

**Health Behavior Change: Effects of Motivation, Self-Regulation,  
and Incentive-Based Interventions**

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“Self-belief does not necessarily ensure success,  
but self-disbelief assuredly spawns failure.”

-Albert Bandura

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## Abstract

Healthy behaviors are associated with preventing a range of diseases and thus improving an individual's overall health status, however, non-compliance is pervasive. Research has provided compelling evidence that motivation and self-regulation processes help to explain and predict health-related behavior change (e.g., Hagger & Luszczynska, 2014; Schwarzer, Lippke, & Luszczynska, 2011). Moreover, targeting self-regulatory processes in interventions can help to bridge the gap between intentions and behavior (Gollwitzer & Sheeran, 2006). Furthermore, adding financial incentives to psychological components as part of a behavior change program is suggested to provide the most effective results in health-related behavior change (e.g., Cerasoli, Nicklin, & Ford, 2014).

The aim of this thesis was to identify in which ways sequentially (*SSI; Sequential-Specific Intervention*) and in combination (*CCSI; Component-Combined Specific Intervention*) of motivational and self-regulatory components operate best for predicting health behavior changes. To explore SSI question, three experimental studies (*chapter 2, chapter 3, and chapter 4*) were conducted to address the question of whether the order in which the components of two psychological modules (motivation and self-regulation) are delivered, is relevant for the effectiveness of health promotion (i.e., promoting fruit and vegetable intake, oral self-care, and hand hygiene respectively) among young adults in India. And to investigate the effectiveness of CCSI, one intervention study (*chapter 5*) was performed to explore the feasibility of a brief incentive-based intervention to promote oral self-care. For this purpose, the study combined brief psychosocial components with financial incentives and investigated the efficacy of such programs in comparison with a control group in increasing the incidence of dental flossing in outpatients already diagnosed with periodontal diseases in India.

The theoretical rationale for this thesis was based on the *Health Action Process Approach* (HAPA; Schwarzer, 1992, 2008), which is a model of the adoption and maintenance of health behaviors. The findings from the *SSI* evaluations partly support the theorized sequence that motivational processes *precede* self-regulatory ones (Schwarzer, 2008). Here, the beneficial effects of self-regulatory strategies (i.e., self-efficacy, planning, and action control) proved more effective than the motivational components (such as risk perception, outcome expectancies, and intention). Findings attesting the effectiveness of *CCSI* (i.e., free dental treatments including checkups and dentures) with minimal oral health strategies (i.e., information about oral hygiene, instructions how to practice, and goal setting exercises such as planning when, where, and how to floss) proved effective in increasing the dental flossing levels and thus, helps to reduce the further risk of developing oral diseases in patients. Furthermore, in *chapter 2* and *chapter 5*, mediators between behavioral intention and self-efficacy explained the *working mechanisms* of the interventions, indicating the importance of considering these constructs in future research.

The theoretical consideration of innovative intervention designs contained in this thesis and its empirical results may guide the development of theory- and evidence-based interventions to promote fruit and vegetable intake, dental flossing, and handwashing. The highly predictive constructs of the HAPA model and its good fit to the active behavior change techniques taxonomy (v1) (BCTs; Michie et al., 2013) may indicate the suitability of the model for evaluating and developing health-related interventions in future.

## Zusammenfassung

### Effekte von motivationalen, selbstregulativen, und anreizbasierten Interventionen zur Veränderung des Gesundheitsverhaltens

Ein gesunder Lebensstil hilft, Krankheiten zu vermeiden und so die Gesundheit des Individuums zu verbessern. Zahlreiche Studien konnten zeigen, dass Prozesse der Motivation und Selbstregulation die Änderung des Gesundheitsverhalten erklären und vorhersagen können (z.B., Hagger & Luszczynska, 2014; Schwarzer, Lippke, & Luszczynska, 2011). Darüber hinaus wurde in Studien nachgewiesen, dass Interventionen, welche die Selbstregulationsfähigkeit stärken, dazu beitragen, die Lücke zwischen Intention und Verhalten zu schließen (Gollwitzer & Sheeran, 2006). Des Weiteren gibt es Hinweise, dass die Kombination finanzieller Anreize und psychologischer Faktoren eine Verhaltensänderung am effektivsten bewirken kann (z.B., Cerasoli, Nicklin, & Ford, 2014).

Ziel dieser Arbeit war es, herauszufinden, wie genau motivationale und selbstregulative Interventionskomponenten, die entweder sequentiell (*SSI; Sequential-specific intervention*) oder in Kombination (*CCSI; Component-combined specific intervention*) angeordnet werden, eine Verhaltensänderung am besten vorhersagen. Um die Frage der sequentiellen Anordnung zu untersuchen (SSI), wurden drei experimentelle Studien bei jungen Erwachsenen in Indien (*Kapitel 2, 3 und 4*) durchgeführt. Es wurde der Frage nachgegangen, ob die Reihenfolge, in der zwei psychologischen Konstrukte implementiert werden (Motivation und Selbstregulation), relevant für die Wirksamkeit der Gesundheitsförderungsprogramme ist, d.h. für den Obst- und Gemüsekonsum, die Zahnhygiene und Handhygiene. Um die Wirksamkeit der „kombinierten Intervention“ (*CCSI*) zu überprüfen, wurde eine weitere Studie zu Zahnhygiene durchgeführt.



Dabei wurde auch die Wirkung finanzieller Anreize analysiert. Hierfür erhielten Patienten mit Zahnfleischerkrankungen eine Intervention zur Nutzung von Zahnseide, in der psychologische Wirkfaktoren mit finanziellen Anreizen kombiniert wurden. Diese Gruppe wurde mit einer Kontrollgruppe verglichen.

Die theoretische Grundlage dieser Arbeit war das *Sozial-kognitive Prozessmodell gesundheitlichen Handelns* (The Health Action Process Approach; Schwarzer, 1992, 2008). In Kapitel 1 werden der theoretische Hintergrund der Arbeit sowie die Hypothesen dargelegt. In Kapitel 2, werden erste Studienergebnisse präsentiert: Die Ergebnisse der Untersuchungen zur Frage der Anordnung der psychologischen Konstrukte in der sequentiellen Interventionsstudie bestätigen zum Teil die theoretische Annahme, dass ein Motivationsprozess (Intentionsbildung) dem Prozess der Selbstregulation vorangeht (Schwarzer, 2008). Es konnte gezeigt werden, dass selbstregulative Strategien (d.h., Selbstwirksamkeitserwartung, Planung und Handlungskontrolle) motivationalen Komponenten (Risikowahrnehmung, Handlungsergebniserwartung und Intention) überlegen waren. Mit Bezug auf die kombinierte Intervention (CCSI) hat die Studie bestätigt, dass die Nutzung von Zahnseide gesteigert sowie das Risiko für weitere Zahnerkrankungen erfolgreich reduziert werden kann, wenn in der Kurzintervention psychologische Komponenten (d.h. Information zu Zahnhygiene, Anleitung zur Durchführung von Zahnhygiene, Zielsetzung und Planung, wann, wo und wie Zahnseide genutzt wird) mit finanziellen Anreizen (d.h. kostenlose Kontrolluntersuchungen und Zahnbehandlungen) kombiniert werden. In *Kapitel 2* und *5* werden mit Hilfe sequentieller Mediationsanalysen die Wirkmechanismen zwischen Intention und Selbstwirksamkeit der Intervention erklärt. Das unterstreicht die Wichtigkeit der beiden psychologischen Konstrukte Intention und Selbstwirksamkeit für zukünftige Untersuchungen .

In der vorliegenden Studie wurden theoriegeleitet innovative Interventionsdesigns eingeführt und empirisch überprüft. Die Ergebnisse dieser Arbeit können zur Weiterentwicklung theorie- und evidenzbasierter Maßnahmen zur Förderung des Obst- und Gemüsekonsum, der Zahnhygiene und der Handhygiene helfen. Dabei hat sich das HAPA Modell erfolgreich als theoretische Grundlage zur Vorhersage des Gesundheitsverhaltens erwiesen. Zudem können HAPA-basierte Interventionen erfolgreich und praktikabel im Einklang mit der Taxonomie der Techniken zur Verhaltensänderung (*BCTs*; Michie et al., 2013) gestaltet werden. Das unterstreicht, dass das Modell eine gute Basis für gesundheitsbezogene Interventionen in der Zukunft darstellt.

# 1

## Introduction

*Consider the following scenarios.*

- 1. Proper knowledge of health recommendations and guidelines for practicing them are widely distributed across the globe except in your country. This causes inadequate occurrence of practicing healthy habits among the majority of the population, thus increasing (a) the risk of chronic diseases by not consuming enough FV, (b) the risk of infectious diseases by not washing hands as required, or (c) the risk of caries and periodontal diseases by not practicing complete oral self-care. It appears that just teaching people the importance of a particular behavior is not effective.*

*Unfortunately, public health policies have not been updated and prevalence data on more effective strategies have rarely been published. How would you evaluate and improve the approach to changing their health behavior so as to increase their health recommendation adherence?*
- 2. There have been longstanding theoretical discussions on the effectiveness of either motivation intervention or self-regulation intervention in health psychology research. However, in application scenarios, the researcher receives disturbing reports from the study participants: some claim the motivation package is mundane and some claim the self-regulation package is exaggerated. Both packages thus impede potential change in the participants' behaviors regardless of the active ingredients in each package. How would you investigate and design a unique sequential-specific-intervention (SSI) encompassing both motivation and self-regulation to ensure that participants benefit maximally from the interventions in changing their health behavior?*
- 3. Despite your government's emphasis on the importance of complete oral care and the fact that dental programs have been initiated for outpatients in government hospitals,*

*studies reveal that only few patients are complying with the recommendations. Such incidents of non-adherence to the oral practices may not only be due to the unaffordable cost of dental treatment; the lack of proper knowledge is also a reason for this. How would you design a component-combined specific intervention (CCSI) using government resources and self-monitoring strategies to enhance oral care among outpatients?*

- 4. Governments aim to advance efforts to persuade and enable people to make healthy changes in their behavior. Behavioral researchers and practitioners have a range of health behavior theories (HBTs), and each of these theories offers a more nuanced picture of human behavior than the mere knowledge of health risks. Thus, they can be used as frameworks to build intervention packages in order to explain and predict health-related behavior changes. However, the intervention study should not simply be based on any valid theory; the content of the interventions should also have a cross-fit with reliable and validated behavior change techniques (BCTs) so that researchers can arrive at best practice implications. With such two-fold purposes in mind, which compatible HBT would you use to derive intervention components that enable you to define your intervention contents in terms of BCTs for the future replication or meta-analysis in the field?*

### **Introduction**

‘To keep the body in good health is a duty... otherwise we shall not be able to keep our mind strong and clear’ these words by Gautama Buddha reflect on the fact that human beings have, in principle, control over their conduct. But, despite good intentions and sufficient perceived control, many people fail to act on their intentions, especially concerning

regular self-care regimes (Sniehotta, Araújo-Soares, & Dombrowski, 2007). This problem of everyday life, which indicates that intentions are an important but insufficient prerequisite for successful behavior change, is a phenomenon that has been labeled the *intention-behavior gap* (Sheeran, 2002; Sniehotta et al., 2007).

Health behavior change is a complex process that involves a multitude of causal factors. Informing people about the benefits of adopting healthy behaviors and the risks of unhealthy behaviors is not enough. From a psychological standpoint, people require both an initial motivation to change, followed by self-regulatory efforts to translate their intention into action to change their regular health behaviors. This calls for interventions that have been explicitly designed based on the evidence-based theories explaining the structural and psychological determinants of health behavior change. Interventions to change behavior are typically complex, involving many interacting components (Craig & Petticrew, 2013).

Although the literature has provided compelling evidence on the beneficial effects of motivation and self-regulation processes in health behaviors (Gholami, Wiedemann, Knoll, & Schwarzer, 2014; Hagger & Luszczynska, 2014; Schüz, Sniehotta, & Schwarzer, 2007; Wiedemann, Lippke, & Schwarzer, 2012) the research has not addressed the question of whether the order in which intervention components (motivation and self-regulation) are delivered, is relevant for the effectiveness of strategies concerning regular health behaviors such as nutrition, oral self-care, and hand hygiene promotion strategies. Moreover, financial incentives were shown to have beneficial effects on changing people's behavior like dental flossing.

It is suggested that providing psychological techniques such as self-efficacy and self-regulatory skills in addition to incentives as part of a behavior change program provides - good outcomes (Cerasoli et al., 2014; Giles, Sniehotta, McColl, & Adams, 2015). However,

there is a lack of intervention-based studies that used a combination of self-management cues and incentive-based strategies on oral self-care promotion. Moreover, research on incentive-based interventions has been mainly conducted as surveys and the questions regarding the mechanisms among the psychological factors that explain effects of intervention facilitating health behavior change have remained unanswered.

The major aim of this thesis is to evaluate and examine the effectiveness of two phases (motivational and volitional) of the health action process approach (HAPA; Schwarzer et al., 2011; Schwarzer, 2008) by comparing one intervention sequence (i.e., first motivation and then self-regulation; *Mot-SR*) with the opposite sequence (i.e., first self-regulation and then motivation; *SR-Mot*) in a comprehensive framework in the context of regular health behaviors (i.e., oral hygiene, hand hygiene, and fruit and vegetable intake) (more details are contained later in the thesis). This thesis also examines whether a combination of self-management cues (targeting self-efficacy and self-regulatory skills) and an incentive-based strategy (offering free dental treatment) improve the dental flossing behaviors of Indian outpatients of a wide range of age groups, from adolescent to older adults, who were diagnosed with periodontal diseases. Moreover, potential factors that may account for the effects of theory-based interventions are investigated to gain a better understanding of their underlying working mechanisms in the field settings. Additionally, given that the samples are from a rarely studied population, Indians, and given that my data includes reports from participants from both a healthy as well as a patient population, this thesis makes a contribution to the cumulative knowledge in the health behavior change literature.

In this introductory *chapter 1*, a theoretical framework for this dissertation is outlined followed by a summary and integration of recent literature. This provides the rationale for the

research questions investigated in the following empirical chapters of this thesis (*Chapters 2 to 5*).

*The Behavioral Context: Why are particular Behavioral Domains Studied?*

The term ‘health behavior’ has been broadly defined by Conner and Norman (2005) as any activity undertaken for the purpose of preventing or detecting disease or for improving health and well-being. They further claimed that a variety of behaviors would fall within such a definition, including medical service usage, compliance with medical regimens, and self-directed health behaviors. Health behaviors can be described as health enhancing or health impairing behaviors. The behaviors under consideration in this thesis are health-enhancing behaviors, namely hand washing, fruit and vegetable intake, and interdental hygiene, which are very much related to one another. For instance, oral hygiene recommendations can further be tweaked based on the individual’s nutrition and general health behaviors, such as their hand hygiene. Moreover, individuals can prevent and manage existing heart diseases like cardiovascular disease by adopting a healthy diet. Practicing these basic but very vital behaviors is pivotal to achieving superior oral health and a better overall quality of life.

*Regular Health Behaviors*

The *chosen behavior domains* (i.e., fruit and vegetable intake, hand hygiene, and oral hygiene) in this thesis share common characteristics that enable me to analyze the present thesis’s theoretical considerations: First, they are part of a daily routine and they have to be practiced *regularly* to be effective; thus, they demand not only motivation but also special effort through self-regulation as compared to behaviors with one-off performance (Sutton, 1994). Nevertheless, there is likely the use of transfer of the knowledge and strategies learned



in one behavior domain (e.g., dietary intake) in a different health behavior (e.g., oral hygiene), known as *transfer motivation* (Fleig, Kerschreiter, Schwarzer, Pomp, & Lippke, 2014), in such multiple health behavior research. Furthermore, a social cognitive model such as the HAPA (Schwarzer, 2008) states that individuals' decisions on whether to change their behaviors have psychological origins, and thus, the individuals have to become motivated to do so (in this case, to adhere to the recommendations) by raising their self-efficacy. In addition, if an individual is motivated, they need to have access to additional self-care strategies (such as setting goals and pursuing them) to translate a behavioral intention into action. The difficulty here, thus, is not the technical demand of consuming fruit and vegetables, or washing hands with soap or, flossing the teeth, but rather with performing them regularly as integrated parts of daily life, which is not easy for most people, particularly when they are not motivated enough.

Second, over the last decades, preventive nutrition, preventing the transmission of infectious diseases, and preventing dental caries and periodontal diseases have emerged as a public health concern (Latham et al., 2014). However, the level of adherence to these regular health behaviors in the general population is very low despite the recommendations of health authorities. The reasons for non-adherence are well documented in the previous research (see *Table 1*). This underlines the urgent need to investigate effective interventions to enhance behavioral improvements.

The third common characteristic that these behaviors share is that the non-adherence to the recommendations and non-performance of these daily habits is associated with malnutrition and certain types of cancers (WHO, 2004), with the extensive spread of infections and diarrhoeal disease (Wright, Zillmer, Biran, Hall, & Sidibe, 2015), and with periodontal diseases (Grewal et al., 2014), resulting an overall poor health status.

Beyond these health effects, non-adherence to these recommendations produces higher costs for treatments, which are typically paid for privately in India (78% of medical spending in India is funded through private expenditure, as compared to 14% in the Maldives, 29% in Bhutan and 61% in China); hence, the resulting out-of-pocket costs make up a large portion of the spending on medical treatment in India. Moreover, the health care system in India is primarily recognized as a state responsibility, there is a great discrepancy in the quality and coverage of medical treatment and public spending on health was only 0.94% of Gross domestic product (GDP), which was among the lowest in the world (Srivastava, 2014).

Due to the lack of adequate coverage by the health care system, many Indians turn to private health care providers, which are generally inaccessible to the poor. Therefore, most Indians lack health insurance and face long-term illnesses, which result in a reduced quality of life for the general population in India. This leaves room for exploring innovative combinations of different intervention components to improve adherence to common regular health behaviors.

