = 387)	Intervention group (*n* = 403)
Family status, *n* (%)			
Single	78 (9.9)	35 (44.9)	43 (55.1)
Close relationship but not living together	46 (5.8)	22 (47.8)	24 (52.2)
Close relationship and living together	76 (9.6)	41 (53.9)	35 (46.1)
Marital partnership/common law marriage	524 (66.3)	258 (49.2)	266 (50.8)
Divorced	54 (6.8)	27 (50.0)	27 (50.0)
Widowed	12 (1.5)	4 (33.3)	8 (66.7)

T-tests revealed small yet significant differences between German ($n = 371$) and Dutch participants ($n = 419$) regarding age ($t = 8.51$, $p = .004$), BMI ($t = 5.38$, $p = .021$), self-efficacy for physical activity ($t = 8.24$, $p = .004$), fruit and vegetable consumption ($t = 7.78$, $p = .005$), and planning for fruit and vegetable consumption ($t = 18.91$, $p < .001$). German participants were found to be slightly older and have a higher BMI and higher self-efficacy levels compared to the Dutch participants, whereas they reported less planning of their fruit and vegetable consumption. In addition, there were more women among the Dutch participants ($\chi^2(790) = 9.07$, $p = .004$).

Dropout Analyses

Dropout analyses (1 = dropout, 2 = no dropout) showed no significant differences between the participants who completed all waves of data collection (T0, T1, and T2) and those who dropped out after T0 regarding age ($F(1, 789) = 1.11$, $p = .293$), BMI (F(1,789 = 0.38, p

= .535), baseline intentions (fruit and vegetable consumption: $F(1,789) = 0.81$, $p = .776$; physical activity: $F(1, 798) = 0.02$, $p = .904$) and baseline habit strength (fruit and vegetable consumption: $F(1, 789) = 0.23$, $p = .630$; physical activity: $F(1, 789) = 2.75$, $p = .098$). In addition, the dropouts after T0 did not significantly differ from those who participated in the follow-up questionnaire in terms of gender ($\chi^2(1, 789) = 2.08$, $p = .149$) and country ($\chi^2(1, 789) = 1.20$, $p = .274$): Men and women as well as German and Dutch people dropped out after the baseline measurement T0 in equal numbers.

Those who dropped out after post-test T1 did not differ from those who participated in all measurement points in terms of age ($F(1, 789) = 3.36$, $p = .067$), BMI ($F(1, 789) = 0.42$, $p = .517$), baseline intentions (fruit and vegetable consumption: $F(1, 789) = 1.56$, $p = .212$; physical activity: $F(1, 798) = 0.01$, $p = .978$) and baseline habit strength for fruit and vegetable consumption ($F(1, 789) = 1.22$, $p = .270$). In addition, the dropouts after T1 did not differ from those who participated in the follow-up questionnaire in terms of country ($\chi^2(1, 789) = 1.20$, $p = .274$); German and Dutch people dropped out after the baseline measurement T0 in equal numbers. However, there were significant differences between those who dropped out after T1 and those who completed all measurement points in terms of baseline habit strength for physical activity ($F(1, 789) = 6.71$, $p = .010$) and gender ($\chi^2(1, 789) = 4.29$, $p = .038$). Slightly more women than men dropped out after T1 and those people who dropped out after T1 showed significant lower baseline habit strength for physical activity than those who completed all measurement points. Overall, T0 to T1 attrition was 73.9% ($n = 584$) and T0 to T2 attrition was 85.3% ($n = 705$).

Table 2 presents the number of participants who participated in the single intervention sessions. Participation declined from 90.8% ($n = 314$) in the first session to 19.9% ($n = 69$) participation in the last session of the eight-week intervention. Participants completed a mean 2.0 intervention sessions (SD = 2.4) out of eight potential sessions. Most participants completed only one session (41.9%, *n* = 331), 15.3% (*n* = 120) completed two sessions, 8.7% (*n* = 68) completed three sessions, 4.6% (*n* = 36) completed four sessions, 3.8% (*n* = 30) completed five sessions, 5.8% (*n* = 45) completed six session, 5.5% (*n* = 43) completed seven sessions, and 8.1% (*n* = 63) completed all eight sessions.

Table 2

Intervention Use in Terms of Participation in the Single Intervention Sessions

Weekly intervention session	Participation in the specific session, *n* (%)
Physical activity	
Session 1	373 (47.2)
Session 2	240 (30.4)
Session 3	202 (25.6)
Session 4	148 (18.7)
Fruit and vegetable consumption	
Session 5	166 (21.0)
Session 6	141 (17.8)
Session 7	132 (16.7)
Session 8	123 (15.6)

Intervention Effects on Baseline to Post-Test Changes in Habit Strength

The assumption that the eight-week web-based intervention would lead to an increase in habit strength for fruit and vegetable consumption and physical activity at post-test T1 was tested first. The results of the ANCOVA with repeated measurements (see Table 3) showed an interaction effect of group×time for habit strength for fruit and vegetable consumption (F(1, 199) = 7.71, p = .006, ES = .30) as well as habit strength for physical activity (F(1, 199) = 7.71, p = .006, ES = .37) with medium effect sizes. The intervention group showed a higher increase of dietary habit strength and physical activity habit strength from baseline (T0) to post-test (T1) than the waiting control group. This was then tested for the T2 follow-up as well, examining changes from T0 to T2. There was neither an intervention effect for habit strength for fruit and vegetable consumption ($F(1, 114) = 0.82$, $p = .137$) nor for habit strength for physical activity ($F(1, 114) = 0.43$, $p = .236$) at follow-up T2.

Table 3

Changes of Outcome Measures from Baseline (T0) to Post-Test (T1) (N=790)

	Intervention group *M* (SD)	Waiting control group *M* (SD)	*F*	*p*	*d*
Physical activity					
Self-Efficacy	0.22 (1.47)	-0.06 (1.28)	2.11	.01	0.22
Planning	0.60 (1.76)	0.14 (1.25)	5.70	.02	0.35
Habit Strength	1.00 (1.66)	0.34 (1.53)	7.71	.006	0.37
Fruit and vegetable consumption					
Self-Efficacy	0.22 (1.47)	-0.06 (1.28)	1.40	.03	0.20
Planning	0.58 (1.72)	0.03 (1.60)	5.48	.02	0.36
Habit Strength	0.83 (1.83)	0.26 (1.51)	7.71	.006	0.30

Intervention Effects on Baseline-post-test Changes in Self-Efficacy and Planning

ANCOVA with repeated measures revealed significant interaction effects of condition×time for self-efficacy for physical activity ($F(1, 199) = 2.11$, $p = .014$, ES = .22) and self-efficacy for fruit and vegetable consumption ($F(1, 199) = 1.40$, $p = .036$, ES = .20). The increase in self-efficacy from baseline (T0) to post-test (T1) was higher in the intervention group in comparison to the waiting control group. There was no intervention effect for self-efficacy for fruit and vegetable consumption ($F(1, 114) = 3.63$, $p = .061$) nor for self-efficacy for physical activity ($F(1, 114) = 0.39$, $p = .535$) at follow-up T2.