Table 1. *Health Behaviors, Recommendations, Levels of Non-Adherence, and Associated Diseases of Non-Adherence*

Behavior	Recommendation	Non-adherence in India	Non-adherence Reasons	Diseases associated with non-adherence
Fruit & Vegetable Intake	To consume 5 servings of fruit and vegetables (~ 400 g) <sup>1</sup>	74% <sup>2</sup>	Lack of basic nutritional knowledge, motivation and strategies engage <sup>3</sup>	-Cardiovascular diseases -Certain types of cancers -diabetes -Micronutrient <sup>4</sup>
Hand-washing	At least 10 times a day <sup>5</sup>	90% <sup>6</sup>	Lack of facilities <sup>7</sup>	-Diarrhoeal disease -Respiratory infection <sup>7, 8</sup>
Dental Flossing	To clean interdental spaces once a day <sup>9</sup>	Flossing is an uncommon behavior in India <sup>10, 11</sup>	Lack of awareness, training, availability, and cost <sup>10, 11</sup>	-Periodontal disease -caries <sup>10, 11</sup>

Note. <sup>1</sup>WHO, 2003; <sup>2</sup>Hall, Moore, Harper, & Lynch, 2009; <sup>3</sup>Adriaanse, Vinkers, De Ridder, Hox, & De Wit, 2011; <sup>4</sup>WHO, 2004; <sup>5</sup>Freeman et al., 2014; <sup>6, 8</sup>Scott, Curtis, & Rabie, 2003; <sup>7</sup>Pittet et al., 2008; <sup>7</sup>Wright et al., 2015; <sup>9</sup>American Dental Association, 2015; <sup>10</sup>Kumar, 2012; <sup>11</sup>Madan et al., 2014.

*Healthy Nutrition: Fruit and Vegetable Intake*

Our purposes in studying the particular behaviors are not only to promote overall health but also to prevent different kinds of diseases. A healthy and balanced diet includes foods low in fat and rich in fiber and vitamins, which facilitates health, physical fitness, and the maintenance of body weight. In order to obtain such a nutritionally balanced diet, fresh fruit and vegetables are one of the essential components, because consumption of them are associated with various health benefits, including (1) reductions in the prevention of non-communicable chronic diseases including cardiovascular diseases and certain types of cancers, (2) protection from being obese, (3) improvements in the overall diet profile, and (4) increases in psychological well being (for an overview see in Boeing et al., 2012; Fulton, McKinley, Young, Cardwell, & Woodside, 2014). However, dietary habits are difficult to change (Fulton et al., 2014) leading to almost 3% of deaths worldwide (Guilbert, 2003). Therefore, the World Health Organization (WHO) recommends that adults should consume a minimum of 400g (approximately five portions) of fruit and vegetables per day. However, many people still consume below the recommended levels (Fulton et al., 2014; Hall et al., 2009).

To a large extent, there are psychological reasons for unhealthy dietary behavior that could be attributed to motivational or volitional factors (Schwarzer, 2008, 2014a). Accordingly, previous studies have explored motivational factors such as beliefs about capabilities and consequences, social support, knowledge, habits, and goals as potential predictors of dietary behaviors (Reyes Fernández, Warner, Knoll, Montenegro Montenegro, & Schwarzer, 2015). Adding self-regulatory strategies, particularly self-efficacy and planning components, to interventions has induced larger effects than interventions based solely on

information provision. Meaning, even if people are aware of health-behavior recommendations, it is difficult to translate their intentions into action, they need to develop self-regulatory strategies (Hagger & Luszczynska, 2014; Schwarzer, 1999). Nevertheless, it is still unclear how the motivational and volitional variables underlying fruit and vegetable intake, such as the role of intention and self-efficacy (Luszczynska, Tryburcy, & Schwarzer, 2007; Mosher et al., 2013).

Additionally, a systematic review suggested that university and college students in different countries fail to consume the recommended amount of fruit and vegetables, which leads to poor dietary habits (Plotnikoff, Collins, Williams, Germov, & Callister, 2015). Therefore, in the *chapter 2*, an intervention study based on the HAPA is designed to explore the role of intention, self-efficacy and planning in increasing FVI in university students in India.

### *Infection control: Handwashing*

Proper daily hand hygiene practice contributes to reduced diarrheal disease (Contzen & Mosler, 2015; Freeman et al., 2014) as well as reduced influenza and acute respiratory infection (Wong, Cowling, & Aiello, 2014). Fortunately, it is well documented in the hand hygiene literature (e.g., Contzen & Mosler, 2015; Pellegrino, Crandall, O'Bryan, & Seo, 2015; Wong et al., 2014) that the apparently simple and relatively cheap act of handwashing with soap and clean water is the single most effective measure for preventing the above-mentioned infectious diseases. Handwashing is like a "do-it-yourself" vaccine involving five simple and effective steps (Wet, Lather, Scrub, Rinse, Dry) for twenty seconds, and it is recommended that people practice it a minimum of ten times a day to lower rates of additional infectious diseases (CDC, 2015). Nevertheless, handwashing is a behavior

developed with childhood lessons of self-protection and becomes habitual through years of repetition in response to certain clues like going to the bathroom (Pellegrino et al., 2015).

Despite sufficient awareness about hand hygiene, studies report that university students wash their hands less frequently than required, even in key situations, such as before eating or after defecation (Ejemot-Nwadiaro, Ehiri, Meremikwu, & Critchley, 2012; Mariwah, Hampshire, & Kasim, 2012). The scenario is not better in Indian college and university residential halls.

The literature on hand hygiene has however far principally consisted of educational campaign material and has rarely been grounded in theory (Azor-Martínez et al., 2014). These types of approaches were shown to initially increase compliance, but found to be non-sustainable (Pellegrino et al., 2015). Furthermore, these studies often focused on hand hygiene behavior itself and merely investigated infection rates, emotional drivers such as disgust, or the role of social factors. However, little is known about the underlying psychological intervention aspects such as the motivational components (e.g., risk-perception, outcome expectancies, and task self-efficacy) to form behavioral intention and self-regulatory components (e.g., volitional self-efficacy, planning, and action control) to translate their intentions into actual health behavior and to maintain the behavior over time (Schwarzer, 2008).

Taken perceived self-efficacy (i.e., belief in one's capability of performing the desired action) as an example, it is known as a universal construct as it plays a pivotal role throughout the entire process, from the formation of behavioral intention (as *action self-efficacy*) to the maintaining of the performance (*volitional self-efficacy*) depending on the challenges that people meet as they progress from one phase to the next (Schwarzer, 2014a). Moreover, in various meta-analyses, the literature has extensively documented that self-efficacy, planning, and action control are effective self-regulatory skills to promote health-

related behaviors including those practiced daily such as handwashing (AbuSabha & Achterberg, 1997; Luszczynska et al., 2015; Prestwich et al., 2014; Schwarzer, Antoniuk, & Gholami, 2015). To my knowledge, the role of such theory-based interventions has not yet been examined in the Indian context and thus, it will be studied in this thesis. Moreover, to conduct this study, soaps and soap solutions will be provided in all washing areas of the participants' residences during the study period for their use. This will be done because providing accessible resources is an obvious necessary component of any hand hygiene intervention (Huis et al., 2012; Mariwah et al., 2012).

#### *Caries and Periodontal Prevention: Interdental Cleaning*

A non-adherence to oral preventive recommendations including dental flossing in addition to tooth brushing (Sambunjak et al., 2011) results in dental caries and periodontal diseases, which affect 10 to 15% of the adult population worldwide and more than 50% of the population in India (Agarwal et al., 2010; Grewal et al., 2014). This leads to further unaffordable treatment procedures and cost on the individual level as well as on the government in a country like India, where people below poverty line are dependent on government hospitals (Rajalakshmi, 2013). This then impacts on the people's quality of life in terms of their functionality, self-esteem, and social relationships (Petersen & Ogawa, 2012; Tonetti et al., 2015). Some reasons given for poor oral hygiene include not only the lack of complete oral health knowledge but also financial barriers to changing health behaviors (Giles, Robalino, McColl, Sniehotta, & Adams, 2014). Consequently, only few individuals worldwide, including in India, practice interdental cleaning such as daily dental floss use (Kumar et al., 2011) and it is even reported as an uncommon behavior (Schüz, Sniehotta, Wiedemann, & Seemann, 2006). Furthermore, rural populations have a higher prevalence of

periodontal diseases than urban populations due to a lack of health knowledge, infrastructure and oral health care facilities to maintain good oral hygiene (Agarwal et al., 2010).

Therefore, it is of utmost importance to increase awareness about oral health and then engage individuals in strategies to improve oral self-care. According to the World Health Organization (WHO, 2012), *oral health* means to be free of pain related to oral and facial problems and oral diseases such as oral cavities, tooth decay, oral infections, and periodontal (gum) disease that hinders an individual's capacity to bite, chew, smile and speak and his/her psychosocial wellbeing. Furthermore, a literature review on oral health (Calderon & Mallory, 2014) describes the common conception of oral health behavior as including all those activities that an individual him/herself engages in (self-care) to promote oral health such as, brushing, flossing, using mouth rinses, teeth whitening products, and visits to dental care professionals. Particularly, dental flossing is the most common oral self-care practice and an effective adjunct to tooth brushing to reduce gingivitis and help in avoiding plaque formation (Sambunjak et al., 2011).

Self-care is defined as encompassing the autonomous management of medical and treatment-related tasks as well as the capacity to attend to one's broader psychosocial needs (Pelicand, Fournier, Le Rhun, & Aujoulat, 2013). It requires two key ingredients: the motivation to initiate and maintain self-management behaviors, and the skill necessary to execute a defined pattern of activities congruent with the desired self-management goals (Aujoulat, d'Hoore, & Deccache, 2007; Maes & Karoly, 2005). Furthermore, evidence shows that long-term self-care capacity is linked to a self-regulation process through which motivation to self-care is internalized in such a way that behaviors are eventually performed with a sense of choice (Williams, Rodin, Ryan, Grolnick, & Deci, 1998). Therefore, research is still needed to understand how healthy as well as unhealthy adults internalize the



motivation to self-care, (in this case, oral self-care) through preventive strategies derived from an appropriate social cognitive model, which is indeed what I am going to explore in this thesis.

*The Study Samples: Why are Specific Target Populations studied?*

The life of university students in India is a public health concern. This is quite simply because a great proportion of college and university students live in college residential halls where their health related habits are no longer supported and bolstered by the other family members. This shift in environment from parent-controlled care (home) to self-managed care (university) further contributes to subsequent poor health-related habits such as food purchasing. Moreover, infection transmission could occur easily in student residences because of students' carefree habits. Therefore, it is very crucial that university students acquire proper hand hygiene habits for their later behavior in professional settings, because, being the better educated citizens, they would be role models for the rest. Some researchers claim that the time when students' transition to university is a period when they are particularly likely to engage in unhealthy life styles (Bray & Born, 2010).

Research has indicated that there is a possibility for students to deliver health initiatives as a part of their studies to become health professionals, and that this makes education institutions ideal settings for promoting healthy lifestyles (see review by Plotnikoff et al., 2015). Consequently, this particular population attracts the researchers because of the continuous rise in the number of individuals participating in higher education, which is predicted to reach worldwide 262 million by 2025. In particular, India has the world's largest youth population despite having a smaller population than China (United Nation, 2014). However, there is lack of theory-based intervention studies promoting fundamental daily

health behaviors. For example, in the hand hygiene literature, the previous studies were mainly conducted either among health care workers or school children (e.g., Azor-Martínez et al., 2014; Freeman et al., 2014; Kapil, Bhavsar, & Madan, 2015) and very few of them were generalizable to the common adult population. Hence, three intervention studies will be conducted among *college and university students* in India as part of this thesis.

Non-adherence to oral preventive recommendations affects more than 50% of population in India (Agarwal et al., 2010) and produces unaffordable costs on the individual level as well as on the government in a country like India, where people below the poverty line are dependent on government hospitals. Furthermore, rural populations have a higher prevalence of periodontal diseases than urban populations due to a lack of health knowledge, infrastructure, and oral health care facilities to maintain good oral hygiene.

Incentives as a behavioral change technique are emerging as a new tool and becoming increasingly popular among both policy makers and health care providers (Giles et al., 2014; Giles, Robalino, Sniehotta, Adams, & McColl, 2015). A systematic review and meta-analysis (Mantzari et al., 2015) emphasized the need for research to move beyond the question of whether incentives work and rather identify the circumstances under which incentives are most effective in achieving and sustaining changes. This might involve delivering incentives alongside other intervention components (Giles et al., 2014) for those population whose health is depended on government's support, such as people below the poverty line in India who need extra support to eliminate some of their financial barriers when trying to change their health behaviors. Because some reasons given for poor oral hygiene include not only the lack of complete oral health knowledge but also financial barriers to changing health behaviors (Giles et al., 2014). However, such programs are rare, and the effectiveness of comprehensive incentives when combined with psychological interventions is therefore

unknown. Thus, I will examine in this thesis (*chapter 5*) the effectiveness of a combined intervention of incentives with self-management cues to promote oral hygiene in Indian outpatients already diagnosed with periodontal diseases.

To conclude this section, it is important to note that contextual factors such as the choice of behavioral domain and target population can contribute to the effectiveness of behavior change interventions; they can determine whether the parameters for effectiveness are satisfied (e.g., some behaviors are easy to perform, but others are hard; and some populations are high in self-efficacy, and others are low). Taking the characteristics of behavior domains and target populations into account is very important and therefore, I will describe this point more specifically in the following sections.

### *Social-Cognitive Theories: A Conceptual Lens to Explore Health Behavior Change*

Over the last four decades, researchers have developed a number of individual-level health behavior theories to explain and predict health behaviors and change processes. A recent paper by Atkins and Michie (2015) explains the benefits of using theory in designing of interventions to change behavior as, “it can provide a framework to facilitate the accumulation of evidence, i.e. summarizing what is known; it can permit communication across research groups, i.e. a common language; theory can be used as a starting point for intervention design to identify what needs to shift in order for behavior to change and also in the evaluation of interventions by identifying mechanism of action, i.e. how an intervention is working”. Moreover, the purposes that health behavior theories serve can be summarized into three main points: to educate students (Rhodes, 2014) and practitioners (Abraham, 2014), to inform and use them as a framework to interpret and explain observed behaviors (Abraham, 2014; Kok & Ruiter, 2014). They can also be applied to the health psychology research to

inform the development of research empirical hypotheses (Sniehotta, Presseau, & Araújo-Soares, 2015).

The terms ‘model’, ‘theory’ or even sometimes ‘framework’ are closely related although distinct concepts; for instance, model is descriptive, whereas a theory is explanatory as well as descriptive. However, the difference between them is not always clear, and thus, the terms are sometimes used interchangeably (Nilsen, 2015). In case of the current thesis, the meaning of the theory shares ideas of Glanz and Rimer (2005, p.4), where it states, “A theory presents a systematic way of understanding events or situations. It is a set of concepts, definitions, and propositions that explain or predict these events or situations by illustrating the relationships between variables”. Nevertheless, a “good theory” provides a clear explanation of how and why specific relationships lead to specific events.

The commonly used health behavior theories that focus on psychological factors in predicting behavior change include the health belief model (HBM; Stretcher & Rosenstock, 1997). The HBM postulated six main determinants of behavior, namely perceived susceptibility, perceived severity, perceived benefits, perceived barriers, health motivation, and cues to action. This theory emphasized the importance of individuals’ beliefs (i.e., the perceived disease threat or benefits of behavior). This theory is a staged one stating that each step in the decision making process is dependent on the previous decision or belief. However, it ignored an essential dimension of individuals’ behavior, the belief in one’s own competence to successfully implement action. The protection motivation theory (PMT; Maddux & Rogers, 1983) is defined operationally as the intention to adopt the recommended action and emphasizes on the cognitive processes mediating behavioral change. PMT can be regarded as an adaption of the HBM (see Armitage & Conner, 2000; Lippke & Ziegelmann, 2008 for an overview of the theories).

The social cognitive theory (Bandura, 2001) is based on the assumption that psychological constructs, namely self-efficacy and outcome expectancies, serve as core predictors of behavior (Bandura, 1997). Self-efficacy refers to confidence in one's ability to execute a difficult behavior and the capability to perform the actions that are required to attain a desired outcome state. Outcome expectancies are defined as the individuals' perceived estimation that adopting a specific health behavior will lead to positive or negative consequences. However, outcome expectancies are thought to lose their predictive power after a personal decision has been made. According to Social cognitive theory (SCT), a person's expectations affect both initiation and persistence in behavior, and self-efficacy determines how much effort people will expend and how long they will persist when facing obstacles (Bandura, 1997). Generally, SCT stated that people who with higher perceived control over outcome expected fewer external obstacles, and their ability to accomplish a specific task would be more successful on initiation and persistence of behavior.

The Theory of Reasoned Action (TRA; Ajzen, 2000) proposed that attitudes and subjective norms predict behavioral intentions, which subsequently predict behavior. A theory of planned behavior (TPB; Ajzen, 1991, 2011, 2014) is an extension of the TRA, which added perceived control as a predictor of intention. The integrative model of these two is what has recently been labeled the reasoned action approach (RAA; Fishbein & Ajzen, 2010). This states that attitudes towards the behavior, perceived norms, and perceived behavioral control determine people's intentions, while people's intentions act as the proximal predictor of behavior. The intention refers to self-instructions to attain desired outcomes or perform a particular behavior, which Gollwitzer (1999) formulated as "I intend to reach the aimed health behavior". The Theory of Planned Behavior contributes by identifying intentions as a central construct in the processes, whereby the stronger the intentions to change the behavior,

the more likely people are to perform the behavior. Although TPB served as a starting point, out of which new and extended theories of health behavior could emerge (Hagger & Luszczynska, 2014), questions relating to the concept such as the relationship between intention and behavior—described as “the intention-behavior gap” (Sheeran, 2002)—arose.

Consequently, the Theory of Planned Behavior faced critique and it was suggested that this theory be retired due to its rather static nature. It also faced critique that it lacked concepts to understand behavioral change (see commentaries by e.g., Rhodes, 2014; Schwarzer, 2015; Sniehotka, Preeceau, & Araújo-Soares, 2014). That being said, the reasoned action approach is also solely focused on the motivation process and not on the action process. Furthermore, the Theory of Planned Behavior is also described as a motivation theory, which is more efficient in predicting and changing behavioral intentions than the behavior itself (Abraham, 2014; Kok & Ruiter, 2014; Schwarzer, 2015).

The above-mentioned models assumed that a person’s behavior is a direct result of his/her behavioral intention and that his/her behavior may change linearly with time in a quantitative way, thus these models are called continuum models. However, behavior could also be predicted and explain in conditional terms, i.e., depending on the person’s mental stage. Examples of stage models include the Transtheoretical Model of change (TTM; Prochaska & Velicer, 1997) where five stages of behavioral change are proposed, namely, pre-contemplation, contemplation, preparation, action and maintenance. The Transtheoretical Model introduced the concept of decisional balance, where the individual cultivates awareness that the advantages (the "pros") of changing a specific behavior outweigh the disadvantages (the "cons") and the costs of changing the behavior. However, there is sparse evidence to suggest that the model applies and that stage-based interventions are effective in changing health-related behaviors (West, 2005).

Another theory, the Precaution-Adoption Process Model (PAPM; Weinstein, 1988) attempted to explain how a person comes to decision to take action and how he or she translates that decision into action, however, the Precaution-Adoption Process Model does not apply to the gradual development of habitual patterns of behavior due to the discontinuity patterns in some of the important constructs across the stages (Sniehotta, Luszczynska, Scholz, & Lippke, 2005).

The Rubicon model of action phases, (“Rubicon Model”; Heckhausen & Gollwitzer, 1987) made a clear distinction between a pre-decisional phase (known as motivational), which has a deliberative orientation, and a post-decisional phase (known as volitional), which has an implementation orientation. Regarding this, Gollwitzer, (1999) introduced the concept of implementation intentions (II) in order to explain the process between the initiation and conclusion of an action. An II is a self-regulatory strategy in the form of an “if-then plan” that helps people to achieve better goal attainment, where “if” represents a situational cue they may face, and the “then” represents the behavioral response to that cue. II is subordinate to goal intentions as it specifies the when, where and how portions of goal-directed behavior. The Rubicon model suggests that the people move from planning and goal setting to the implementation of plans in changing their behavior; they cross a metaphorical Rubicon. However, in practical settings some people relapse when challenged, therefore despite the fact that the model has been verified, evidence for the interventions based on this model has been scarce.

### *Challenges in Bridging the Intention-Behavior Gap*

So far, the theories described and discussed (e.g., HBM, TRA, TPB, and SCT) prove useful to explain behaviors but are not enough to guide behavioral interventions. Behavioral

intentions only accounted for about 30% of the variance in actual behavior in empirical studies, which indicate that intentions are an important but insufficient prerequisite for successful behavior—a phenomenon that has been labeled the *intention-behavior gap* (Sheeran, 2002). This low percentage of explained variance was mainly due to the fact that even strong intentions often do not lead to the behavior itself (Orbell & Sheeran, 1998) resulting this gap between intention and actual behavior. Although the second type of theories (e.g., TTM, PAPM, Rubicon) posited a motivational and volitional dual process for behavior change, the evidence that these models can be applied to explain the ‘gap’ between individuals’ intentions and their subsequent behavior has been scarce.

Above-mentioned *concern* leaves room for the investigation with these questions; which theory would guide to form sustained motivation by increasing behavioral intention first and then further guides to form self-regulatory strategies to translate the intention into action? Which theory facilitates bridging the intention-behavior gap and increase the likelihood of desired behavior attainment? Which theory enables the health-related behavior change *in accordance* to the temporal *mind-sets* of the individuals? Which theory has high compatibility with behavior change techniques taxonomy (v1) (BCTs; Michie et al., 2013) and thus, enables defining the intervention components in terms of BCTs? To answer these questions, we need to be reminded that out of many reasons such as the salience, priority, strength, or stability of intentions, one reason why individuals fail to act on their intentions relates to their inability to remember their intended action when the opportunity to act presents itself. Because once a novel behavior has been imitated, volition strategies are needed to ensure maintenance of the behavior, that is, the performance of the task (e.g., hand washing or flossing) as part of a daily routine. Hence, there is need of a model which focuses on the volitional processes that underlie goal striving and proposes to bridge the gap between



intentions and behaviors by providing a variety of beliefs and dispositions that guide individuals to successfully adopt and maintain health behaviors (Gollwitzer, 1999; Schwarzer et al., 2011; Webb & Sheeran, 2008).

*A Theory of Adoption and Maintenance of Health Behaviors: Health Action Process Approach (HAPA)*

The health action process approach (HAPA; Schwarzer et al., 2011; Schwarzer, 2008) is designed initially to overcome some of the limitations inherent in other theoretical frameworks. The core reason is that this model stands out as having the best fit for explaining differences between pre-intentional processes and post-intentional processes integrating constructs from different motivational and volitional theories (Kraemer, Helmes, & Bengel, 2014). Accordingly, this thesis is inspired by this model guiding the theoretical frameworks for the studies included in this thesis in changing the corresponding health behaviors. In particular, this comprehensive framework provides a variety of beliefs and dispositions that guide individuals to a successful adoption and maintenance of health behaviors, and thus, known as Theory of Adoption and Maintenance of health behaviors (see *figure 1*). This theory not only allows for a prediction of behavior but also an understanding of the causal mechanisms involved in the changes of behaviors in domains ranging from the dietary to hygiene domains. Accordingly, the HAPA is used to predict a range of health behaviors including dietary intake (e.g., Kreausukon, Gellert, Lippke, & Schwarzer, 2012; Lange, Corbett, Lippke, Knoll, & Schwarzer, 2015), dental flossing (e.g., Schwarzer et al., 2015), and hand hygiene (e.g., Zhou, Jiang, Knoll, & Schwarzer, 2015) and is applicable to range of samples, from healthy university students to individuals with chronic illnesses or disabilities

(e.g., Lippke & Plotnikoff, 2014; Paxton, 2015; Smith, Murray, Greaves, Hooper, & Abraham, 2014).

This versatile model was developed in 1988 (Schwarzer, 1992), and its author attempted to integrate the model of action phases (Heckhausen & Gollwitzer, 1987) with social-cognitive theory (Bandura, 1997), based on the following five principles (Schwarzer, 2014a):

Principle 1: Motivation and volition according to the mindsets of the people when they move from deliberation to action while changing their behavior. HAPA differentiates between (a) pre-intentional motivation processes that result in a behavioral intention, which therefore has been described as goal setting, followed by (b) post-intentional volition processes, which ultimately lead to behavioral enactment, which has been described as goal pursuit. The motivation phase is the initial point for behavioral performance, during which an individual weighs up the costs or risks (i.e., *risk perception*) and balances the advantages and disadvantages of certain behavior consequences (i.e., *positive outcome expectancies*). Additionally, individuals need to believe in their capability to perform a desired health behavior and thus self-efficacies need to be boosted. Hence, *perceived self-efficacy* operates together with risk perception and positive outcome expectancies, both of which contribute in forming behavioral *intention* (Fleig et al., 2015; Gollwitzer, 1993; Schwarzer, 2008). After individuals have decided to change their behavior, the behavioral intention has to be translated into action through volitional processes.

Afterwards, they enter the post-intentional process (i.e., volition phase). In the context of the current thesis, volitional strategies are termed self-regulation strategies that explain an individual's own efforts to reduce discrepancies between behavioral intentions and actual behavior (Lauper, Moser, Fischer, Matthies, & Kaufmann-Hayoz, 2015) and thus, bridge the

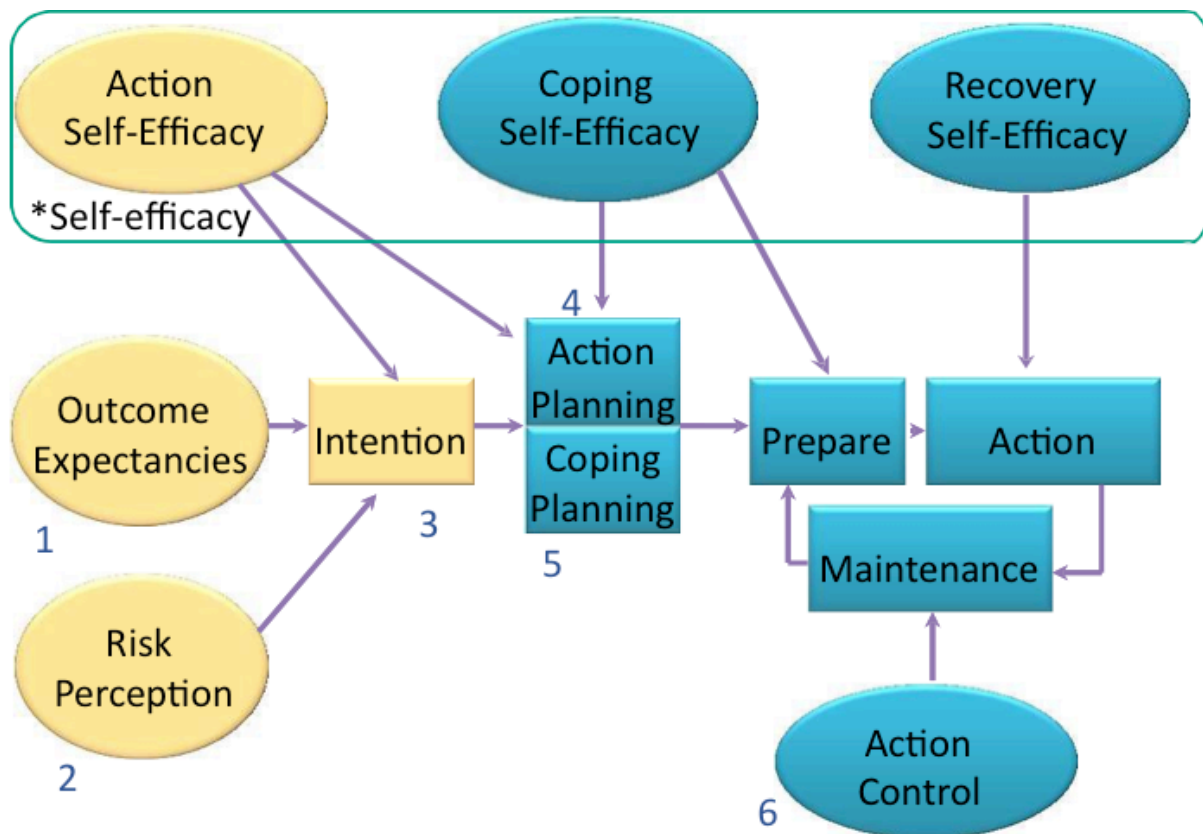
intention-behavior gap (Sheeran, 2002). Volition phase involves self-regulatory skills such as *self-efficacy, planning, and action control*, which are required to translate a behavioral intention into action (Hagger & Luszczynska, 2014). A lack of self-regulatory skills is associated with a disinclination to change health behaviors, including deficits in self-efficacy, planning, and action control (e.g., Lhakang, Godinho, et al., 2014; Schüz et al., 2007; Schwarzer et al., 2015; Suresh, Jones, Newton, & Asimakopoulou, 2012).

Principle 2: Two volitional phases: In this phase, there are intenders (those who have not yet translated their intentions into action), and actors (those who have transformed their intention into action), and thus, there are two types of group characterized by their different psychological states. As a continuous process of health behavior change, the model could include *pre-intenders* as a third category of people with a different mindset in order to depict their current location within the course of their behavior change. Principle 3: Post-intentional planning: Intenders who are through the volitional pre-action stage but who still lack the right skills to translate their intention into action. Principle 4: *Two kinds of mental stimulation*, referring to two types of planning; the when, where, and how of intended action as *action planning*, and the act of anticipating the possible barriers and then designing a corresponding strategy to cope and attain one's goal in spite of challenge, which is termed *coping planning*.

Principle 5: *Phase-specific self-efficacy*, suggesting that perceived self-efficacy is required throughout the entire process of health-related behavior change. However, the specific type depends on the nature of the different challenges that people face when they advance from one phase to the next (i.e., the chain of goal setting-planning-initiative-action-maintenance-recovery). Thus, there is action self-efficacy, maintenance or coping self-efficacy, and recovery self-efficacy. Hence, self-efficacy plays a crucial role in both the initiation phase (motivation phase) and the maintenance phase (volition phase) of health

behavior by directly influencing health behavior as well as by affecting several other factors, thus it is included in most prominent health behavior theories (Luszczynska, Gutiérrez-Doña, & Schwarzer, 2005). Moreover, more parsimonious model of the HAPA (Schwarzer, 2008) takes into account also social resources such as social support as important volitional concepts, because for instances, giving support for instance found to be beneficial for the helper's well-being (Knoll, Kienle, Bauer, Pfüller, & Luszczynska, 2007) and, it further seemed to be good booster for the recipient's self-efficacy level (Knoll, Burkert, Luszczynska, Roigas, & Gralla, 2011).

Clearly, it is not always possible that all five principles are covered in every single empirical study. Depending on the research question, one might choose the one or the other. In the case of this thesis, our objective is to predict the behavior change. Therefore, based on our specific research questions, the contextual relevance and the constraints, I have accordingly chosen to focus mainly on the first principle in this dissertation; however, the objectives are still in line with the suggested approach.



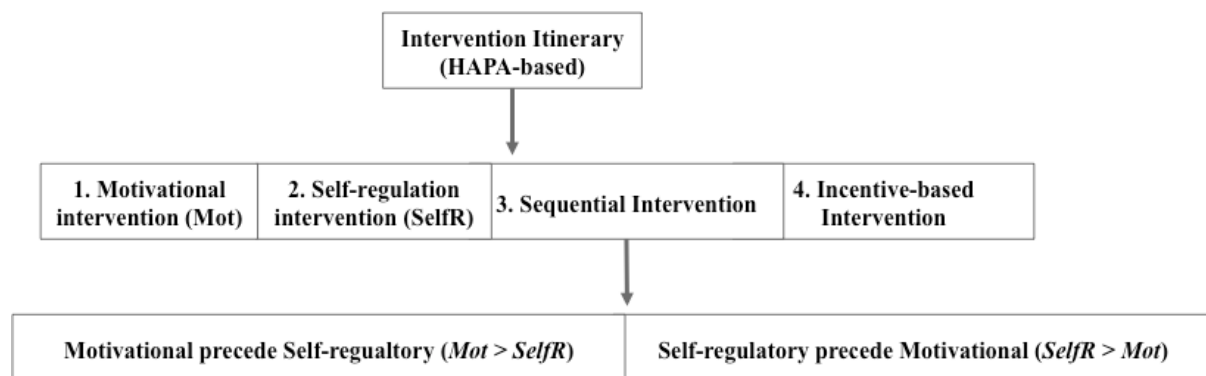
\*Note. Self-efficacy as a key determinant of behavior from initiating behavior to maintenance, plus 6 other defined HAPA components, motivational (1-3) and volitional (4-6).

Figure 1. Health Action Process Approach model (HAPA; Schwarzer et al., 2011; Schwarzer, 2008).

### *Hypothetical Intervention Itineraries based on the HAPA Model*

As discussed above, the HAPA model has been demonstrated to be one of the most efficient models to predict diverse health behaviors with both its motivational as well as volitional determinants. Nevertheless, (a) the differentiation of concepts by both content and process, and (b) clear recognition of the existence of sequential aspect in the health behavior change, are two major contributions of the HAPA (Leventhal & Mora, 2008). However, very few intervention studies have been conducted in the literatures that compare the differential effects of HAPA based interventions in terms of sequences or in terms of contents. Such

knowledge on the efficiency of different theory-based interventions would provide beneficial guidance in the future development and evaluation of interventions. Therefore, below highlights brief information on the different types of hypothetical interventional directions that could be derived from the HAPA (see *figure 2*) and their particular potential in predicting health behaviors.



*Figure 2.* Illustration of latent HAPA-based intervention itinerary for the health behavior change process.

### *1. Motivational Intervention (Educational)*

According to the HAPA model, motivational intervention focuses pre-intentional processes, such as risk perception, outcome expectancies, and task self-efficacy. Risk perception in itself is insufficient to enable a person to form an intention. Rather, it sets the stage for a contemplation process and a further elaboration of thoughts about consequences and competencies (Schwarzer et al., 2011). Outcome expectancies pertain to the perceived consequences of one's actions. Furthermore, perceived self-efficacy operates jointly with outcome expectancies and risk perception to form a behavioral intention (Schwarzer, 2008). This type of intervention could be also based on almost all the popular health behavior change theories that I discussed earlier, including Social cognitive theory (Bandura, 1997),

Theory of planned behavior (Ajzen, 2014), and the Reasoned action approach (Fishbein & Ajzen, 2010), which consider intention as the proximal antecedent of behavior.

Since intentions account for less than one third of the variance in behavior, it led researchers to consider the intention-behavior gap (Sheeran, 2002) as a topic in contemporary research. Because having strong goal intentions is a necessary prerequisite, it is often not sufficient for goal-directed behavior (Fennis, Adriaanse, Stroebe, & Pol, 2011; Gollwitzer & Sheeran, 2006). Moreover, motivational interventions rely solely on knowledge sharing as evidence-based education, and these types of approaches were shown to initially increase compliance (for example handwashing), but were found to be ineffective in sustaining changes in behavior (Pellegrino et al., 2015).