For planning, we also found a significant interaction effect of condition×time for both physical activity ($F(1, 199) = 5.70$, $p = .021$, ES = .35) and fruit and vegetable consumption ($F(1,199) = 5.48$, $p = .020$, ES = .36) with small to medium effect sizes. This indicates that the intervention led to a significantly higher increase in planning from baseline (T0) to post-test (T1) in the intervention group as compared to the waiting control up for both target behaviours.

Mediation Analyses

To address whether the intervention had an effect on habit strength through self-efficacy and planning, self-efficacy and planning at post-test T1 were considered to serve as sequential mediators between the intervention and habit strength at T2 follow-up. The entire hypothesised model is portrayed in Figure 2 and shows an acceptable fit to the data ($\chi^2(1, 91) = 6.13$, $p < .001$; CFI = .91; TLI = .81; RMSEA = .08).

The intervention group condition significantly predicted T1 self-efficacy (physical activity: *ß* = .32, $p < .001$; fruit and vegetable consumption: *ß* = .39, $p < .001$), holding higher mean values in the intervention group. T1 self-efficacy was significantly interrelated with T1 planning (physical activity: *ß* = 0.61, $p < .001$; fruit and vegetable consumption: *ß* = .63, $p < .001$) for both target behaviours, whereas T1 planning predicted subsequent T2 habit strength (physical activity: *ß* = .22, $p < .001$; fruit and vegetable consumption: *ß* = .50, $p < .001$). Accordingly, people who plan more were also more likely to show strengthened habits later. Baseline habit strength also significantly predicted habit strength at T2 (physical activity: *ß* = .79, $p < .001$; fruit and vegetable consumption: *ß* = .43, $p < .001$). The standardised indirect effect of the intervention through T1 self-efficacy and T1 planning on T2 habit strength was *ß* = .04 (95%CI: 0.02-0.06) for physical activity and *ß* = .12 (95%CI: 0.09-0.16) for fruit and vegetable consumption. The multiple mediator model accounted for 68% of the variance in T2 physical activity habit strength and 44% of the variance in T2 fruit and vegetable consumption habit strength.

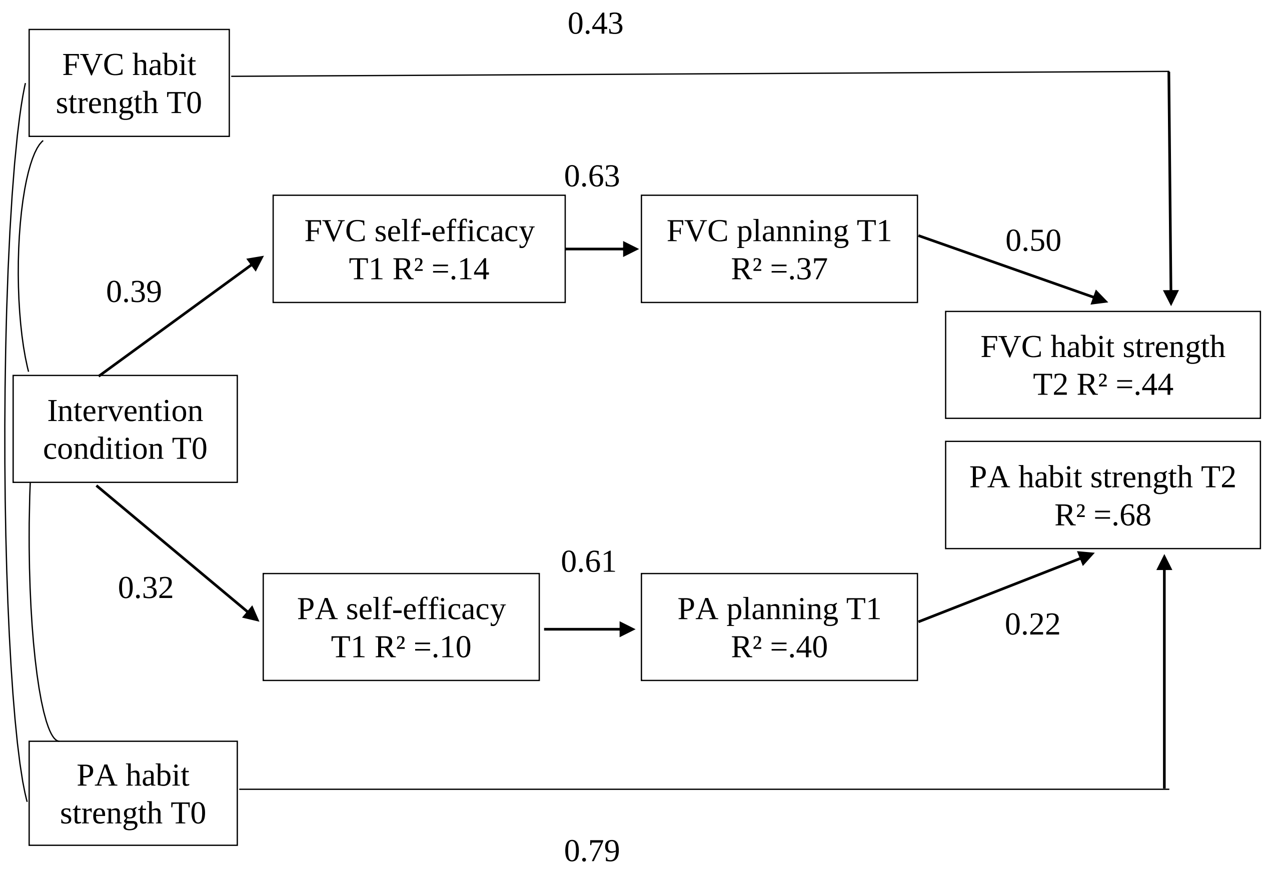

Figure 2. Conceptual model with standardised regression coefficients showing the effect of the intervention for fruit and vegetable consumption (FVC) and physical activity (PA) habit strength at follow-up controlling for age, gender, employment status, highest education, marital status, country, BMI, and baseline levels for self-efficacy and planning.