## 2. *Volitional Intervention (Self-Regulatory)*

Self-regulation interventions are required for pursuing the goal, that is, performing the actual behavior (Schwarzer, 2014b). When designing interventions for a particular sample, for example increasing the FVI of already motivated participants, the traditional continuum models are rather inadequate because they do not account for post-intentional processes. Therefore, these models have been criticized mainly because of the discordance between intention and actual behavior (i.e., failure of intention to predict behavior). The HAPA explicitly includes post-intentional factors to overcome this gap and thus serves as an integrative theory of intention and action. When a person is inclined to adopt a particular health behavior, the intention has to be transformed into detailed plans on how to perform the desired action through self-regulatory strategies such as planning, action control, social support, and recovery self-efficacy (Schwarzer et al., 2011). These volitional factors relate to

the ability to increase the likelihood of successful implementation of one's intention and overcome the intention-behavior gap (see review by Pellegrino et al., 2015).

A great deal of research has documented the pivotal role of self-regulatory strategies for a variety of health behaviors (e.g., Hagger & Luszczynska, 2014; Schwarzer et al., 2015; Schwarzer, 2008; Sniehotta et al., 2007). However, the effectiveness of just self-regulatory factors was rarely tested; intervention packages frequently include motivational ones. To use the HAPA model as a causal model (i.e., motivation causes volition) in evaluating interventions, it is necessary to change its specified causes to produce a change in a particular variable (Sutton, 2008). For example, in order to change dental flossing behavior, we need to change post-intentional factors such as planning and/or recovery self-efficacy; to change recovery self-efficacy, we need to change motivational self-efficacy; to change planning, we need to change intention and to change intention, we need to change one or more of a number of motivational factors such as self-efficacy, outcome expectancies, and risk perception.

Having said that, delivering a self-regulatory intervention alone would result in the downside of '*jumping into the causal chain*' (Sutton, 2008), that is, revealing what happens when the participants try to change post-decisional predictors of behavioral change without changing their prior determinants first. Moreover, self-regulatory strategies might prove unsuitable for the unmotivated individuals and even if they result in behavior change, the effect may not hold over a longer period of time. However, such an approach has not yet been investigated to our best knowledge—although it certainly could be, based on the model. Therefore, the effectiveness of the two phases of the HAPA, motivation and self-regulation, will be explored in this thesis.



### 3. *Motivation and Self-Regulation in Sequence*

As stated above, the individual beneficial effects of motivation and self-regulation processes derived from HAPA is well highlighted in the research on changing health related-behaviors (see review by Hagger & Luszczynska, 2014) including dental flossing (e.g., Schüz et al., 2007; Schwarzer et al., 2015), FVI (e.g., Gholami et al., 2014; Godinho et al., 2015), and hand hygiene (e.g., Curtis et al., 2011; Pincock, Bernstein, Warthman, & Holst, 2012). Appropriately, the HAPA model serves as a framework for both types of intervention package (motivation and self-regulation) and asserts that a motivational intervention should precede a self-regulatory intervention (Schwarzer et al., 2011; Schwarzer, 2008).

Specifically, once the individuals have formed a behavioral intention through a motivational intervention, then they should be guided by self-regulatory strategies to improve and maintain their new health behavior. In such cases the HAPA suggests that the theorized sequence—i.e. a self-regulatory intervention with a motivational precursor—would be the most intuitive sequence. However, the opposite sequence, starting with self-regulation and followed by motivation, may be better and more parsimonious sequence. For instance, when they are already beyond that stage, some participants may not benefit from the former sequence because they feel patronized by the motivational messages or they perceive them as redundant. However, research has not addressed the efficacy of this reversed intervention sequence. Additionally, the validity of such interventional sequential on health promotion is yet to be explored. Specifically, the question of whether the order by which the HAPA intervention components (motivation and self-regulation) are delivered, is relevant for the effectiveness of regular health behavior promotion (in this case FVI, dental flossing and, hand hygiene) needs to be addressed.

Thus, I will compare the effectiveness of the theorized order or the opposite reversed order with an intervention sequential design in this thesis. By *intervention sequential design*, I mean combining the two arms of the HAPA (motivation and volition), however, they are arranged in a different sequence or order. In this, a sample of the population is studied at intervals to examine the effectiveness of each intervention. This theory-based intervention designs so far are relatively unexplored concerning the interventions to promote regular health behaviors. Thus, such unique intervention design makes contribution to the literature. The application of this design in this dissertation is described in detail later in the respective section.

#### 4. *Incentive-Based Interventions*

The use of financial incentives to promote health behaviors is increasingly seen as a viable intervention for a wide range of behaviors (see review by Adams, Giles, Robalino, McColl, & Sniehotta, 2012). Nevertheless, behavioral incentives (i.e., any reward including free or subsidized costs for specialized health services, cash like vouchers that can be exchanged for health benefits or services, and financial rewards) have been defined as motivating rewards that are provided to subjects' contingent on behavior performance of target health behaviors (Abraham & Michie, 2008; Giuffrida & Torgerson, 1997). Hence, I use the term 'financial incentives' in this dissertation to refer to any kind of reward and not just cash rewards.

Using financial incentives to promote healthy behaviors may appear to be too simple a solution to a serious public health problem such as oral hygiene in patients diagnosed with periodontal diseases. Fortunately, incentives could be incorporated into the other behavioral change techniques such as the motivational technique, which some researchers suggest is the

most effective behavior change technique (Cerasoli et al., 2014; Giles et al., 2014). However, the literature does not provide information on the efficacy of interventions combining psychosocial-based self-management cues and incentive based-interventions. Therefore, I will explore in this thesis the effectiveness of a brief psychological intervention inspired by the HAPA in addition to an incentive-based intervention to promote oral hygiene in outpatients diagnosed with periodontal diseases in India. The purpose was to explore the feasibility of a very brief intervention following an idea from Sniehotta and colleagues (2007) who conducted a 1-min intervention to change oral self-care behavior.

To summarize, the predictive value of the two arms of the HAPA model (motivation and volition) could be used in interventions to change regular health behaviors in a variety of ways. Hence, I will explore comprehensively the effectiveness of interventions based on HAPA in changing multiple regular health behaviors using different types of intervention designs. In doing so, I explore and highlight the significant issues and barriers that are essential to HAPA based intervention development. I also bring to light the application of this theory to satisfy the criteria for an effective system for explaining health related behavior and provide better guidance as to the processes and mechanisms involved. Additionally, I ultimately make recommendations for how to move forward in this important area of investigation to change health related behaviors. Below, the theoretical assumptions and the constructs of the HAPA used in the current thesis are illustrated in detail.

#### *Explanation of the HAPA Constructs Included in the Current Thesis*

Although individuals' general perceptions of risk (e.g., dirty hands cause infectious diseases) could be high, many might not feel personally at risk, and thus, personal perceptions of risk (Klein & Cerully, 2007) could often be low. Moreover, risk perception is

considered to be only a distal antecedent of the intention formation process and may not be important motivational variables and may, therefore, be less salient in the context of most of the behaviors including dietary change and hygiene (Fleig et al., 2015; Luszczynska et al., 2007). Outcome expectancies are the perceived positive or negative consequences expected by adopting or not adopting the health behavior, however, they are supposed to lose their predictive power after a personal decision has been made, i.e., an intention has formed (Schwarzer et al., 2011). Thus, risk perception and outcome expectancies were not studied in the current thesis studies. Perceived self-efficacy, that is, the belief in one's capability of performing a desired action, is seen to be influential at all stages of the behavior change process (Bandura, 1997). A detailed description of all the social-cognitive constructs of the HAPA, which are investigated within the framework of this thesis, is given in the following.

### *Behavioral Intention*

Behavioral intentions represent a person's motivation to engage in a desired target behavior. According to the reasoned action approach (Fishbein & Ajzen, 2010), behavioral intention is the most proximal antecedent of health-related behaviors. In the initial stage of health behavior change, people need to develop motivation, for which behavioral intention is an indispensable variable (Schwarzer et al., 2011). Furthermore, in the process of motivation, intention has been regarded as a kind of "watershed" between an initial goal-setting phase and a subsequent goal-pursuit phase (Schwarzer et al., 2011).

Although behavioral intentions play a key role in motivating people to change health-related behaviors, the intention to act does not yet guarantee that the target behavior will be performed. Intention is often the endpoint of a motivating phase, when people explicitly state their intention to perform the target behavior in the very near future. Later volitional

construct such as planning, action control, and volitional self-efficacy (which are described in detail below) are more influential in the self-regulation process and are supposed to be more proximal predictors of behavior than intention. Nevertheless, changes in behavioral intention along with changes in self-efficacy have proven to be sequential mediators between intervention conditions and behavioral outcomes in the domain of oral hygiene (Gholami et al., 2014) and FVI (Hall et al., 2009; Kreausukon et al., 2012).

### *Self-Efficacy: Universal Psychological Construct*

Perceived self-efficacy has been defined as beliefs in one's capabilities to organize and execute the courses of action required to produce given levels of attainment (Bandura, 1997). It is a core construct in health psychology and most health-behavior change theories assume its crucial role and thus, it is known as a universal psychological construct (French, 2013; Luszczynska et al., 2005; Warner et al., 2014). It represents a belief in one's competence to tackle difficult tasks and to cope with adversity in specific demanding situations (e.g., "I am certain that I can floss regularly even if I have to force myself"). Such optimistic self-beliefs make a difference to how people feel, think, and act. For instance, people with high self-efficacy choose to set themselves higher goals and stick to them, whereas, people with low self-efficacy doubt their capacity to act and so have low motivation.

As I discussed earlier in this thesis that depending on this situation in the course of behavior change, different types of self-efficacies, i.e., action self-efficacy, maintenance self-efficacy, and recovery self-efficacy may be used to master different challenges (Bandura, 1997; Schwarzer & Renner, 2000). This has since been applied to a range of health behaviors. *Action self-efficacy* is an optimistic belief that operates jointly with outcome

expectancies and risk perception to form intention in the motivational phase, and individuals with high action self-efficacy imagine success, anticipate the potential outcomes of diverse strategies, and are more likely to initiate a new behavior (Schwarzer, 2008). *Coping self-efficacy* represents optimistic beliefs about one's capability to cope with barriers that arise during the maintenance period. Individuals with high coping self-efficacy invest more effort and persist longer than those who are less self-efficacious. *Recovery self-efficacy* addresses the experience of failure and recovery from setbacks. Individuals with high recovery self-efficacy trust in their competence to regain control after a setback or failure and to reduce harm (Marlatt & Witkiewitz, 2002).

While action self-efficacy is instrumental in the motivation phase, coping and recovery self-efficacies are instrumental in the subsequent volition phase and can, therefore, also be summarized under the heading of 'volitional self-efficacy' (Parschau et al., 2014; Schwarzer et al., 2011). Bandura (1997) introduced four sources of self-efficacy: mastery or performance accomplishment, modeling or vicarious experience, verbal persuasion and physiological states. Mastery experience, i.e., successful performance of the behavior is held to be a key determinant of self-efficacy (French, 2013). Since some of these self-efficacy sources comprise social influences, such as in case of vicarious experience or verbal persuasion, social support (e.g., received family support) compensate the deficits of self-efficacy in individuals with low self-efficacy levels (Warner, Gutiérrez-Doña, Villegas Angulo, & Schwarzer, 2015).

Self-efficacy influences the processes of planning, taking initiative, maintaining behavior change, and managing relapses (Bandura, 1997). When individuals are already motivated, self-efficacy gives them the confidence to implement their intentions and initiate and maintain behavioral changes in the volitional phase of the change process. Self-efficacy

is found to be one of the potential predictor in the domain of regular health behaviors, including oral self-care (e.g., Buglar, White, & Robinson, 2010; Schüz et al., 2006; Schwarzer et al., 2015), FVI (see meta-analyzes by Prestwich et al., 2014), and hand hygiene (e.g., van der Meer et al., 2014). Moreover, self-efficacy was also found to mediate the relation between intention and behavior (e.g., Luszczynska et al., 2007; Mosher et al., 2013). Correspondingly, self-efficacy plays a major role within all chapters of this thesis, which will focus on the relationships between intention and self-efficacy as sequential mediators in the context of FVI among university students (*Chapter 2*) and dental flossing among dental patients (*Chapter 5*) and as a potential predictor along with other self-regulatory strategies derived from the HAPA in the context of all regular health behaviors studied in the current thesis.

#### *Planning: Prospective Self-Regulatory Strategy*

Planning as (cf. implementation intentions; Gollwitzer, 1999; see above) is a self-regulatory strategy that helps individuals prepare for initiating an action in good opportunity to realize the behavioral intention and anticipating barriers and how to cope with them with *if-then* plan. Hence, planning is a prospective self-regulatory strategy, one of the well-established behavior change techniques that has been well documented in various meta-analyses to be an effective self-regulatory skill to promote a range of health-related behaviors (Adriaanse et al., 2011; Gollwitzer & Sheeran, 2006; Kwasnicka, Penseau, White, & Sniehotka, 2013; Wiedemann, Lippke, Reuter, Ziegelmann, & Schüz, 2011) and research has documented the pivotal role of planning interventions for a variety of regular health behaviors (Hagger & Luszczynska, 2014; Kwasnicka et al., 2013).

In the framework of HAPA, planning may be divided into two kinds, namely *action planning* and *coping planning* (Sniehotta, Schwarzer, Scholz, & Schüz, 2005). *Action planning* refers to the specification of the situational details of action implementation, stating exactly ‘when’ and ‘where’, and then linking these specified cues to concrete behavioral responses with ‘how’ one will adopt a certain behavior. However, despite action planning, the execution of the planned action may still be impeded by deep-rooted habitual responses. Hence, *coping planning*, referring to the anticipation of barriers that may jeopardize behavioral performance and thus identifying strategies to cope with them may come to play a role (Kwasnicka et al., 2013; Scholz, Sniehotta, Burkert, & Schwarzer, 2007; Sniehotta, Schwarzer, et al., 2005). Coping planning might be a more effective self-regulatory form of behavior than action planning, first, because it implies already developed action plans, and second, to maintain behaviors in the long run, coping planning is a promising strategy (Scholz, Schüz, Ziegelmann, Lippke, & Schwarzer, 2008; Schwarzer et al., 2011; Schwarzer, 2008).

#### *Action Control: In Situ-Self-Regulatory Strategy*

More planning may not *always* result in higher levels of behavior and its maintenance. It should be accompanied by consecutive *action control* (Sniehotta, Schwarzer, et al., 2005), with which “the ongoing behavior is continuously evaluated with regard to a behavioral standard” (Schwarzer et al., 2011, p.165). Within the theoretical framework of HAPA (Schwarzer, 2008), action control is a situ self-regulatory strategy, which operates by self-monitoring one’s progress, comparing performance with goals, and investing more effort if needed (Sniehotta, Schwarzer, et al., 2005). It particularly contributes to the maintenance of a behavior as well as to the prevention of relapses.



Research has shown self-monitoring to be the most effective component of action control. Moreover, whereas planning is a prospective strategy, that is, behavioral plans are made before the situation is encountered; action control is a concurrent self-regulatory strategy, where the ongoing behavior is continuously evaluated with regard to a behavioral standard. Action control facilitates adherence to health-related behaviors including dental flossing (Schüz et al., 2007; Suresh et al., 2012). Furthermore, recent evidence emphasizes the relevance of action control for health behavior change in various domains (Godinho, Alvarez, Lima, & Schwarzer, 2014; Schwarzer et al., 2015).

Hence, research has provided compelling evidence on the beneficial effects of the psychological factors derived from HAPA on a range of health behaviors. However, regular health behaviors have rarely systematically been studied before among the Indian population, and therefore, in order to enhance their use, they need to be studied with social cognitive theory-based interventions.

### *Reporting the Intervention Contents*

Interventions to change behavior are generally complex, involving many interacting components (Moore et al., 2015) and there are challenges in identifying the active, effective components within them (Michie et al., 2013). Thus, to obtain the best health behavior change, researchers need a theory to identify the best predictors that promote health behavior change and they need to investigate the way in which they operate to develop interventions. Such theory-based interventions can aid understanding of why some interventions are effective whereas others are ineffective in providing an understanding of the underlying working mechanisms of behavior change (Michie & West, 2013). Moreover, in intervention studies, a lack of clarity and detail regarding the intervention content being

evaluated causes problems related to a lack of consistency and consensus (Michie et al., 2013). To minimize this substantial problem in the literature, there has been a call for more precision and detail in the reporting of content of the intervention components (Abraham & Michie, 2008).

The content of the intervention packages used in each studies of the current thesis will be defined and reported in terms of behavior change techniques (*BCTs*; Abraham & Michie, 2008; Michie et al., 2013). Furthermore, the compatibility of the HAPA potential constructs with active BCTs will be also compared in the course of the current thesis. The BCT is defined as “an observable, replicable, and irreducible component of an intervention designed to alter or redirect causal processes that regulate behavior; that is, a technique is proposed to be an ‘active ingredient’” (Michie et al., 2013, p.23). Authors further claim that BCTs can be used alone as well as in combination in a variety of formats and can be delivered by an “interventionist” or self-delivered. Effective BCTs have been accordingly identified for interventions to improve a range of health related behaviors, and using multiple BCTs to target pre- and post-intentional predictors of behavior is a common approach in behavior change interventions.

In the motivational condition (*Mot*), the leading components in terms of BCT are 4.1, e.g., the recommendations on healthy nutrition, such as the consumption of at least five portions of FV per day in *chapter 2* in accordance with World Health Organization (WHO) recommendations. The information about oral hygiene is based on the American Dental Association (ADA) in *chapter 3*. The instruction on why and how to wash the hands properly in *chapter 4* were adopted from the webpage of the Centers for Disease Control and Prevention (CDC, 2015). BCT 5.1 included general information addressing the benefits of action and behavioral risks of inaction, focusing on what will happen if the person complies

with the particular health behavior recommendations. For example, in the case of *chapter 2*, susceptibility to obesity or cardiovascular diseases due to insufficient intake of FV and positive outcomes as a result of taking enough fruit or vegetables are emphasized. In BCT 1.3, it consists of a prompt to intention formation, encouraging participants to decide to act or set a general goal. For example, it encourages the participants to make a behavioral resolution such as “I will floss two times every day in addition to brushing” (in case of *chapter 3*).

In the self-regulatory condition (*SelfR*), in addition to the similar information about the particular behaviors regarding the instructions, the intervention package was focused on self-regulatory skills including self-efficacy, action and coping planning, and action control. In BCT 1.4, the general structure for this technique was formulated as “have you made a plan on (behavior performance, e.g., washing your hands) to be (outcome e.g., free of germs? If so, please indicate here your most important plans regarding... how often (frequency), ...when (time), ...how long (duration)”. In particular, individuals were asked specifically to generate plans for consuming FV (example from *chapter 2*), specifying the place, accompanying person, the time or meal, day of the week, and which kind of fruit and vegetable they wanted to consume (using questions asking where, with whom, which meal or time, when and what).

BCT 1.2 involved generating three coping plans, which included both barrier identification and problem-solving behavior that may help individuals to identify barriers to performing the behavior. This instrument was formulated as; “If I face difficult situations that might prevent me (*critical events* in performing the particular behavior), then I plan to overcome them by (*coping strategy*)”. They were asked to think of two situations that may impede the planned behavior, and a strategy to overcome such barriers. An example from *chapter 2* is “If I ran out of vegetables to make salad for lunch, then I will have fruit at the

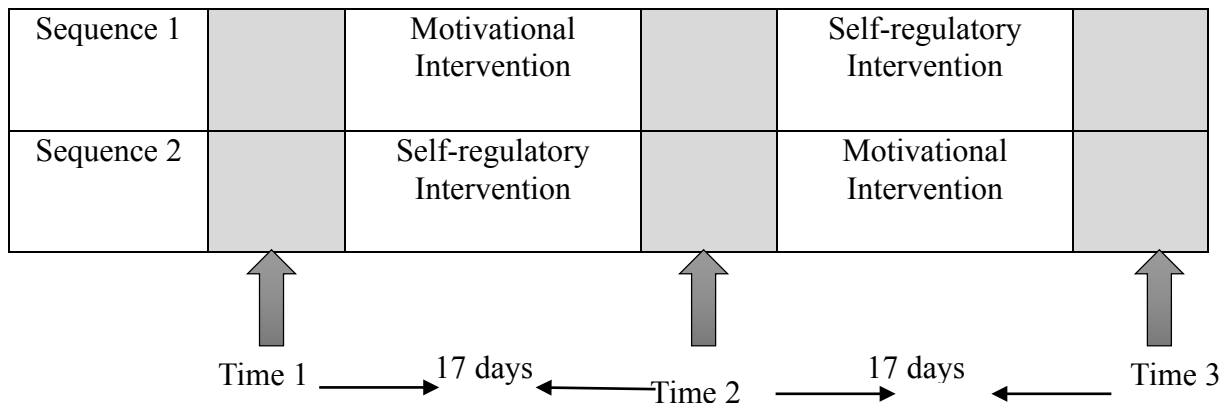
end of my meal”. An example of coping planning from *chapter 3* includes “If I face difficult situations that might prevent me from washing my hands, then I plan to overcome them by making hygiene my priority”. In addition, after each of the three situations (action and coping plans), an item (“How certain are you that you can follow these plans?”) instructed participants to rate their perceived ability to follow through with the plan on a 4-point scale. These items were designed to boost self-efficacy.

To compare their performance with goals and to increase mastery experience, participants are prompted to review and visualize their past successes (“which success experiences did you have in (performing the particular behavior; e.g., washing your hands regularly? Please write here”). BCT 2.3 involves a self-monitoring of behavior, so people in the self-regulation condition will be given calendars (dietary calendars for FVI in *chapter 2*, dental calendars in case of dental flossing in *chapter 3* and *chapter 5*) with suggestion to record their behavior performance during the study period. In *chapter 5*, BCT 10.1, material incentives in the form of free dental treatment access was given to the participants in the intervention group during the study period.

Finally, providing accessible resources is an obvious necessary component of any hand hygiene intervention (Mariwah et al., 2012; Pincock et al., 2012), and therefore, to serve the study’s purposes, soaps and soap solutions will be provided in every toilet and washing areas for the hand hygiene study in *chapter 4*. Moreover, 2 meters of Colgate waxed dental floss for oral hygiene was provided for the oral self-care study in *chapter 3* as part of a self-regulatory package.

Therefore, through a sequential intervention design in *chapter 2*, *chapter 3*, and *chapter 4*, both types of intervention components will be provided to all participants, either in

the hypothesized correct order or in the reversed order (MotSelfR versus SelfRMot, see *Figure 3*).



*Figure 3.* Intervention sequence designs for the first three studies (*chapter 2, 3, and 4*).

In *chapter 5*, after the baseline measurement of all study participants, a trained research associate delivered the interventions for those participants who were in the intervention group during outpatient visits at the hospital, whereas patients in the control group received no treatment. The intervention consisted of two combined components, a brief psychosocial-based component and an incentive-based component in the form of a free dental treatment including checkups, dentures, removing of caries, fillings, and dental aids free of charge during the study period. The psychosocial component comprised self-management cues targeting self-efficacy and self-regulatory skills with the purpose of exploring the feasibility of a very brief intervention of a one-minute conducted by Sniehotta et al., (2007) in changing oral self-care. Thus, our intervention package was a two-sided page leaflet that included detailed information on why and how to perform oral self-care, which were adopted from the American Dental Association (ADA). This was followed by instructions to participants to generate their own concrete action and coping plans for dental flossing. To

boost their self-efficacy, participants were instructed to rate their perceived ability to follow their plans through a 4-point scaled item; “How certain are you that you can follow these plans?” In terms of BCTs, the leading components were goal setting (BCT 1.1), instructions on how to practice oral self-care (BCT 4.1), information about health consequences (BCT 5.1), information about planning (BCT 1.2 and 1.4), and the self-efficacy booster (Michie et al., 2013). However, the planning and goal setting were used as part of an intervention package and not as assessment tools for this study.

It is possible that the cash received by the participants as part of a health promotion scheme may be abused, and the literature also suggest that cash incentives may lower intrinsic motivation in changing behavior (Giles, Sniehotta, et al., 2015). Taking these obstacles into consideration, I preferred an incentive in the form of free non-cash over direct financial incentives for the behavior change. Therefore, the incentive component of this study comprised a free dental care assistance incentive in the form of free dentures and dental treatment. This was made available through a scheme called Muskan Yojna, launched by the Department of Public Health Dentistry with the purpose of giving patients below the poverty line easy access to oral care.

### *Objectives of the Present Thesis*

Does it make a difference in the outcome in which order the interventions derived from HAPA are presented? What if potential predictors are combined with other facilitators such as incentives will that change the behaviors? Investigating these questions, the present thesis aims to contribute to the elucidation and facilitation of intervention components derived from the HAPA model in changing health related behaviors.

*(I) Motivation or Self-Regulation: Sequential-Specific Interventions (SSI)*

As stated already that a behavioral intention needs to be formed first before they can adopt and maintain the actually intended behavior. According to which an intervention sequence starting with motivation and followed by self-regulation is the most intuitive one. However, in the case of already motivated individuals, they might perceive motivational content as redundant and feel patronized by motivational messages because they are beyond that stage. In such cases, exposing the individuals directly to a self-regulatory intervention would be a better and more parsimonious option.

Despite the availability of numerous intervention studies based on the HAPA model (see reviews by Brunstein, A., Brunstein, J., & Martin, 2014; Smith et al., 2014), to the best of our knowledge none have explored the question of validity of a sequential intervention whether the order by two phases within HAPA model (i.e., motivation and self-regulation) are delivered, is relevant for the effectiveness of health-related behavior change promotion. Therefore, I will address the following research questions to address the sequential intervention validity:

- 1. Intervention sequential-specific question: Would it make a difference in which order motivational and self-regulatory intervention modules are presented to improve regular health behaviors?*

Is one intervention sequence (e.g., motivational followed by self-regulation; Mot-SelfR) better than the opposite sequence (e.g., self-regulation followed by motivational; SelfR-Mot) in changing regular health behaviors? If so, what are the ingredients that make the differences in the intervention effectiveness?

In order to answer these sequential-specific intervention (ISS) questions, the following hypothesis were tested through the first three studies of this thesis. *Chapter*

2, *chapter 3* and *chapter 4*, were conducted in the spring of 2013 between March 2013 to April 2013 in the student residences of New Delhi University, North India. The same participants were recruited for all three studies and verified in different behavior domains, namely the promotion of FVI in *Chapter 2*, handwashing in *Chapter 3*, and oral self-care in *Chapter 4*.

*Chapter 2:* (1a) Comparison of two subsequent intervention sequences (motivational components: Mot, and self-regulatory components: SelfR), placed in different order (MotSelfR Versus SelfRMot) will be explored and examined in the context of FVI.

*Chapter 3:* (1b) The effectiveness of a set of two brief theory-based psychological intervention arms (MotSelfR Versus SelfRMot) are designed and evaluated to improve hand hygiene, specifically handwashing.

*Chapter 4:* (1c) The effectiveness of two-sequential interventions, MotSelfR versus SelfRMot were explored in a randomized crossover design and the advantages of one sequence over the other were evaluated to adopt an oral self-care regimen.

2. *Which of a self-regulation intervention or a motivation one is more effective to facilitate health behavior change, which active ingredients are responsible for its effectiveness?*

In order to answer this question, the following objectives will be tested to unveil the underlying mechanisms that might explain why one intervention sequence operates better than the other, inspecting the psychological processes by which the various intervention contents impact behavior change.



*Chapter 2:* (2d) The effects of self-regulatory components (i.e., self-efficacy and action planning and coping planning) and the motivational component (i.e., intention) in improving FVI were tested in an experimental setting. Additionally, the putative mechanism of changes in dietary intention and self-efficacy and their putative role within a sequential mediation model between the intervention groups and FVI are tested.

*Chapter 3:* (2e) The effects of a self-regulatory intervention module consisting of self-efficacy and planning on hand hygiene promotion are tested in a cross-over longitudinal design against a motivational module consisting intention.

*Chapter 4:* (2f) Differences from the intervention effects should result in changes in behavior (i.e., oral self-care) as well as changes in mindsets, as reflected in the increase in the dental self-efficacy, planning, and action control.

*(II) Incentive based-Intervention to promote Oral Hygiene: Combination-Specific*

It is suggested that in addition to provide financial incentives, raising people's self-efficacy and providing them with very brief self-regulatory skills may increase their motivation to translate the intention into action and such behavior change program will provide the most effective behavior change (Cerasoli et al., 2014; Giles, Robalino, et al., 2015; Sniehotta et al., 2007). Hence, the fourth study in *chapter 5* in this thesis was conducted, where an intervention group was compared with a passive control group to test the following hypothesis concerning *component-combined specific intervention (CCSI)*;

1. *Components combined-specific intervention: Can a brief oral health promotion program in combination with an incentive facilitate the adoption of regular dental flossing in individuals diagnosed with periodontal diseases? Will the effects of this incentive-based intervention differ from a control group?*

*Chapter 5:* (3g) Effects of minimal self-management cues (focusing self-efficacy and self-regulatory skills) in combination with an incentive (free dental treatment) to improve dental flossing frequency were compared against a passive control group in a Randomized Control Trial (RCT) design.

(3h) The underlying working mechanism of changes in self-efficacy and intention will be investigated via sequential mediation.

These main objectives (I and II) with the respective sub-hypothesis (*1a* to *3h*) of the present dissertation are addressed and elaborated more in detail in each empirical chapter.

The content of each chapter and the specific constructs are summarized in Figure 4.

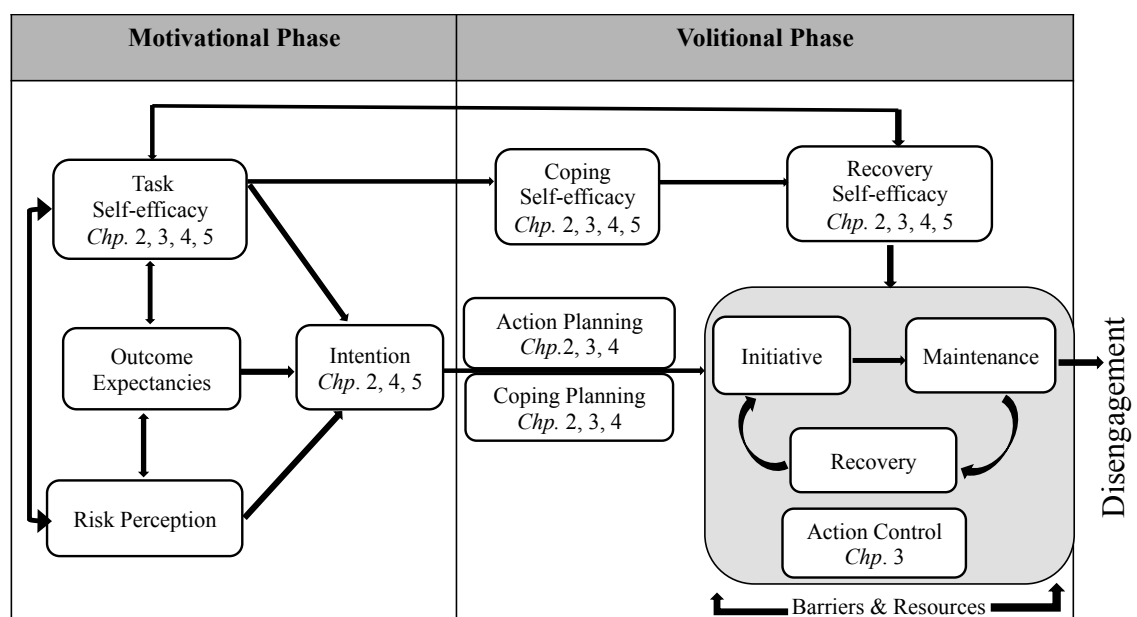


Figure 4. Content of chapters' (*Chap.*) within the Health Action Process Approach model.

### Outline of this Thesis

As stated earlier that improved hand hygiene has the potential to reduce the extensive spread of infectious diseases and enough consumption of FV reduces cardiovascular diseases, cancers, and prevents several micronutrient deficiencies. However, the adherence to a frequent proper handwashing or regular intake of FV is low. Similarly, the

burden of periodontal disease ranges from 50% to 100% because of non-adherence to complete oral self-care (Madan et al., 2014). Consequently, the prevalence of a range of diseases due to inadequate preventive strategies has become a major public health concern in the “transition India” of today. Hence, this thesis presents four stand-alone studies to increase fruit and vegetable consumption, to promote hand hygiene, and to improve oral self-care with different intervention designs through motivational, self-regulatory, and incentive-based interventions among Indian population. The structure of the empirical chapters is demonstrated in Figure 5.

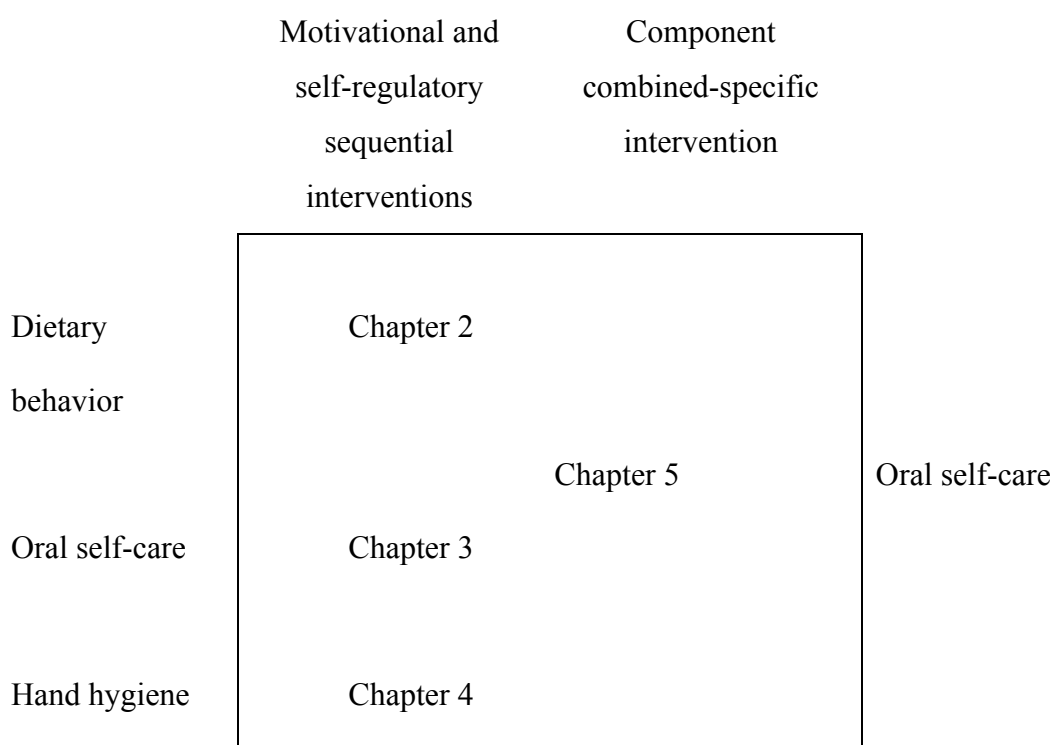


Figure 5. Structure of the empirical chapters.

In the first study in *Chapter 2*, a motivational and self-regulatory groups will be compared to test their efficacy in terms of increasing FVI with a crossover randomized

controlled design. The primary outcome was FVI, whereas self-efficacy and dietary intention were hypothesized to be mediators. In the second study in *Chapter 3*, by a cluster randomization, the sequential interventions were compared in relation to increasing oral self-care, taking dental flossing as an example. Furthermore, the changes in terms of flossing frequency, planning, self-efficacy, and action control levels were assessed at all three measurement points. Similar sequential intervention designs, but in the context of hand hygiene, were applied in the third study in *Chapter 4*, taking handwashing as an example in this case. Handwashing frequency served as a dependent variable, whereas intention, self-efficacy, and planning served as intermediate outcomes.