Discussion

Principal Results

The aim of this study was to test the effectiveness of a web-based intervention in terms of improving habit strength for regular physical activity and fruit and vegetable consumption.

The intervention led to significant increases in participants' self-reported physical activity habit strength, as well as fruit and vegetable consumption habit strength eight weeks after baseline. This is in line with the results from previous self-regulatory intervention studies, which yielded effects on habit strength at short-term follow-up in the case of physical exercise (Fleig et al., 2011) and non-smoking (Webb, Sheeran, & Luszczynska, 2009). However, our study extends these findings to the context of web-based computer-tailored interventions for physical activity and also with fruit and vegetable consumption, and shows the online practicality of a multiple behaviour change intervention.

Previous research has mainly tested how habit strength is formed based on cues to action (Gardner, Lally, & Wardle, 2012; Orbell & Verplanken, 2010). Such a cue can be the medical treatment or advice received during an eHealth program. Instead, we investigated which self-regulatory mechanisms accounted for the effect of the intervention on habit strength. We were able to show that the intervention successfully addressed two key intervention variables, self-efficacy and planning, which subsequently mediated the intervention effect on habit strength three months after the baseline (i.e., changes in self-efficacy and planning contributed additively to habit strength). This replicates the results of Fleig et al. (2013), who used a multiple health behaviour model and theoretical assumptions (Lippke, 2014). Both self-efficacy and planning were predictive of habit strength at a later point; thus they are not only important for behaviour initiation (Allison & Keller, 2004; Kreausukon et al., 2012; Luszczynska, Tryburcy, & Schwarzer, 2007), but also behaviour maintenance. In future studies, this behaviour maintenance should be researched in more depth with an Internet study design in a medical context (i.e., with patients only).

The theoretical framework of habit strength used in this study may also be applied to processes when individuals try to break unhealthy habits, such as smoking and snacking. For example, Webb, Sheeran, and Luszczynska (2009) show that smokers with moderate or low smoking habits were successful in overriding their unhealthy habitual responses when accompanied with behavioural alternatives that they had specified in an action plan (e.g., “If I am walking from the office to my car, then I will chew some gum instead of smoking a cigarette!”). These compensatory cognitions were not researched explicitly in this study, but should be addressed in the future (Lippke, 2014).

Our results for the hypothesized mechanisms are important because they point towards the potential target constructs of web-based interventions and how to make such interventions more efficient. It is imperative to address self-efficacy and planning to enable individuals to develop habits and translate intentions into behaviours. However, in future research this needs to be evaluated further. For instance, it should be tested whether the intervention effect only translates in the sequence via self-efficacy first and then planning or whether it could also be that self-efficacy moderates the mediation of intentions into behaviour via planning. In addition, experimental designs should test whether the intervention addressing planning works only in intenders or people with high self-efficacy because it was found in previous studies (Lippke et al., 2010).

Limitations

This study is subject to some limitations, including the measurement of our criterion variables fruit and vegetable consumption and physical activity habit strength. The SRHI offers a standardised and reliable measure to assess habituated action with evidence across behaviours and populations (Thurn, Finne, Brandes, & Bucksch, 2014; Gardner, de Bruijn, & Lally, 2011). However, we relied on a short version of the habit strength measure referring to general physical activity and fruit and vegetable consumption. Future studies may include additional items of the SRHI to capture further facets of habitual automaticity (e.g., lack of control). In addition, self-report for behavioural outcome measures of intervention studies can be criticised for their limitations, such as response and recall bias, underreporting, socially desirable answers, and measurement errors (Prince et al., 2008). Thus, the inclusion of measures such as biomarkers or pedometers is advocated as an objective indicator of effectiveness (Bravata et al., 2007; Combs et al., 2013).

Furthermore, the high dropout in our study needs to be addressed. Web-based interventions typically come with dropout rates (Eysenbach, 2005) that can be very high (e.g., up to 86%; Reinwand et al., 2015). Although appropriate usage of the intervention differs among certain participant characteristics (Reinwand et al., 2015), we did not find any personal characteristics that could explain high dropout. Due to our widespread recruitment strategies, it can be assumed that a large number of the participants who signed up for the intervention did so out of curiosity rather than having a genuine interest in changing their health behaviour, which could be one explanation for the high dropout rate (Crutzen & Ruiter, 2015). Furthermore, dropout and not responding to questions could also be caused by intervention characteristics, such as the length of the questionnaire, layout or navigation through the intervention (Brouwer et al., 2011). Future studies should further investigate characteristics of dropout and the non-response to eHealth interventions and consider how to tackle them to obtain larger sample sizes, including at follow-up. The results from a recent systematic review (Kelders, Kok, Ossebaard, & van Gemert-Pijnen, 2012) have shown that the differences in technology and interaction predict user adherence in web-based interventions.

One possible recommendation for future interventions is the inclusion of social media interaction, the integration of environmental components, and regular updates to promote adherence. Participants might show higher levels of engagement and complete programme challenges in a web-based programme when they have social ties (Poirier & Cobb, 2012), the possibility to exchange experiences with others, and receive social support (Oh, Lauckner, Boehmer, Fewins-Bliss, & Li, 2013). In addition, because environmental intervention components (e.g., information on how to plan a cycling route for being physically active) might support people to find possibilities to translate their goal intentions to behaviours (Peels et al., 2013), the integration of these environmental components could be useful in stimulating more active intervention participation.

Finally, our study participants form a rather heterogeneous group because we included participants via different recruitment channels. Unfortunately, no data on how many participants were recruited through each strategy are available. Although baseline intentions and sociodemographic data was controlled for in all analyses, a physician rating, medical diagnosis or objective index of medical severity should be included as a control in future studies. In addition, there were small yet significant differences between German and Dutch participants regarding the measures used, although it is assumed that none of the differences in the results are due to country given that both countries have similar nutrition recommendations (World Health Organisation, 2003; World Health Organisation, 2006) and prevention campaigns (e.g. “5 a day”; Deutsche Gesellschaft für Ernährung, 2012; Voedingscentrum Den Haag, 2011).

Conclusion

The results of this study are important for the future development of web-based computer-tailored interventions to improve lifestyle behaviours that can reduce the risk of cardiovascular events. Web-based computer-tailored interventions can be a suitable delivery mode to successfully foster changes in self-efficacy and planning, which predict physical activity and fruit and vegetable consumption habit strength. This research adds to the growing literature on real-world habit strengthening, with our findings suggesting that planning and confidence in one’s action may aid the process of making behaviour automatic. Our results add up to the current body of knowledge bcause they display mechanisms of how this intervention affects behavioural habit change. Future interventions should address habit formation by targeting self-efficacy and planning by model learning and concrete planning tasks.