The intervention procedures for first three studies were such that I implemented the intervention sequences after the baseline measurement. Intervention sequence group 1 (*Mot-SelfR*) received a written motivational module after the baseline measurement (Time 1; T1) and a written self-regulatory module after the post-test (Time 2; T2). The intervention sequence group 2 (*SelfR-Mot*) was treated with a self-regulatory module after the baseline measurement, followed by a motivational module after T2. Follow-up data (Time 3; T3) from both the groups were assessed 17 days from T2 to T3 and 34 days after the baseline T1. The interventionist directly delivered the interventions to the participants together with four student research assistants, who were blinded completely and, therefore, were not aware of the aims, intervention content, and any other information that could bias the results. Nevertheless, the interventionist resided with the participants during the whole study period and observed the students practicing and engaging in the intervention modules. Each intervention session lasted 20 minutes, and the measurement intervals were approximately similar for all three studies.

Furthermore, the essential roles of incentives in the behavior change process (Giles et al., 2014) showed important for facilitating and maintaining behavioral gains. Hence, the fourth study in *Chapter 5* will explore the effectiveness of an oral health promotion intervention group (combining incentives with motivational techniques inspired by the HAPA) with a control in the adoption of interdental cleaning (taking dental flossing as an example) in a population below the poverty line, already diagnosed with periodontal diseases. In detail, the participants (N = 116, age ranging from 18 to 69 years) were recruited between October and December 2014 during their dental outpatient visits at the Dental College and Hospital, Shimla, Himachal Pradesh, North India. The primary outcome was dental flossing frequency, and self-efficacy and intention served as mediators. After the baseline (Time 1), the intervention group received theory-guided materials and free dental treatment. Follow-up assessment was to be performed three weeks later (Time 2). It was assumed that a brief incentive-based self-regulatory intervention would have beneficial effects on oral self-care behavior of people at further oral disease risks. Furthermore, I hypothesized sequential mediating roles of self-efficacy and intention between intervention conditions and behavioral outcomes.

Therefore, *chapter 2*, *chapter 3*, *chapter 4*, and *chapter 5* are written for publication in journals and can each be read as stand-alone chapters in any desired order and can be understood without prior knowledge of the other chapters. *Chapter 6* summarizes the general discussion of the main findings from the empirical chapters and, draws conclusions where the limitations are commented on and the implications of the HAPA theory in intervention development and the evaluation of health behavior change are highlighted. Moreover, here suggestions for evaluating theory-based interventions and for developing research in the future, and advice for public health practices are also laid out.

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# 2

## A Brief Intervention Increases Fruit and Vegetable Intake: A Comparison of Two Intervention Sequences

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Lhakang, P., Godinho, C., Knoll, N., and Schwarzer, R. (2014). A self-regulatory intervention increases fruit and vegetable intake: A comparison of two intervention sequences. *Appetite*, 82(2014) 103–110. [doi:10.1016/j.appet.2014.07.014](https://doi.org/10.1016/j.appet.2014.07.014)

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### Abstract

*Background and Purpose:* To evaluate the effectiveness of two subsequent intervention components (motivational and self-regulatory components), placed in different order, to promote fruit and vegetable (FV) intake.

*Methods:* After baseline assessment, university students (N = 205, aged 18–26 years) were allocated to two groups. One group received a motivational intervention (outcome expectancies, risk perception, and task self-efficacy) followed by a self-regulatory intervention (planning and dietary self-efficacy) after 17 days. The second group received the same intervention conditions in the opposite order. Follow-up assessments were done after another 17 days.

*Results:* Both intervention sequences yielded gains in terms of FV intake and self-efficacy. However, this gain was only due to the self-regulatory component whereas the motivational component did not contribute to the changes. Moreover, changes in intention and self-efficacy mediated between intervention sequence and follow-up behavior, suggesting that improving these proximal predictors of FV intake was responsible for the behavioral gains.

*Conclusions:* Findings highlight the superiority of a self-regulatory intervention over a motivational intervention when it comes to dietary changes in this sample of young adults.

Moreover, changes in dietary self-efficacy may drive nutritional changes

*Keywords:*

Fruit, Vegetables, Motivation, Self-regulation, Self-efficacy, and Planning

## Introduction

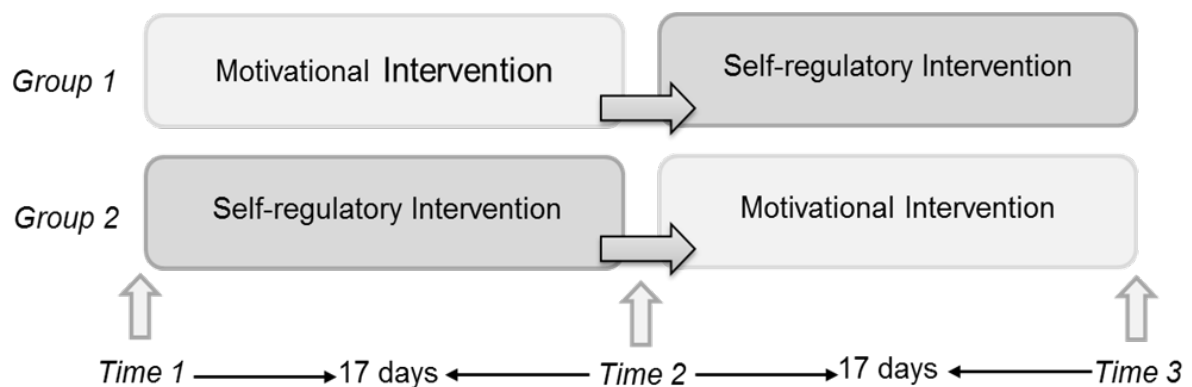
Underscoring the benefits of consuming a sufficient amount of fruit and vegetables (FV), a World Health Organization (WHO) review on the effectiveness of interventions and programs promoting FV intake showed that consumption of FV reduces cardiovascular diseases, cancers, diabetes, obesity and prevents several micronutrient deficiencies, especially in less developed countries (Pomerleau, Lock, Knai, & McKee, 2005). However, most people do not attain the recommendation of a minimum of 400 g of FV per day (i.e., approximately five portions). Moreover, this review highlights the need for data collection on FV intervention effectiveness in the majority of countries. India is a vast subcontinent covering 2.4% of the global landmass, it is inhabited by more than one-sixth of the world's population. Currently, the country is undergoing a rapid socio-economic, demographic, and health transition. For instance, over the last two decades, preventive nutrition has emerged as a public health concern; there have been increases in the prevalence of obesity, diabetes, and cardiovascular diseases, especially in urban areas (Ramachandran, 2006).

Thus, evidence-based interventions are needed for the promotion of FV intake, as well as an understanding of the underlying working mechanisms of intervention effectiveness. In addition to basic nutritional knowledge, both motivation and self-regulation are required for people to change their habitual dietary patterns (Adriaanse, Vinkers, De Ridder, Hox, & De Wit, 2011; Verhoeven, Adriaanse, Evers, & De Ridder, 2012).

### *Motivational and self-regulatory mechanisms of health behavior change*

Health behavior change is a complex process that involves a multitude of causal factors. From a psychological standpoint, both an initial motivation to change, followed by self-regulatory efforts are needed to change health behaviors, including FV intake. The health action process approach (HAPA; Schwarzer, 2008), a model of the adoption and maintenance

of health behaviors, suggests two phases of change, namely (a) a motivational phase (where the most relevant variables are risk perception, outcome expectancies, and task self-efficacy) and (b) a self-regulatory phase (where the most relevant variables are maintenance self-efficacy, planning, and action control). The first phase leads to a behavioral intention, whereas the second phase reflects the translation of the intention into actual behaviors.



*Figure 1.* Illustration of the sequential, crossover research design with two groups that receive both interventions in different order (Group 1 = Motivation → Self-regulation Sequence, Group 2 = Self-regulation → Motivation Sequence).

*Risk perception* can be a starting point for contemplating health behavior change in some cases, but it is considered negligible in the context of FV consumption (Schwarzer et al., 2007). *Outcome expectancies* are the pros and cons expected by adopting (or not adopting) the health behavior, but they lose their predictive power after a personal decision has been made – an intention formed. To form a behavioral intention, one also needs to believe in one’s capability of performing a desired action (i.e., task self-efficacy). Perceived self-efficacy is the confidence in one’s ability to execute a difficult or resource-demanding behavior (Bandura, 1997). Self-efficacy plays a critical role in health behavior initiation and maintenance by directly influencing health behavior and by affecting several other determinants (Bandura, 2004). Various experimental studies have shown that self-efficacy

interventions help to increase FV intake which attests that self-efficacy is an operative construct that facilitates self-regulation processes such as effort and persistence (Luszczynska, Tryburcy, & Schwarzer, 2007). Self-efficacy plays an important role in the long-term adherence to healthy dietary practices (Mosher, Lipkus, Sloane, Snyder, Lobach, & Demark-Wahnefried, 2013).

To translate the intention into action requires self-regulatory beliefs and strategies, in particular self-efficacy and planning (Hagger & Luszczynska, 2014). Action *planning* refers to the when, where, and how of an intended behavior, whereas *coping planning* pertains to the anticipation of barriers and ways to overcome them (Kwasnicka, Premeau, White, & Sniehotka, 2013). A great deal of research has documented the pivotal role of planning as a self-regulatory strategy in health behavior change (for a review, see Hagger, & Luszczynska, 2014), and planning as a mediator between intention and action as well (e.g., Gholami, Lange, Luszczynska, Knoll, & Schwarzer, 2013; Godinho, Alvarez, Lima, & Schwarzer, 2013).

*Intervention working mechanisms:* Research not only needs to identify factors that promote health behavior change, but also the way in which they operate. According to the HAPA, a motivational intervention should precede a self-regulatory intervention. Participants should first be made aware of the risks of poor nutrition as well as the benefits of consuming the recommended amount of FV and be encouraged to adopt better nutritional habits. Afterwards when they have formed a behavioral intention they should be guided to increase their dietary self-efficacy level and generate dietary plans. A study on adherence to dental flossing among young adults highlighted the advantage of a self-regulatory intervention following a motivational dental flossing intervention (Lakhang, Gholami, Knoll & Schwarzer, 2014, under review). However, research has not addressed the validity of such a sequence on FV intake.

Based on the assumption that motivational processes precede self-regulatory ones (Schwarzer, 2008), we hypothesize that the order by which intervention components are delivered is relevant for its effectiveness in the promotion of FV intake. More specifically, we hypothesize that an intervention comprising a motivational component followed by a self-regulation one will be more effective than an intervention comprising the same components, but in the opposite order. Therefore, in the present study both types of intervention components will be provided to all participants, either in the hypothesized correct order or in the reversed order (AB versus BA, see Fig. 1).

Moreover, very few intervention studies have tested whether self-efficacy mediates the relation between intention and behavior and, furthermore, whether intention and self-efficacy work jointly as sequential mediators between intervention and behavior. On the basis of prior research (e.g., Luszczynska et al., 2007; Mosher et al., 2013), we hypothesize that changes in intention and self-efficacy for increasing FV intake would mediate the intervention's effect on participants' daily servings of FV.

### *Aims*

The aim of the present study is to compare one intervention sequence (i.e., first motivation and then self-regulation) with the opposite sequence (i.e., first self-regulation and then motivation) in the context of FV consumption (see Fig. 1). Besides, we aim to unveil the mechanisms that might explain why one sequence operates differently than the other, inspecting the psychological processes by which the intervention sequence impacts behavior change.

A longitudinal intervention design with three assessment points over a 34-day period was used to test a series of predictions derived from the HAPA for FV intake.



Hypothesis 1: On average, participants will attain higher levels of FV intake along with an increase in their dietary self-efficacy, (pre-post comparison), independent of group assignment.

Hypothesis 2: At follow-up (Time 3), participants in Sequence 1 (first motivation, then self-regulation) will show a superior pattern of gains over time in terms of FV intake, intention, self-efficacy, and planning, as compared to participants in Sequence 2 (first self-regulation, then motivation).

Hypothesis 3: The increases in intention and in self-efficacy reflect the psychological mechanisms that explain higher FV intake at follow-up, i.e., they mediate the relationship between the intervention groups and FV intake.

Hypothesis 4: Changes in dietary intention and self-efficacy sequentially mediate the relation between the intervention groups and FV intake at Time 3.

Table 1. *Demographic Characteristics of the Sample and their Fruit and Vegetables (FV) Intake (Sequence 1= Motivation →Self-regulation, Sequence 2= Self-regulation → Motivation)*

	Sequence 1 ( <i>n</i> = 94)	Sequence 2 ( <i>n</i> = 111)	Whole sample ( <i>n</i> = 205)
FV intake T1 (Mean, standard deviation)	-	-	4.82 (2.07)
Age (Mean, standard deviation)	19.8 (1.3)	21.4 (1.4)	-
Gender ( <i>N</i> Female/Male)	49/45	57/54	-
Education ( <i>N</i> science / commerce / humanities)	37/33/24	44/39/28	-
Nationality ( <i>N</i> Indian origin/ Immigrant in India)	19/75	25/86	-

## Method

### *Participants*

Participants (106 women, 99 men; mean age = 20.7 years with  $SD = 1.57$  and range of 18 to 26 years) were recruited from a university student residence in New Delhi, India, through a notice by the student council board of the university, with authority permission (Table 1).

### *Research design*

The study was conducted over a time span of six weeks from March 2013 to April 2013 with three assessment points in time. The experiment followed APA ethical principles regarding research with human participants. Participants were randomly allocated to two sequences of intervention groups (see Fig. 2), Sequence 1 and Sequence 2 using a crossover randomized controlled design. Sequence 1 group received a motivational package after the baseline measurement (Time1; T1) and a self-regulatory intervention after the post-test (Time 2; T2). The Sequence 2 group received a self-regulatory intervention after the baseline assessment, followed by the motivational component at T2. The measurement intervals were 17 days from T1 to T2, and 17 days from T2 to Time 3 (T3).

### *Procedure*

#### *Session 1 (baseline assessment and first intervention component)*

A total of 231 students were recruited and informed about the study. Following recruitment seven individuals refused to join the program. Thus, 224 participants were allocated to two intervention groups (see Fig. 1), namely Sequence 1 and Sequence 2 groups. Four student research assistants helped in conducting the study; they were blinded completely and therefore not made aware of the aims, intervention packages and any other information that could bias the results. Each session began with filling in a self-administered questionnaire assessing socio-demographic information (e.g., age, gender, educational

background and nationality), FV intake, intention, and dietary self-efficacy levels in the same session. After the baseline assessment, the Sequence 1 group first received the motivational package whereas the Sequence 2 group first received the self-regulatory package.

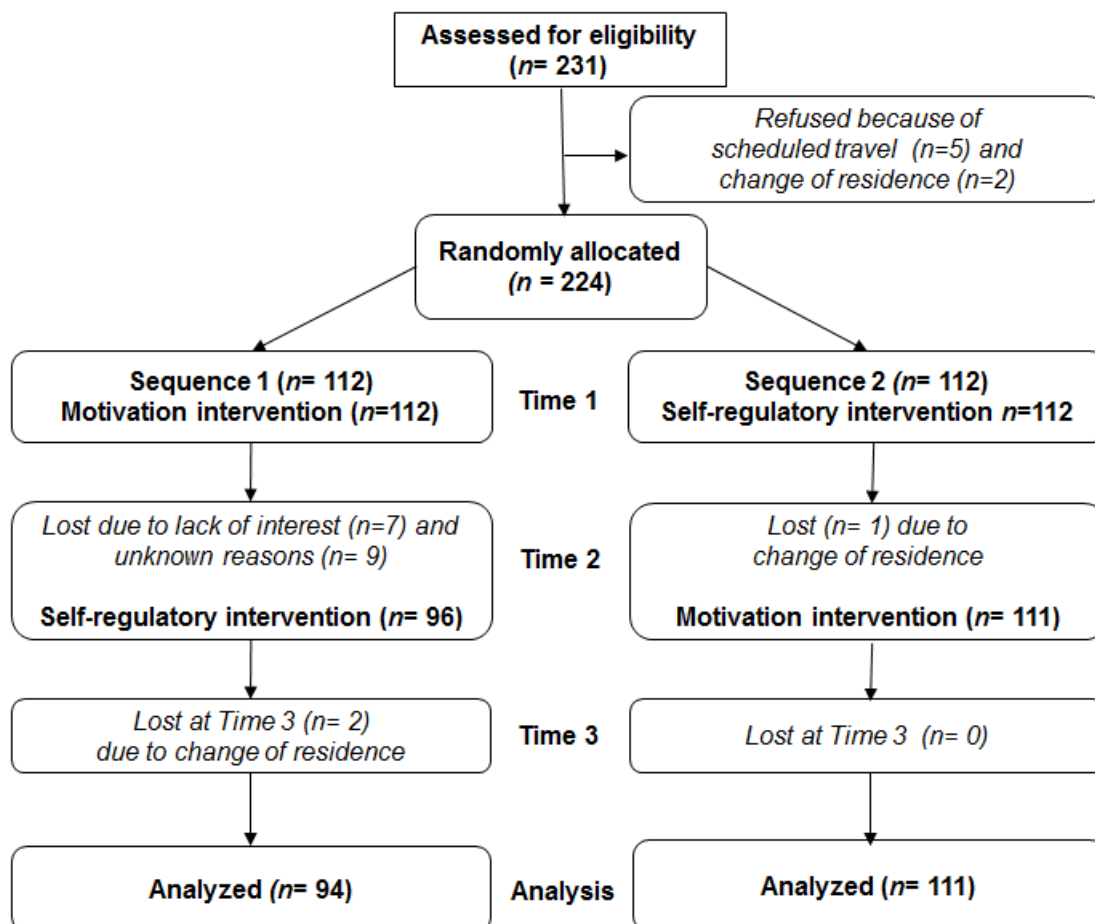


Figure 2. CONSORT flow chart.

### Session 2 (post-test assessment and second intervention component)

Seventeen days later, participants were re-invited to the study and followed the same procedure. At T2, the same assessment as before, a self-report of FV intake and social-cognitive variables, was applied to both groups (N = 207) prior to the intervention sessions. Then, interventions were reversed, i.e., participants in Sequence 2 were treated with the

motivational condition whereas the participants in Sequence 1 were treated with the self-regulatory condition.

### *Session 3 (follow-up assessment)*

Participants were requested to reconvene after another 17 days for the T3 assessments. They received the same self-administered questionnaire assessing their FV intake frequency over the past two weeks, in conjunction with the social-cognitive variables. The post-test (T3) questionnaire was completed by 205 participants.

### *Measures*

*FV intake* was measured with two open answered items: “during the last week, I have eaten...portions of fruit a day”, and “During the last week, I have eaten.....portions of vegetables a day”. One portion of FV was defined as equivalent to one handful of chopped apple or any vegetables, for instance.

*Dietary self-efficacy* was assessed with three items with the stem “I am confident that I can eat fruit and vegetables regularly on a long-term basis . . .” followed by “even when I cannot see any positive changes immediately”, “even when it costs some extra money”, and “even when it takes a long time to become part of my daily routine”. Internal consistencies were satisfactory at T1 ( $\alpha = 0.70$ ), T2 ( $\alpha = 0.88$ ) and T3 ( $\alpha = 0.75$ ).

*Dietary intention* was assessed with two items with the stem “I intend to eat fruit and vegetables regularly...” followed by “more than five portions a day”, and “at least five portions a day”. Internal consistencies were satisfactory at T1 (Spearman’s  $\rho = 0.62$ ), T2 ( $\rho = 0.61$ ), and T3 ( $\rho = 0.53$ ).

*Dietary planning* was assessed with six items, three items measuring action planning and three items measuring coping planning. For action planning, the item stem “I have made a concrete and detailed plan regarding.” was followed by the items “when and where to eat

fruit or vegetable (at which occasion)", "which and how much (fruit or vegetables) to eat", and "with whom to eat fruit and vegetables". For coping planning, the item stem "To keep my nutrition habit in difficult situations, I have made a concrete plan regarding..." was followed by the items "what to do if something interferes with my goal of eating required fruit and vegetables", "what to do when there is not enough fruit or vegetables", and "how to cope with the family diet habits". Internal consistencies were satisfactory at T1 ( $\alpha = 0.74$ ), T2 ( $\alpha = 0.89$ ) and T3 ( $\alpha = 0.81$ ).

Responses were rated on a four-point Likert-type scale ranging from (1) not at all true to (4) exactly true. Questions were adapted from Schwarzer (2008). The inventory was in English because it is the first and official language for the participants.

*Intervention content: motivational and self-regulatory conditions*

Intervention content is described in terms of the *Behavior Change Techniques* (BCT; Michie et al., 2013). In the motivational condition, participants received a package containing the World Health Organization (WHO) recommendations on healthy nutrition, e.g., consumption of at least five portions of FV per day (BCT 8). General information about the behavioral risk, for example, susceptibility to obesity or cardiovascular diseases due to insufficient intake of FV (BCTs 1 and 2). Then information about the benefits and costs of action or inaction, focusing on what will happen if the person does or does not perform the behavior. Moreover, participants were asked to specifically visualize three benefits of FV intake such as 'If I take enough fruit or vegetables every day, then I'll have a balanced physical health'. Finally, they received a prompt to intention formation, encouraging the person to decide to act or set a general goal, for example, to make a behavioral resolution such as "I will eat five portions of fruit and vegetables every day"(BCT 4; Michie et al., 2013).

In the self-regulatory condition, participants received an intervention package which covered the BCTs similar to the motivation condition and instructions on how to perform the behavior, e.g., taking an extra serving of vegetables or a side salad with lunch. The self-regulatory intervention focused on self-efficacy and planning, giving tasks that may help participants to execute the critical action and increase their FV intake. In line with BCT 5, the intervention provided a prompt for barrier identification, stimulating people to identify barriers of not performing the behavior and generating plans to overcome them. Following BCT 10 recommendations the intervention prompted specific goal setting, i.e., the request to think about where, when and how to eat FV. Participants were asked specifically to generate plans for two occasions, specifying the place, accompanying person, the time or meal, day of week, and which kind of FV they wanted to consume (by the questions where, with whom, which meal or time, when and what). Moreover, they were asked to evoke two situations which may impede the planned behavior, and a strategy to overcome such barriers (for example, “If I ran out of vegetables to make salad for lunch, then I will have a fruit at the end of my meal”). Also, in accordance with BCT 11, they were prompted to review their goals, by considering previously set intentions. To enhance self-efficacy, they responded to questions such as “How certain are you that you can follow these plans?”

#### *Analytical procedure*

All analyses were run with SPSS 20 and AMOS 20. Dropout analyses compared retained participants with those lost after T1 and T2 using t-tests for continuous measures and  $\chi^2$ - tests for categorical measures. To examine intervention effects, repeated measures analyses of variance (ANOVA) were computed with FV intake, intention, and dietary self-efficacy as dependent variables at three points in time, and the intervention group (Sequence 1 versus Sequence 2) as a between subjects factor. Given that baseline differences in several

variables of interest were found, ANCOVAs were computed with the intervention group as a between-subjects factor and FV intake, intention and dietary self-efficacy at T2 and T3 as dependent variables, with their corresponding T1 measures as covariates.

The mediation model was estimated through structural equation modeling (SEM) with AMOS 20, using the unweighted least squares method. With the exception of intervention type all variables were defined as latent ones. Residualized change scores for intention from T1 to T2 and for self-efficacy from T1 to T3 were defined as sequential mediators between intervention type and FV intake at T3. The baseline level of FV intake was also specified as an independent predictor of FV intake at T3 and was allowed to correlate with intervention type, because baseline differences in FV intake were found between the two groups before the intervention. All parameters were estimated through bootstrapping, generated from 5000 resamples.

## **Results**

### *Randomization check*

Results revealed baseline differences (see *Table 2*) between the two experimental conditions regarding FV intake, self-efficacy, and age at baseline ( $p < .001$ ). Therefore, corresponding T1 measures were used as covariates in all analyses testing group differences in those variables.

### *Manipulation check*

Planning at T2 and T3 in both groups was compared through ANCOVA, in order to control for the baseline differences. As expected, the self-regulatory package proved more effective for the increase in planning than the motivational intervention. At T2, the Sequence 2 group, which had participated in the self-regulation intervention, first obtained a higher level of planning ( $M = 2.72$ ,  $SE = 0.05$ ) than Sequence 1 group, which had only been exposed

to the motivation intervention at this point ( $M = 1.77$ ,  $SE = 0.06$ ),  $F(1, 201) = 154.31$ ,  $p < .001$ ,  $\eta^2 = 0.43$ . Conversely at T3, the Sequence 1 group showed higher planning levels ( $M = 2.93$ ,  $SE = 0.05$ ) after the self-regulatory intervention than Sequence 2 group ( $M = 2.21$ ,  $SE = 0.05$ ) after the motivational intervention,  $F(1, 197) = 92.43$ ,  $p < .001$ ,  $\eta^2 = 0.32$ .

Table 2. Means ( $M$ ) and Standard Deviations ( $SD$ s) of Fruit and Vegetables (FV) Intake as Portions per Day, Self-Efficacy and Planning Levels (Range: 1-4), and Comparison Between Two Intervention Groups at Three Points in Time

	Sequence 1		Sequence 2		t	p	d
	M	SD	M	SD			
<b>FV Intake</b>							
Time 1	4.28	1.89	5.28	2.14	-3.55	<.001	-0.50
Time 2	4.64	1.71	6.73	1.86	-8.24	<.001	-1.16
Time 3	6.91	1.63	5.94	2.05	3.65	<.001	0.52
<b>Self-efficacy</b>							
Time 1	2.11	0.48	2.58	0.65	-5.80	<.001	-0.81
Time 2	2.14	0.64	3.13	0.63	-11.09	<.001	-1.56
Time 3	3.16	0.51	2.72	0.64	5.35	<.001	0.76
<b>Planning</b>							
Time 1	1.73	0.38	2.06	0.52	-5.23	<.001	-0.73
Time 2	1.72	0.49	2.77	0.56	-14.19	<.001	-0.99
Time 3	2.86	0.47	2.26	0.55	8.24	<.001	1.17

#### *Attrition analyses and missing values*

Participants who discontinued after T2 ( $n = 17$ ) and T3 ( $n = 2$ ) did not differ on baseline measures, and were excluded from the longitudinal data analyses.

There were no missing values in baseline (T1) for all variables and missing rates in later assessments (T2 and T3) FV intake and self-efficacy ranged between 0.5% and 3.9%. Missing data were therefore imputed using the Expectation Maximization algorithm in SPSS.



### *Intervention effects*

To describe changes in the two intervention sequences across three points in time, repeated measures ANOVAs were computed for FV intake and dietary self-efficacy. Means, standard deviations, and group comparison statistics are summarized in Table 2 and displayed in Figs 3 and 4. Prior to the intervention, 66% of the participants did not reach the recommended amount of FV intake (5 portions, approximately 400 g/day), with FV intake at baseline for the whole sample  $M = 4.82$  ( $SD = 2.07$ ). No gender differences ( $p = .18$ .) were found.

### *Changes in FV consumption*

A repeated measures ANOVA was applied with FV intake as the dependent variable at three points in time, and group as between- subjects factor. An effect of time emerged,  $F(2, 388) = 45.00, p < .001, \eta^2 = 0.19$  and a treatment sequence effect as well,  $F(1, 194) = 14.35, p < .001, \eta^2 = 0.07$ . Moreover, there was an interaction between treatment and time,  $F(2, 388) = 41.25, p < .001, \eta^2 = 0.18$  (see Fig. 3). In both sequence groups, participants reported more FV intake after being treated with the self-regulatory condition as opposed after being treated with the motivational condition.

Group differences in FV intake at T2 were also tested with ANCOVA, controlling for the baseline. Sequence 2 with the self-regulation intervention obtained a higher level of behavior change ( $M = 6.62, SE = 0.17$ ) than Sequence 1 with motivation intervention ( $M = 4.77, SE = 0.18$ ) with  $F(1, 200) = 54.02, p < .001, \eta^2 = 0.21$ .

However, at T3, after the two groups had received the same intervention components, but in opposite orders, participants of the Sequence 1 group reported higher FV intake levels ( $M = 6.97, SE = 0.20$ ) than those of the Sequence 2 group ( $M = 5.89, SE = 0.19$ ),  $F(1, 194) =$

15.72,  $p < .001$ ,  $\eta^2 = 0.08$ , indicating the superiority of the first one and also indicating the effectiveness of the self-regulation over the motivation intervention on promoting FV intake.

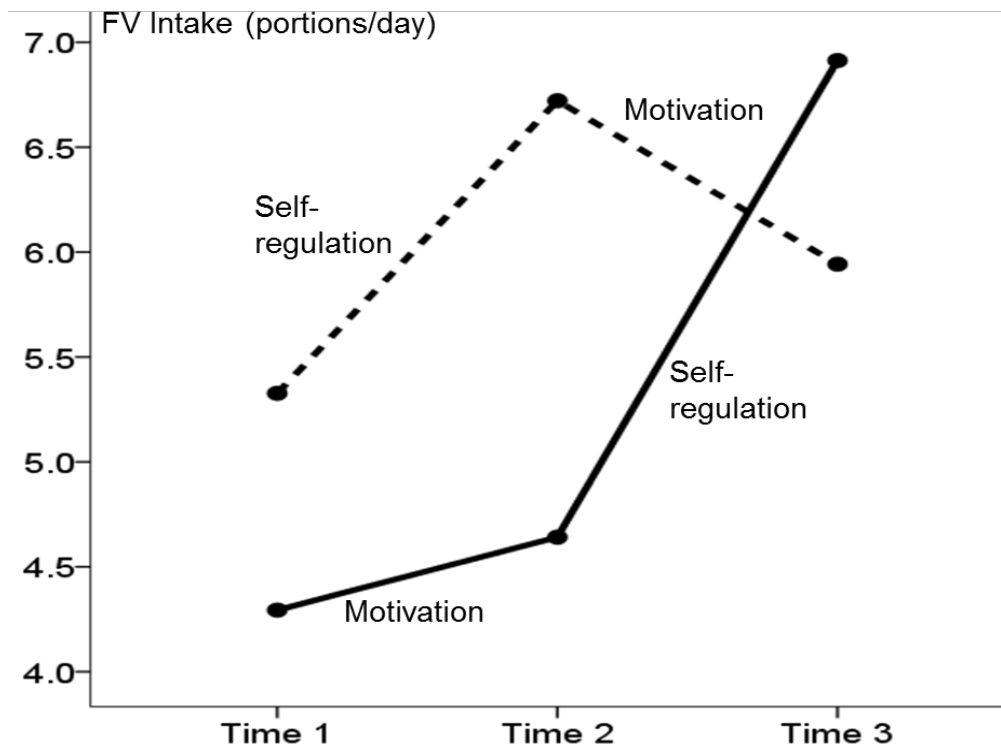


Figure 3. Fruit and vegetables (FV) intake as portions per day at three points in time in two experimental conditions (Group 1 = Motivation → Self-regulation Sequence, Group 2 = Self-regulation → Motivation Sequence).

#### *Changes in dietary self-efficacy*

For self-efficacy, there was an overall sequence effect,  $F(1, 198) = 39.37$ ,  $p < .001$ ,  $\eta^2 = 0.17$  and an effect of time,  $F(2, 396) = 59.61$ ,  $p < .001$ ,  $\eta^2 = 0.23$ . An interaction between treatment and time emerged,  $F(2, 396) = 89.32$ ,  $p < .001$ ,  $\eta^2 = 0.31$ . Figure 4 displays the patterns of differences in self-efficacy changes.

Group differences in self-efficacy at T2 were also tested with ANCOVA, due to the baseline differences. Sequence 2 who had experienced the self-regulation condition first, obtained a higher level of self-efficacy ( $M = 3.11$ ,  $SE = 0.06$ ) than Sequence 1 who had only

received the motivation condition at this point ( $M = 2.17$ ,  $SE = 0.07$ ),  $F(1, 201) = 96.84$ ,  $p < .001$ ,  $\eta^2 = 0.34$ . However, at T3 the opposite pattern emerged. Sequence 1 had higher self-efficacy levels ( $M = 3.18$ ,  $SE = 0.06$ ) than Sequence 2 ( $M = 2.72$ ,  $SE = 0.06$ ),  $F(1, 197) = 27.35$ ,  $p < .001$ ,  $\eta^2 = 0.12$ , indicating that the self-regulation condition was more effective than the motivation condition in changing dietary behaviors.

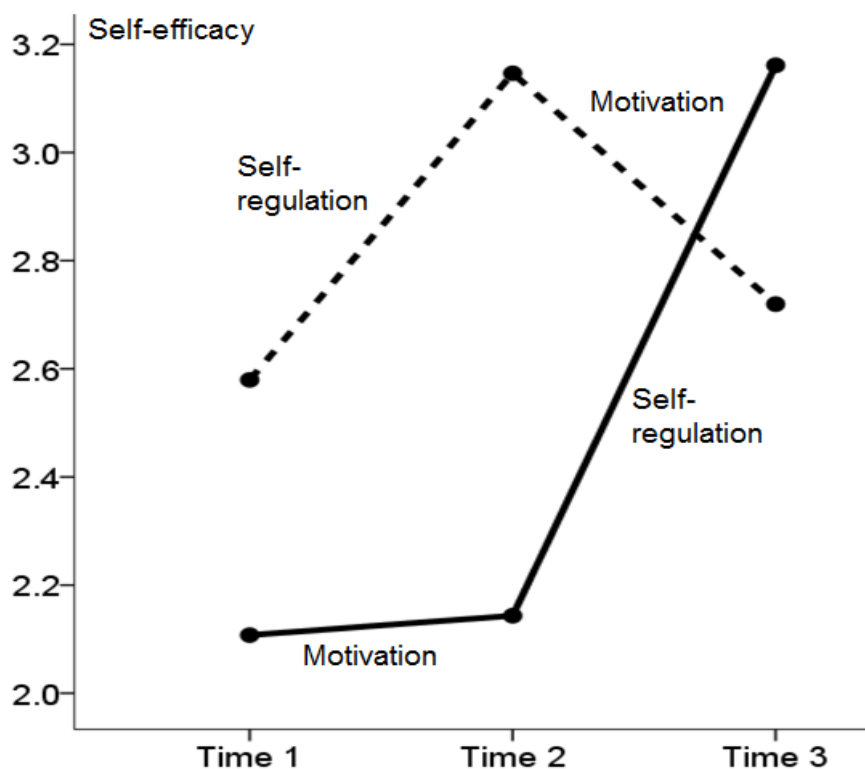


Figure 4. Self-efficacy levels (Range: 1–4) at three points in time in two experimental conditions (Group 1 = Motivation → Self-regulation Sequence, Group 2 = Self-regulation → Motivation Sequence).