Due to the high dropout rate, our results must be interpreted with caution, although these findings can guide further researcher. In particular, the investigated constructs and mechanisms should be further elaborated. Practical implications can be retrieved from the fact that habit-strengthening resources for plans and self-efficacy boosters can be delivered briefly via the Internet, are easy for people to implement, and theoretically have the potential for longer-term impact.

Future interventions may benefit from features to support the creation and recall of plans, particularly when accompanied with self-efficacy prompting techniques, such as vicarious experience, personalised feedback, providing contingent rewards, self-monitoring (tracking one's own food- and exercise-related behaviour), and becoming conscious of mastery experience (Ashford, Edmunds, & French, 2010; Prestwich et al., 2014).

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Conflict of Interests

None declared.

Abbreviations

BMI: Body Mass Index

CVD: cardiovascular disease

FIML: full information maximum likelihood

RENATA: Rehabilitation-Aftercare for an optimal Transfer into Autonomous daily life

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Chapter 7: General discussion

The present thesis aimed to add to the description and promotion of single and multiple health behaviour changes relevant to the prevention and management of lifestyle-related diseases (LRDs). In particular, health behaviour change for physical activity was researched regarding the improvement of people's quality of life, as well as sickness absence, and subjective employability. In addition, processes involved in intention formation and translation into intended fruit and vegetable consumption were investigated to unveil mechanisms of successful health behaviour change. Finally, explanatory factors for the effectiveness of newer interventions (e.g. computer-tailored Internet-based intervention) that addresses both physical activity and fruit and vegetable consumption were analysed in a field setting.

The following general discussion is directed by the focus area specific research questions presented in *Chapter 2*. Empirical results of the four studies (*Chapter 3* to *Chapter 6;* Table 1) will be summarised first. Subsequently, methodological, theoretical, and practical implications for future research will be outlined, followed by an overall conclusion.

7.1 Summary of main findings

a) Health behaviour change and functioning in everyday life

In *Chapter 3* the relationship between stage of change for physical activity and self-reported quality of life (QoL) among people who were motivated to reduce their cardiovascular risk was investigated via cross-sectional data analysis. It was shown that the more advanced individuals are in their stage of change, the better their reported quality of life in the physical, psychological, social relations, and environment domain. In addition, the results show that the relationship between stage of change and quality of life differs according to BMI groups. Obese yet regularly active people (maintainers) reported significantly higher physical quality of life than obese people who did not intend to start exercising (pre-contemplators/contemplators). Quality of life was not associated with stage of change among people with normal weight.

In *Chapter 4*, the research aim was to analyse the relationship between regular physical activity, subjective employability, and sickness absence in an eight-year longitudinal design among former rehabilitation patients with musculoskeletal diseases (MSD). It was shown that physical activity levels decline within the first year after discharge from medical rehabilitation treatment. Most importantly, *Chapter 4* provides us with the finding that being physically active for at least 40 minutes a week, six months after rehabilitation treatment reduces sick leave during the first follow-up year. However, there was no effect of physical activity status on sick leave in the long run (e.g. three years and eight years later). Moreover, the results from *Chapter 4* show that being physically active for at least 40 minutes a week is positively associated with the subjective ability to work. Those people who had become regularly active since rehabilitation treatment were more likely to feel able to work, not only in the short term but also three years later, regardless of their age, gender, and baseline behaviour.

b) Understanding behaviour change: the theory behind intending, motivating, and planning for health behaviours

Chapter 5 and Chapter 6 made use of single and multiple health behaviour change models to understand processes of behaviour change. In particular, the Health Action Process Approach (HAPA; Schwarzer, 1992; Schwarzer, Lippke, & Luszczynska, 2011) and the Compensatory Carry-Over Action Model (CCAM; Lippke, 2014) were used to test assumptions on antecedents of behaviour and behaviour-related outcome variables. The study in *Chapter 5* was conducted to provide new insights into the concept of compensatory health beliefs (CHBs) in predicting intentions and actual fruit and vegetable consumption among people who were motivated to reduce their cardiovascular risk. Higher levels of self-efficacy were associated with higher intentions to eat fruit and vegetables. CHBs did not directly interrelate with intentions to eat fruit and vegetables. Nonetheless, CHBs were negatively interrelated with intentions for fruit and vegetable consumption when self-efficacy levels were particularly low. Intentions for fruit and vegetable consumption were only moderately associated with fruit and vegetable consumption eight weeks later, indicating the typical intention-behaviour gap (Sheeran & Orbell, 1998; Ajzen, 2011). However, higher intentions was related to more planning, which subsequently enabled higher levels of fruit and vegetable consumption eight weeks later.

Based upon the assumptions of the Health Action Process Approach (HAPA; Schwarzer, 1992; Schwarzer, Lippke, & Luszczynska, 2011), it was shown in *Chapter 6* that both behaviour-specific self-efficacy and planning are positively associated with habit strength for physical activity and fruit and vegetable consumption, respectively.

c) Improving health via development and promotion of habit strength

In *Chapter 6* the effectiveness of an eight-week computer-tailored Internet-based intervention to increase habit strength for physical activity and fruit and vegetable consumption was tested in a randomised controlled trial design. The Internet-based computer-tailored intervention led to significant increases in participants' self-reported habit strength for physical activity as well as fruit and vegetable consumption eight weeks after the baseline. It was further shown, that the intervention successfully addressed the two key intervention variables - self-efficacy and planning - leading to significant increases eight weeks after baseline. Increased self-efficacy and planning subsequently mediated the intervention effect on habit strength three months after the baseline. Thus, changes in self-efficacy and planning contributed additively to habit strength.

Table 1

Summary of Findings and Conclusions of the Empirical Chapters (Chapter 3 to 6) in this Thesis

	Aims & hypotheses	Findings	Conclusions
Chapter 3	How do differences in motivational readiness for physical activity interrelate with quality of life?	Maintainers showed the highest QoL levels across all domains, while the pre-contemplators/contemplators showed the lowest QoL values.	Healthcare providers should individually encourage people to attain higher stages of change for physical activity and should give personalised feedback on physical activity levels. There is a need for longitudinal studies to acquire a more complete understanding of long-term mechanisms of stage of change for physical activity and QoL.
Chapter 4	What are the short-term and long-term relations between physical activity and sickness absence, and subjective employability?	Inactive participants (< 40min/week) were 3.28 times more likely to be on sick leave twelve months later. Physical activity was positively related with subjective employability twelve months and three years later.	Aftercare programs could be a promising tool to maintain rehabilitation outcomes and support people in changing their lifestyles. Intervention studies are needed that specifically address the impact of physical exercise on work-related outcomes, including yearly follow-ups.
Chapter 5	How do self-efficacy and compensatory health beliefs relate to intentions for fruit and vegetable consumption (FVC)? How can planning add to the translation of intentions into FVC?	Higher levels of elf-efficacy were positively related to intentions for FVC. Compensatory health beliefs negatively predicted intentions at low self-efficacy levels only. Planning mediated between intentions and FVC eight weeks later.	Future researchers should include extra self-efficacy modules to counteract CHBs when forming intentions to eat healthy or tailor an intervention to self-efficacy levels of participants. Planning should be integrated to help translate intentions into action.
Chapter 6	How effective is an Internet-based computer-tailored intervention in increasing habit strength of regular physical activity and FVC? What mechanisms account for the intervention effects in promoting the habit strength of physical activity and FVC?	The intervention led to an increase in self-efficacy, planning, and habit strength for physical activity and FVC eight weeks after baseline. Self-efficacy and planning mediated the intervention effect on habit strength three months later.	Self-efficacy and planning seem to play a major role in the mechanisms that facilitate the habit strength of these behaviours, and they should therefore be actively promoted in web-based interventions. Although the results need to be interpreted in view of the high dropout rates and medium effect sizes

7.2 Directions and implications for future research

Based upon the findings of the four studies, directions for future research are suggested. Theoretical, methodological, and practical implications are discussed to further advance theory of health behaviour change, to contribute to the design and evaluation of health behaviour interventions, as well as to optimise uptake and maintenance of a healthy lifestyle.

Incorporating quality of life as additional outcome in health promotion research

Like *Chapter 3*, unfortunately, much of the current research on modifiable behaviour and quality of life is in the form of cross-sectional associations and does not inform of causal effects. Future research should use an experimental design to investigate the effect of physical activity on quality of life as evidence of causality. Indeed, it is possible that higher quality of life positively influences the motivation to change one's activity behaviour and not vice versa.

For future studies and interventions, some methodological and practical recommendations can be given: *First*, the additional use of objective measures of physical activity such as accelerometers can increase reliability over self-reporting. More objective measures that continuously collect and save behavioural data make the monitoring of progress more easy. They can also help people to estimate their physical activity levels more accurately as especially inactive people have problems in correctly guessing their physical activity levels. Evidence from studies comparing self-report with objective physical activity data indicates that between 43% and 61% of adults who do not currently meet recommended guidelines overestimate their levels of physical activity and refer to themselves as actors or maintainers (Ronda, van Asseman, & Brug, 2001; Van Sluijs, Griffin, & van Poppel, 2007; Watkinson et al., 2010).

Second, there might be many reasons why people who already suffer from lifestyle-related diseases (LRDs) experience declines in quality of life, including the health status itself and physical or psychosocial consequences of possible disease or painful treatments. Therefore, both general and condition-specific quality of life instruments should be used, given that the association between medical symptoms and severity of symptoms varies per condition (Lips & van Schoor, 2005; Jacobsen, Frølich, & Godfredsen, 2012; Orenius et al., 2012).

Third, mechanisms that account for change in quality of life besides the mere effect of physical activity should be investigated. It is possible that people experience enhanced perceived mastery over their fate via increasing their physical activity levels, which subsequently feeds into increased quality of life. The inclusion of social-cognitive variables such as self-efficacy and perceived behavioural control is thus suggested to detect potential mediation effects between physical activity and quality of life.

Finally, behavioural and quality of life data should be collected at multiple time points over a longer period to make associations of patterns of change visible, particular since the change of health-related behaviour is complex and subjective constructs like quality of life are not straightforward (Jepsen et al., 2015).

Integrating work-related outcomes to activity-based treatment programmes

Chapter 4 provides us with the finding that being regularly physically active for at least 40 minutes a week is associated with a lower likelihood of sick leave during the first follow-up year after a medical rehabilitation treatment for musculoskeletal disease (MSD) patients. However, in our study there was no relationship between physical exercise status on sick leave in the longer run (e.g., three years and eight years later). This might be due to the fact that other factors might influence sickness absence such as an work-related social cognitive factors, stressors in the work and social environment (Nimistö, Sarna, Lahtinen-Suopanki, Lindgren, & Hurri, 2004; Pfingsten, Hildebrandt, Leibing, Franz, & Saur, 1997) or non-changeable risk factors such as age, gender, and genetic predispositions for certain health problems (Hubertsson et al., 2014).

Previous studies have shown that self-efficacy and the intention to resume work despite having symptoms is positively associated with successful return to work (Brouwer et al., 2010;

van Oostrom et al., 2010; Volker et al., 2015). Here, self-efficacy comprises the belief that employees have, on their own, ability to meet the demands required to return to work (Lagerveld, Blonk, Brenninkmeijer, & Schaufeli, 2010). These results have important policy implications, because factors such as return to work self-efficacy and outcome expectancies can be influenced by interventions working on these cognitions. A recommendation for future interventions would thus be to integrate such factors.

A web-based intervention aimed at maintaining or restoring employability would be an appealing approach. Web-based interventions should focus on the employees' work-related cognitions and use common behaviour change techniques (BCTs) such as psychoeducation, increasing problem-solving skills, pain and fatigue management, and relapse prevention. Moreover, the recovery process of the employee terms of physical and mental well-being and functioning should be monitored. With a similar study design, Volker et al. (2015) could show a positive effect of such a web-based intervention on the duration until first return to work.

Employee health promotion that aims at LRD prevention and reintegration of sick-listed employees is a process that the organisation can influence directly. Employers should use their various communication channels to convey health information and create a health-minded company culture, thereby bringing about a meaningful change in their employees' health behaviours (Bray, 2009).

First, health messages need to be communicated in efficient ways to educate employees regarding healthy behaviours such as regular physical activity and healthy diet. Employers are usually provided with several communication channels to their employees (Barrett, 2002). Employee communication might use techniques ranging from print company newsletters to computer-mediated communication tailored to the content, needs and resources of the target employee or department. By using multiple channels, even a broader dissemination to employees and their families may be realised (Lewis, 1999; WHO, 2007).

Secondly, it is important to clearly describe the content and structure of workplace health promotion programmes and initiatives so that employees will be empowered to use these programmes. For instance, one could announce a new weight management programme on a company-wide kick-off event or broadly advertise a lunchtime walking group with posters, email messages, and newsletters.

Thirdly, employees should be engaged in every step of planning, implementing and evaluating health promotion programmes. This will promote the cooperation between the company and employees, whereby individual opinions are appreciated. In addition, this will also ensure that the programmes will meet the specific needs of the relevant employee population. Employers that are already offering physical activity and other wellness programmes to their employees should constantly monitor the progress (e.g. uptake, appraisal) of their programmes. They should constantly strive to increase the sophistication of their programmatic efforts to demonstrate greater benefits. Emphasis should be placed on offering programmes that are conceptually sound, are grounded in behavioural theory, and utilise proven BCTs.

Using the Transtheoretical Model (TTM) as basis for stage-matched interventions

Matching interventions to stages of behaviour change is an appealing approach. Published work on the effectiveness of TTM stage-matched interventions has been critically reviewed for the change of various health behaviours (Bridle et al., 2005; Horwarth et al., 2013; Riemsma et al., 2003; Spencer et al., 2006). Despite evidence that TTM-based interventions are effective in promoting physical activity adoption (Adams & White, 2003; Armitage, Sheeran, Conner, & Arden, 2004) results on longer term adherence are unsatisfactory. In previous studies, self-efficacy and decisional balance were generally effective in predicting both backward and forward stage transition for physical activity (Plotnikoff, Hotz, Birkett, & Courneya, 2001), although these factors did not account for all stage regressions and progressions. Further work is therefore required to identify which variables are predictive.

Some recommendations can be given when using the TTM for the development of stage-based interventions: *First*, one possible suggestion for future studies is the incorporation of action and coping planning (Ajzen, 2011; *Chapter 5* and *Chapter 6*). Action planning might be especially useful in the early stages of change because it is a behaviour-facilitating strategy mostly associated with action initiation in good opportunities to act. By contrast, actors and maintainers rather benefit from coping planning because coping planning is barrier-focused, largely grounded in personal experience with the behaviour, and is more relevant for maintaining behaviours (Sniehotta, Schwarzer, Scholz, & Schüz, 2005; Ziegelmann, Lippke, & Schwarzer, 2006).

Secondly, most of the research previously cited has investigated relationships between specific TTM components (e.g. predicting stages of change by sociodemographic factors, decisional balance, and self-efficacy). Thereby, other potential relationships (e.g. moderation, mediation) have been overlooked. For the future, examinations of longitudinal changes of the continuous TTM variables *Latent-Growth Modelling (LGM)* designs are suggested (Duncan, Duncan, & Strycker, 2009; Nigg et al., 2011). LGM with parallel change processes might be an appropriate approach for examining changes in TTM constructs as potential mediators of behaviour change. Longitudinal designs provide the possibility to advance the TTM from a model that not only explains how, but also why people change their behaviour. For example, the LGM approach could be conducted within each stage of change to examine stage as a moderator of the associations between continuous TTM constructs and change in physical activity.

Thirdly, for people in the pre-contemplation or contemplation stage, awareness programmes such as health fairs or screenings might be an effective means to introduce or remind people about various health issues. In these early stages, it is especially important to raise consciousness via verbal communication (Corcoran, 2007), improve self-efficacy (De Vet, de

Nooier, de Vries, & Brug, 2006; Horwath, Schembre, Motl, Dishman, & Nigg, 2013), and foster decisional balance (De Vet, de Nooier, de Vries, & Brug, 2006).

Finally, the growing number of studies that incorporate TTM concepts into behaviour change research reflects the need to standardise and improve the reliability of measurement. When designing and implementing TTM-based interventions, researchers should clearly define the target behaviour, choose a valid and reliable staging tool, and enclose an objective behavioural measurement tool in addition to stage membership (Spencer, Adams, Malone, Roy, & Yost, 2006).

Objective collection and evaluation of human performance measures

Due to their practicality and low cost (Ainsworth, 2009), physical activity and dietary data are often based on self-report (*Chapter 3* to *Chapter 6)*. Therefore, they might be prone to bias such as response and recall bias, under-reporting, socially desirable answers, and measurement errors (Kristal et al., 2009; Prince et al., 2008). Objective measures do not rely on information provided by the person. Instead, they measure and record the biomechanical or physiological consequences of performing a certain behaviour. This is often possible in real time. Luckily, advances in mobile sensing of health behaviours as well as people`s physiological state, and blood-based biomarkers have occurred in several areas. For future studies and interventions, some practical recommendations for collection and evaluation of human performance measures can be given:

Firstly, the current development and implementation of *lifestyle monitoring tools* not only make it easier to collect and save this information for later review, but they also support self-monitoring. Examples include physical activity tracker (current products such as FitBit, Jawbone) and mobile applications for journaling of diet (current examples such as myfitnesspal, trackmymeal). Self-monitoring is one of Abraham and Michie’s (2008) key BCT that have been implicated in supporting behaviour change endeavours in a range of domains, such as physical activity and healthy diet. For future interventions and behavioural data analysis, these lifestyle monitoring tools could be an option for complementing or replacing traditional self-report measures.

Secondly, blood-based *biomarkers* might be used as objective measurement tools or for validation of dietary self-report. These biomarkers such as carotenoids, folate, and plasma vitamin C concentrations result from the metabolism of fruits and vegetables in the body and are often used as objective indicators of fruit and vegetable intake (Souverein et al., 2015).

Thirdly, to objectively measure health outcomes as a consequence of performing a certain behaviour one can use tools that measure the biomechanical or physiological processes in the body. The body's physiological responses to different kind and intensity of physical exercise occur in the musculoskeletal, cardiovascular, respiratory, endocrine, and immune system. Useful objective measures to include in future research studies are *body composition* (specifically muscle mass and fat mass), *physical fitness* (cardiovascular capacity, muscle strength, agility, flexibility, bone densitiy), as well as *heart rate*, and *blood pressure* (Palacios et al., 2015). Even the maintenance of behaviour can be monitored. Exercise training is typically associated with significant adaptations in many physiological systems that are specific to the type of training. Examples include metabolic adaptations in skeletal muscle (e.g. number of capillaries per muscle fiber and in the number, size of mitochondria in skeletal muscles) or cardiovascular adaptations (e.g. increased plasma and total blood volume, resting heart rate (Rivera-Brown & Frontera, 2012). These physiological measures might be used as objective measurement tools or for validation of activity self-report.

Optimising computer-tailored interventions with evidence-based BCTs

Both *Chapter 3, Chapter 5,* and *Chapter 6* provide us with useful results about BCTs to optimise future computer-tailored interventions. They point towards self-regulatory strategies such as self-efficacy and planning as key mechanisms in health behaviour change.

Stronger associations with behaviour might even be obtained when both strategies are combined (Ashford, Edmunds, & French, 2010; Luszczynska, Tryburcy, & Schwarzer, 2006; Williams & French, 2011). Internet-based programmes also provide the opportunity to deliver tailored messages matched to peoples' personal characteristics, clinical profile or motivational stage.

In the medical rehabilitation setting, computer-tailored interventions could be an option for complementing or replacing traditional aftercare programmes. Identifying barriers may help to identify patients at risk of non-adherence and suggest methods to reduce the impact of those barriers thereby maximising adherence. Besides patient factors, it is required to also investigate the barriers introduced by the medical system and the individual practicability of the treatment with the patients' needs and opportunities.

According to Higgins, Middleton, Winner, and Janelle (2014), interventions that involve frequent contact, support, and structured activity sessions are likely less successful at improving self-efficacy because they foster reliance on interventions to maintain behaviour change; rather, the following recommendations can be provided for the development of future interventions. *Firstly*, interventions should emphasise learning to practice intended behaviour ("prompt practice"; Abraham & Michie, 2008; *Chapter 5* and *Chapter 6*) in participants' typical environments.

Secondly, strategies to incorporate these BCTs into people's daily routines should be taught, if possible without supervision. Such strategies encourage participants to acquire mastery experiences of mastery independently, resulting in self-efficacy gains, which subsequently might lead to habituated behaviour (Ashford, Edmunds, & French, 2010; Higgins et al., 2014; Williams & French, 2011; *Chapter 6*). A focus on behavioural feedback rather than face-to-face contact should not only enhance behaviour adherence, but also to improve the cost-effectiveness of interventions (Brodey et al., 2005; Higgins et al., 2014).

Innovative strategies to recruit candidates who are hard to reach and optimise follow-up rates

Research shows that uptake of recommendations remains poor despite the ongoing evidence demonstrating its benefits (Froger-Bompas, et al., 2009; Jackson, Leclerc, Erskine, & Linden, 2005; Peiris, Taylor, & Shields, 2013; Reuter, Ziegelmann, Lippke, & Schwarzer, 2009; *Chapter 4*). The use of the Internet might allow for greater independency and flexibility as people are able to complete or complement health promotion programmes at a self-chosen place and time (Kordy, Theis, & Wolf, 2011). This might be especially attractive for people that live in decentralised areas where health care is limited.

Internet-based studies typically come with high dropout rates (Eysenbach, 2005; Reinwand et al., 2015; *Chapter 5* and *Chapter 6*). However, to ensure maximum intervention effectiveness and generalisability of the results, representative sample sizes at follow-ups are necessary. Future research should, thus, incorporate innovative strategies to recruit and maintain participants in the intervention. Many people might sign up for the intervention out of curiosity rather than out of having a genuine interest in changing their health behaviour. In particular, Crutzen and Ruiter (2015) draw on the fact that interest in using an intervention is different from motivation to change behaviour. Somebody might be motivated to increase his or her consumption of fruit and vegetable, but still not be interested in using an Internet-delivered intervention to support in the behaviour change process.

The *first* possible recommendation for future interventions is the inclusion of social media interaction, the integration of environmental components and regular updates to promote adherence (Taubenheim et al., 2012). In a systematic review, Brouwer et al (2011) found that peer support, especially, was related to better exposure of Internet-delivered interventions. Today's technology provides us with a broad range of possibilities to use the socially related BCTs by Abraham and Michie (2008) in a more sophisticated way. Effective BCTs such as "model or demonstrate the behaviour" and "provide opportunities for social comparison" could be applied via the use of *social media* (e.g. Internet discussion forums) to establish contact with other people who face similar challenges and successes in health behaviour change. The possibility to exchange experiences with others (e.g. recipes, exercises) and social support might motivate people more and overcome challenges more easily due to their social ties (Poirier & Cobb, 2012; Oh, Lauckner, Boehmer, Fewins-Bliss, & Li, 2013).

Secondly, environmental components should be integrated in Internet-based interventions to support people to find possibilities to translate their goal intentions. Connecting with Google maps to delienate running routes, the location of the nearest swimming pools and recreation centres or local (heart) training groups might stimulate more active intervention participation and reduce barriers. The same holds true for obtaining healthy food recipes and information about ingredients of foods via access to online platforms or tailored information material.

Finally, there is evidence of social patterning in motivation for practising health behaviours (Aronowitz, 2008; Marmot, 2005). Therefore, future research should also especially aim at recruiting people who are hard to reach; for example, men (Jordan & von der Lippe, 2012), those in the pre-contemplation stage of behaviour change (Hall & Rossi, 2008; Prochaska, 1994; *Chapter 3*), members of ethnic minorities, and socially disadvantaged groups (Bonevski et al., 2014, Schneider et al., 2013). More information should be derived from *Dissemination and implementation (D&I) research* that focuses on “processes and factors associated with the spread, uptake, and utilization of an intervention of the target audience and the integration within the target setting” (Rabin & Glasgow, 2012; p. 221).

Applying mediation analyses to describe complex relations between variables of interest

Of course, effects on outcome variables, such as behaviour, quality of life, or work-related criteria, determine the success of intervention programmes appropriately. However, if researchers also measure mediating constructs as well as outcome measures, they gain more information about the working mechanisms of an intervention and about theories upon which intervention programmes are based. McKinnon (1994) outlines some benefits of conducting mediation analysis in intervention studies. Mediation analysis provides a manipulation check on whether the intervention changed the variables that it was supposed to change. If the programme did not change the hypothesised mediator, the programme is unlikely to change the outcome variable.

In addition, mediation analysis can contribute to an improvement of both the intervention and the measurement. If an intervention did not change the suggested mediator, improvement of both the mediating construct and the measurement needs to be considered. Ideally, the psychometric properties of possibly mediating variables are resolved prior to the actual implementation of the intervention, e.g. in a pilot study. Some theoretical and practical recommendations can be given:

Firstly, the theoretical assumptions on which intervention programmes (e.g. a health psychological model) are based should be linked to the mediators that are targeted by the programme. When selecting possible mediators, research should suggest that the mediator is somehow related to the outcome measure. For example, previous studies have shown the relationship between self-efficacy and physical activity (Koring et al., 2012) or fruit and vegetable consumption (Luszczynska, Tryburcy, & Schwarzer, 2006; *Chapter 4*). Therefore, it seems plausible to investigate such a mediator. *Secondly,* future researchers should include information on the psychometric properties of mediators and outcome measures such as internal consistency and test-retest reliability (McKinnon, 1994).

Investigation of health behaviour patterns and health literacy

Health behaviours do not occur in isolation (Lakshman et al., 2010; Schneider, Huy, Schüssler, Diehl, & Schwarz, 2009). Rather, behaviours cluster together and behaviour-specific cognitions might interrelate (Lippke, 2014; *Chapter 5*). Examining patterns of health behaviours is important due to the increased risk of mortality, morbidity, and possible synergistic effects. Many LRD prevention campaigns are still targeting isolated behaviours such as physical inactivity, tobacco use or unhealthy diet. However, studies show that it is also possible to intervene on more than one behaviour at a time (Prochaska & Prochaska, 2011; *Chapter 6*). Along with the benefits of addressing multiple health behaviours at a time, a number of obstacles apparently also exist. In a synthesis of meta-analyses and reviews (Sweet & Fortier, 2010), single behaviour interventions were suggested as being more effective than multiple health behaviour interventions in terms of promoting physical activity and healthy diet. It is possible that people feel overwhelmed about changing multiple behaviours at the same time, which may even push them to refuse and return to their unhealthy lifestyle (Nigg, Allegrante, & Ory, 2002). In fact, further studies are necessary that compare single and multiple health behaviour change interventions in the same study to help determine which is more effective.

Some recommendations can be obtained for future research. *Firstly*, it is possible that the effects of single and multiple health behaviours interventions differ as single health behaviour influences the specific behaviours while multiple health behaviours have a greater impact on more global outcomes (e.g. body weight). Although multiple health interventions might only result in small improvements in behaviour, these small improvements in both health behaviours may still produce significant weight loss. Therefore, supplementary outcomes rather than behaviour should also be explored in future studies. Sustained behaviour change, however, often remains difficult to measure because the follow-up duration is short. Behavioural data should be collected at multiple time points over a longer period of time to make the associations of change with these more global outcomes visible.

Secondly, further research is necessary to understand the more technical aspects such as sequencing or timing in health behaviour interventions. Differences in intervention uptake, adherence and effectiveness could also be caused by intervention characteristics such as the length of the questionnaire, layout or navigation through the intervention (Beall, Baskerville, Golfam, Saeed, & Little, 2014).

Thirdly, increased confidence in changing one behaviour may lead to greater success in changing a second behaviour. By developing habits regarding one behaviour, individuals may facilitate engagement in other intended health behaviours via transfer effects (Fleig, Lippke, Pomp, & Schwarzer, 2011). Therefore, possibly mediating cognitive variables or behaviour should be examined to identify facilitators of adoption or maintenance of a second health behaviour.

Fourthly, more studies are needed to investigate the impact of compensatory health beliefs (CHBs) in the health behaviour change process. Here, both the putative unhealthy and the compensating behaviour should be taken into account and it should be explored whether CHBs are activated before or after the performance of the to-be-compensated behaviour. Of course, research also focusing on CHBs also in interventions is needed. Self-efficacy boosting exercises might be an efficient means to reduce the impact of CHBs (*Chapter 5*) but these findings warrant further evidence.

Finally, practicing a healthy lifestyle remains a choice. However, knowing how to seek medical care, and taking advantage of preventive behaviours requires that people understand and use information about health. The cognitive and social skills, which determine the motivation and ability of individuals “to gain access to, understand and use information in ways which promote and maintain good health”, has been termed *health literacy* (Nutbeam, 1998, p. 374). People with limited health literacy often lack knowledge or have misinformation about the relationship between lifestyle factors such as healthy diet and regular exercise, and various health outcomes. CHBs may be the result of inappropriate health literacy in terms of misunderstood information that is relevant to health. Because people may tend to overestimate the benefits of a compensatory behaviour (e.g. being physically active for 30 minutes five times a week), they may not effectively compensate for the negative effects of the unhealthy behaviour (e.g. not eating fruit and vegetables at all). Therefore, future research might include measures of both CHBs and health literacy into one model and investigate the associations between both concepts and possible influences on predictors of behaviour or behaviour itself. Indeed, CHBs might mediate the relationship between health literacy and certain health behaviours. By integrating CHBs and conceptualizations of health literacy into an encompassing model, it can support the practice of LRD prevention and health promotion by serving as a conceptual basis to develop health literacy enhancing interventions.

Conclusion

The present thesis has added to the description and promotion of single and multiple health behaviour changes relevant to the prevention and management of LRDs. Prevention programmes to increase physical activity and fruit and vegetable consumption are warranted for many reasons. Indeed, the improvement of perceptions of behaviour and more functional outcomes such as quality of life and employability are also of importance to tackle the challenges of the demographic change.

The results of this thesis and previous findings on self-regulation strategies corroborate the importance of self-efficacy and planning for health behaviour change processes. Future studies may follow the theoretical rationale of the empirical studies and employ the introduced behaviour change techniques, as well as apply the suggested evaluation strategies to further the understanding of behaviour change, and the development of effective evidence-based interventions in public health, medical rehabilitation, and workplace health promotion.

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Abbreviations

CVD: Cardiovascular diseases

CHB: Compensatory Health Beliefs

ES: Effect size

FVC: Fruit and vegetable consumption

HAPA: Health Action Process Approach

IG: Intervention group

LRD: Lifestyle-related diseases

MSD: Musculoskeletal diseases

PA: Physical activity

QoL: Quality of Life

RENATA: REhabilitationsNAchsorge für einen optimalen Transfer in den Alltag

RTW: Return to work

TTM: Transtheoretical Model

WCG: Waiting control group

WHO: World Health Organisation

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Working experience

10/2013 – 04/2016	Project coordination of the eHealth intervention study "RENATA" *Jacobs University Bremen, Department of Psychology and Methods, Bremen*
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Scholarships

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List of publications

* indicates manuscripts that are part of the dissertation

Articles in peer-reviewed journals

***Storm, V.**, Reinwand, D., Kuhlmann, T., Wienert, T., de Vries, H., & Lippke, S. (2016). Brief report: Compensatory health beliefs (CHBs) are negatively associated with intentions for regular fruit and vegetable consumption (FVC) when self-efficacy is low. *Journal of Health Psychology*, [Epub ahead of print].

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Statutory declaration

I, Vera Storm, hereby declare that I have written this PhD thesis independently, unless where clearly stated otherwise. I have used only the sources, the data and the support that I have clearly mentioned. This PhD thesis has not been submitted for conferral of degree elsewhere.

I confirm that no rights of third parties will be infringed by the publication of this thesis.

Bremen, April 30st, 2016

Signature ______________________________