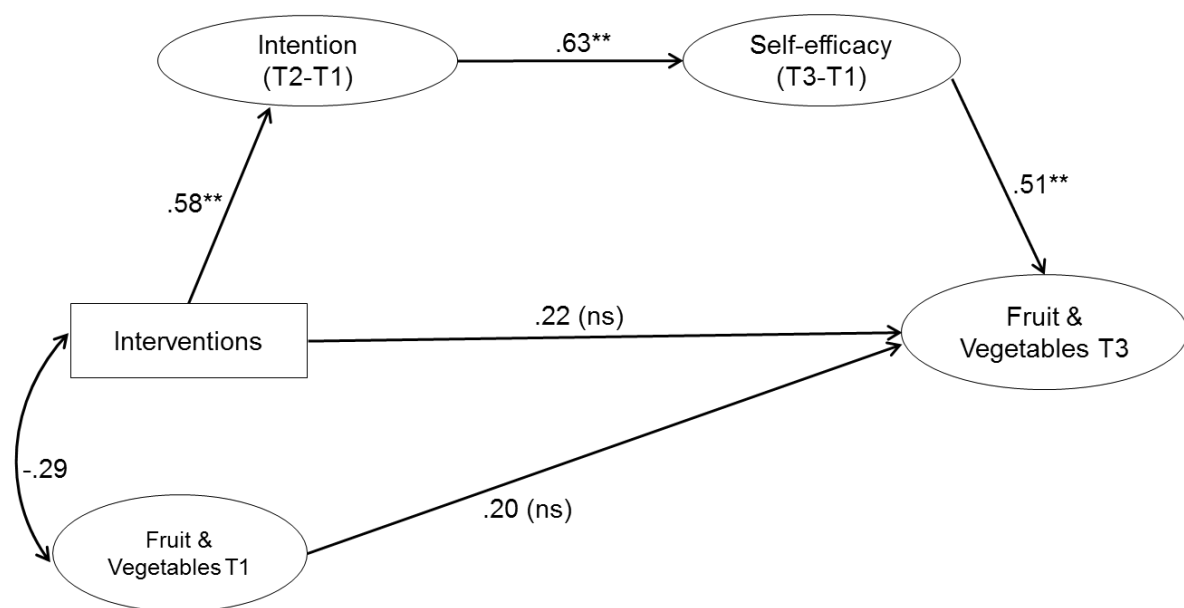
#### Changes in dietary intention

For intention, a main effect of time emerged,  $F(2, 396) = 61.10$ ,  $p < .001$ ,  $\eta^2 = 0.24$ , but no treatment sequence effect,  $F(1, 198) = 0.83$ ,  $p = .36$ , and no interaction between group and time,  $F(2, 396) = 2.12$ ,  $p = .12$ ,  $\eta^2 = 0.01$ .

Group differences in intention at T2 and T3 were tested with ANCOVA. At T2, Sequence 1 with the motivation condition obtained a higher level of intention ( $M = 2.72$ ,  $SE = 0.08$ ) than Sequence 2 with the self-regulation condition ( $M = 2.60$ ,  $SE = 0.07$ ),  $F(1, 201) = 1.29$ ,  $p = .26$ . At T3, an ANCOVA yielded  $F(1, 197) = .12$ ,  $p = .73$ . Sequence 2 had higher intention levels ( $M = 2.92$ ,  $SE = 0.07$ ) after the motivation intervention than Sequence 1 ( $M = 2.88$ ,  $SE = 0.07$ ) following the self-regulation intervention.

### Mediation

The estimated model presented with a good fit:  $\chi^2(30) = 37.05$ ,  $GFI = .98$ ,  $RMR = .06$  (Fig. 5).



*Figure 5.* Sequential mediation of the intervention on FV intake via changes in intentions and self-efficacy. The effect of the intervention sequence on FV intake becomes non-significant after changes in dietary intention and changes in dietary self-efficacy have been specified as a mediator chain, controlling for baseline FV consumption. (Self-regulation followed by motivation = 0; motivation followed by self-regulation = 1). Coefficients are standardized; bootstrapped with 5000 resamples. \*\*  $p < .01$ .

The total effect of the intervention type on FV intake at T3 was  $\beta = .41$ , 95% CI [.17; .72]. As expected, there was a significant indirect effect of the intervention type on FV intake at T3 through an increase in both intention from T1 to T2 and in self-efficacy from T1 to T3,  $\beta = .19$ , 95% CI [.04; .57]. The direct effect was  $\beta = .22$ , 95% CI [-.31; .57], indicating that the effect of intervention on FV intake was fully mediated by sequential changes in intention and self-efficacy.

### Discussion

Prominent theories of health behavior change defend that first individuals need to become motivated to change their health behaviors and only *after* they need to acquire the right skills to implement the intended changes (Schwarzer, 2008; Weinstein & Sandman, 1992), but virtually no prior studies have directly tested this assumption. In the present study, two different interventions providing the same contents (i.e., motivational and self-regulatory), but in two different sequences (Sequence 1: first motivational followed by self-regulatory versus Sequence 2: self-regulatory followed by motivational) were compared in terms of their efficacy on the promotion of FV intake. As expected, Sequence 1 proved to be more effective than the Sequence 2 on the promotion FV intake five weeks later.

Previous studies had already attested to the effectiveness of motivational interventions (Kothe, Mullan, & Butow, 2012; Resnicow et al., 2001) as well as of self-regulatory interventions (Gholami et al., 2013; Lange et al., 2013; Luszczynska et al., 2007; Wiedemann, Lippke, & Schwarzer, 2012) for the promotion of FV intake. Moreover, the combination of motivational intervention components with self-regulatory ones, such as planning, has a long tradition in health behavior change (Leventhal, Singer, & Jones, 1965) and has proven more effective in the promotion of FV intake than a self-efficacy intervention (Luszczynska et al., 2007) or an informational intervention (Stadler, Oettingen, & Gollwitzer,

2010) alone.

When looking closely at the obtained pattern of results for changes in FV intake over time we can observe that, while participants were in the self-regulation part of their intervention conditions, there was a higher increase in both groups than while participants were experiencing the motivational condition. This is theoretically expectable, and similar to what has been found in previous research (e.g., Lakhani, Gholami, Knoll & Schwarzer, 2014) since the intervention ingredients (or target variables) of the self-regulation intervention were the proximal determinants of behavior. Thus, by having an effect on the most proximal causes of behavior, the self-regulation intervention appears to be superior to the motivational one in fostering subsequent FV intake.

Pre-post comparisons have shown that both groups of participants have improved their nutritional behavior as reflected by attaining higher levels of FV intake than before the intervention (Hypothesis 1 supported). Notwithstanding, by T3 both groups had received both interventions, however, in different sequences. And at T3, Sequence 1 was more effective than Sequence 2 supporting the second hypothesis. This result calls attention to the down- sides of “jumping into the causal chain” (Sutton, 2008), revealing what happens when one changes some proximal predictors of behavioral change without changing their former determinants first. In effect, the rise observed in the FV intake after the self-regulatory intervention at T2 for Sequence 2 participants did not hold at T3 when treated with the motivational component. Thus, people may have temporarily increased their FV intake in response to new skills and planning undertaken in the self-regulatory intervention, but they might have lacked the purpose and motivation for keeping up the new nutritional habit. Plus, receiving the motivational intervention at that point did not seem to help. In fact, the motivational intervention had a detrimental effect when delivered after the self-

regulatory one, as attested by the decrease in FV intake in this group at T3.

With Sequence 2, the self-regulation intervention instigated individuals to immediately jump into a post-decisional mindset (Heckhausen & Gollwitzer, 1987), stimulating them to refine their action plans, narrowing the behavioral options and supporting them to pursue this goal, which translated into an immediate increase in FV intake. However, further deliberative reflection, afforded afterwards by the motivational intervention, may have precluded the maintenance of this course of action, by inciting individuals to expand their range of possibilities and weight the costs versus the benefits of keeping with the behavior. The relative efficacy of Sequence 1 in the promotion of FV intake was also explained. Higher changes in intention and in self-efficacy were found in response to Sequence 1 and sequentially mediated the effect of the intervention sequence on FV intake at follow-up (T3), consequently approving Hypotheses 3 and 4 and replicating similar findings in other intervention studies, where changes in intention (Kellar & Abraham, 2005) or in self-efficacy (Kreusikon, Gellert, Lippke, & Schwarzer, 2012) were found to mediate the effects of the intervention on FV intake. The fact that these studies were conducted in different countries with very different nutrition habits speaks in favor of the external validity of the present findings.

This research demonstrates that a motivational intervention in itself does not lead to behavior change. Motivating people about a health behavior is not sufficient. The more successful approach to health behavior change lies in the acquisition of self-regulatory skills and the development of confidence in one's agency. However, this points also to one of the limitations of this study. The behavior change techniques (Michie et al., 2013) were not isolated to be tested individually but were combined as a package. This package has turned out to be effective which justifies its use, but it does not allow identification of active

ingredients.

Other limitations are, first, neither the individuals' prior intentions regarding FV intake nor the baseline stage of change were controlled in the present study. It is likely that some variability existed in terms of participants' readiness for increasing their FV intake, rendering the motivational intervention more adequate for those not yet holding an intention to change and the self-regulatory intervention more adequate for those already motivated. However, it is possible that this confound might have been controlled by the random assignment procedures. Even if that was not the case, and an imbalance in the readiness for change existed across the groups, it would not threaten the validity of the findings, given that both groups received intervention components that were designed to target people in both stages of change. Second, FV intake was assessed through a retrospective self-report, which is not ideal, since people may commit mistakes when estimating their past consumption. Future research may use on-going behavioral assessments such as dietary diaries (Kolar et al., 2005) that allow for constant record keeping but here the calendars were used as an intervention component, not as a daily assessment tool.

Third, no phase-specific self-efficacy was assessed (Ochsner, Scholz, & Hornung, 2012), which could have been informative, because people must master different tasks along the behavior change route, facing different barriers along the way. Finally, using the open-ended question format to measure FV intake may have been a limitation as compared to daily food diaries. Moreover, modern technologies are now available that allow to constantly monitor dietary behaviors (Yusof & Iahad, 2012).

It has been argued that the manipulation of the causal factors that are posited as being the precursors of behavioral change is the best way of demonstrating its underlying mechanisms (Sutton, 2008). In the present study, a motivational intervention that was



specifically targeted at the putative determinants of intention was combined with the self-regulation intervention targeting the most proximal predictors of behavior, but in two opposite sequences. The intervention sequence i.e., first motivation and then self-regulation led to the best results in promoting FV consumption. Considering that the sequence of cumulative health promotion strategies makes a difference, the main implications are that interventions aiming to promote health behavior change such as increasing FV intake are more effective when structured in a way that motivates individuals for the change first, and then provides them with the proper self-regulatory skills afterwards. Compared with most studies on this topic, the present one uses a unique theory-based intervention design. It explores the sequencing of different health behavior interventions in the context of FV consumption, and thus makes a contribution to the cumulative knowledge about building intervention components in health behavior change.

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URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6297239&isnumber=6297196>

# 3

## Comparing a Motivational and a Self-Regulatory Intervention to Adopt an Oral Self-Care Regimen: A Two-Sequential Randomized Crossover Trial

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Lhakang, P., Gholami, M., Knoll, N., & Schwarzer, R. (2015). Comparing a motivational and a self-regulatory intervention to adopt an oral self-care regimen: A two-sequential randomized crossover trial. *Psychology, Health & Medicine*, 20(4), 381-392. doi:10.1080/13548506.2014.951368

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### **Abstract**

*Objectives:* A sequential intervention to facilitate the adoption and maintenance of dental flossing was conducted among 205 students in India, aged 18–26 years.

*Method:* Two experimental groups received different treatment sequences and were observed at three assessment points, 34 days apart. One group received first a motivational intervention (intention, outcome expectancies, and risk perception, followed by a self-regulatory intervention (planning, self-efficacy, and action control). The second group received the same intervention in the opposite order.

*Results:* Both intervention sequences yielded gains in terms of flossing, planning, self-efficacy, and action control. However, at Time 2, those who had received the self-regulatory intervention first were superior to their counter- parts who had received the motivational intervention first. At Time 3, differences vanished as everyone had then received both interventions. Thus, findings highlight the benefits of a self-regulatory compared to a mere motivational intervention.

*Keywords:* self-regulation; intervention; oral self-care; self-efficacy; planning; action control



## Introduction

Periodontal diseases and dental caries are among the most prevalent dental diseases affecting people worldwide (Agarwal et al., 2010). Dental flossing is the most commonly recommended adjunctive oral self-care method to prevent such diseases (Sambunjak et al., 2011). However, a large proportion of people floss their teeth less than recommended or not at all (Petersen, 2008). In India, there is lack of appropriate oral health education even among literates, and flossing is not a well-known behavior (Kumar, 2012).

### *Motivation or self-regulation?*

Informing individuals about the benefits of flossing and the risks of poor oral self-care is not enough. They need to develop a motivation to act and self-regulatory skills to translate their intentions into action. Research has provided compelling evidence on the beneficial effects of motivation and self-regulation processes on dental flossing (e.g. Schüz, Sniehotta, & Schwarzer, 2007; Schüz, Sniehotta, Wiedemann, & Seemann, 2006; Suresh, Jones, Newton, & Asimakopoulou, 2012). Moreover, a great deal of research has documented the pivotal role of planning as a self-regulatory strategy in health behavior change (for a review see Hagger & Luszczynska, 2014). However, research has not addressed the question whether the order by which intervention components (motivation and self-regulation) are delivered, is relevant for the effectiveness of dental flossing promotion.

### *Perceived self-efficacy*

Perceived self-efficacy is the confidence in one's ability to execute a difficult or resource-demanding behavior. The barrier here is not the technical difficulty of oral self-care behavior but rather the regular performance as an integral part of daily life which is not easy for some people. Self-efficacy predicts a range of health behaviors including oral self-care (Anagnostopoulos, Buchanan, Frousiounioti, Niakas, & Potamianos, 2011; Buglar, White, &

Robinson, 2010; Jönsson, Baker, Lindberg, Oscarson, & Öhrn, 2012; Mizutani et al., 2012; Stewart, Wolfe, Maeder, & Hartz, 1996).

Beneficial effects of self-regulatory skills on dental flossing have been reported (Münster Halvari, Halvari, Bjørnebekk, & Deci, 2012; Schüz et al., 2007; Sniehotta, Araujo Soares, & Dombrowski, 2007). A combination of self-efficacy and planning is associated with higher frequency in dental self-care (Pakpour, Hidarnia, Hajizadeh, & Plotnikoff, 2012; Pakpour & Sniehotta, 2012).

#### *Action control and planning*

Self-regulatory skills such as action control facilitate adherence to dental flossing with self-monitoring being the most effective component of action control (e.g. Schüz et al., 2007; Schwarzer, Antoniuk, & Gholami, 2014; Suresh et al., 2012). Action control comprises monitoring one's progress, comparing performance with goals, and investing more effort if needed.

Action planning refers to the when, where, and how of an intended behavior whereas coping planning pertains to the anticipation of barriers and ways to overcome them. A great deal of research has documented the pivotal role of planning interventions for a variety of health behaviors (Hagger & Luszczynska, 2014; Kwasnicka, Penseau, White, & Sniehotta, 2013).

#### *Aims and hypotheses*

It is examined whether one intervention sequence is superior to the other. According to the health action process approach (Schwarzer, 2008), a motivational intervention should precede a self-regulatory intervention because, in unmotivated individuals, first a behavioral intention needs to be formed before they can adopt and maintain the actually intended behavior. Thus, an intervention sequence starting with motivation and followed by self-

regulation is the most intuitive one. However, it may be that some participants do not benefit from such a sequence because they feel patronized by the motivational messages or they perceive them as redundant, as they are already beyond that stage. In such cases, a mere self-regulatory intervention without a motivational precursor would be the better and more parsimonious option. Moreover, the intervention benefits should not only be documented by changes in dental self-care but also by changes in mindsets as reflected by higher levels of self-efficacy, planning, and action control. Thus, the following hypotheses are put forward:

- (1) Participants will improve their oral self-care as reflected by attaining higher levels of dental flossing than before the intervention, independent of group assignment.
- (2) Participants receiving a motivational intervention prior to receiving a self-regulatory intervention (Sequence 1) will show a superior pattern of gains over time in terms of flossing, self-efficacy, planning, and action control, as compared with participants receiving a self-regulatory intervention prior to a motivational one (Sequence 2).
- (3) While participants are in the self-regulation condition, they will gain more than while being in the motivation condition, no matter at which point in time.

## **Method**

### *Participants*

University students ( $N = 231$ ) were recruited from a student residence in New Delhi, India, through a notice by the student council board of the host institute with an authority permission (Table 1). Individuals who had dental treatment or made travel plans during the study time were excluded. After 7 of them did not agree to participate, the final sample consisted of 106 women and 99 men, (mean age = 20.7 years with  $SD = 1.59$  and range of 18–26 years).

### *Research design and procedure*

By cluster randomization, participants were allocated to two intervention groups using a crossover design. One group (Sequence 1) received a written motivational package after the baseline measurement (Time 1; T1) and a written self-regulatory package after the post-test (Time 2; T2). The other group (Sequence 2) was treated with a self-regulatory package after baseline measurement and after T2 with a motivational package (see Figure 1). Each intervention session lasted 20 min, and the measurement intervals were 17 days from T1 to T2, and another 17 days from T2 to Time 3 (T3). The first author together with four student research assistants, who were blinded completely and, therefore, were not aware of the aims, intervention content, and any other information that could bias the results, conducted the study.

#### *Measures*

*Dental flossing* was assessed with an open answer format: “During the last week, I have flossed my teeth ... times per day”.

Table 1. *Demographic Characteristics of the Sample (Sequence 1 = Motivation → Self-Regulation, Sequence 2 = Self-Regulation → Motivation)*

	Sequence 1 ( <i>n</i> =94)	Sequence 2 ( <i>n</i> = 111)
Age (Mean, standard deviation)	19.8 (1.3)	21.5 (1.4)
Gender ( <i>N</i> Female/Male)	49/45	57/54
Education ( <i>N</i> science/ commerce/humanities)	37/33/24	44/39/28
Nationality ( <i>N</i> Indian origin/ Immigrant in India)	19/75	25/86

*Self-efficacy* was assessed with six items ( $\alpha_{T1} = .88$ ), ( $\alpha_{T2} = .84$ ), and ( $\alpha_{T3} = .75$ ), including three items for task self-efficacy (e.g. “I am confident that I can start flossing

immediately on a regular basis even if it is time consuming”); and three items for coping self-efficacy (e.g. “I am confident that I can regularly floss my teeth on a long-term basis even when I cannot see any immediate effects”).

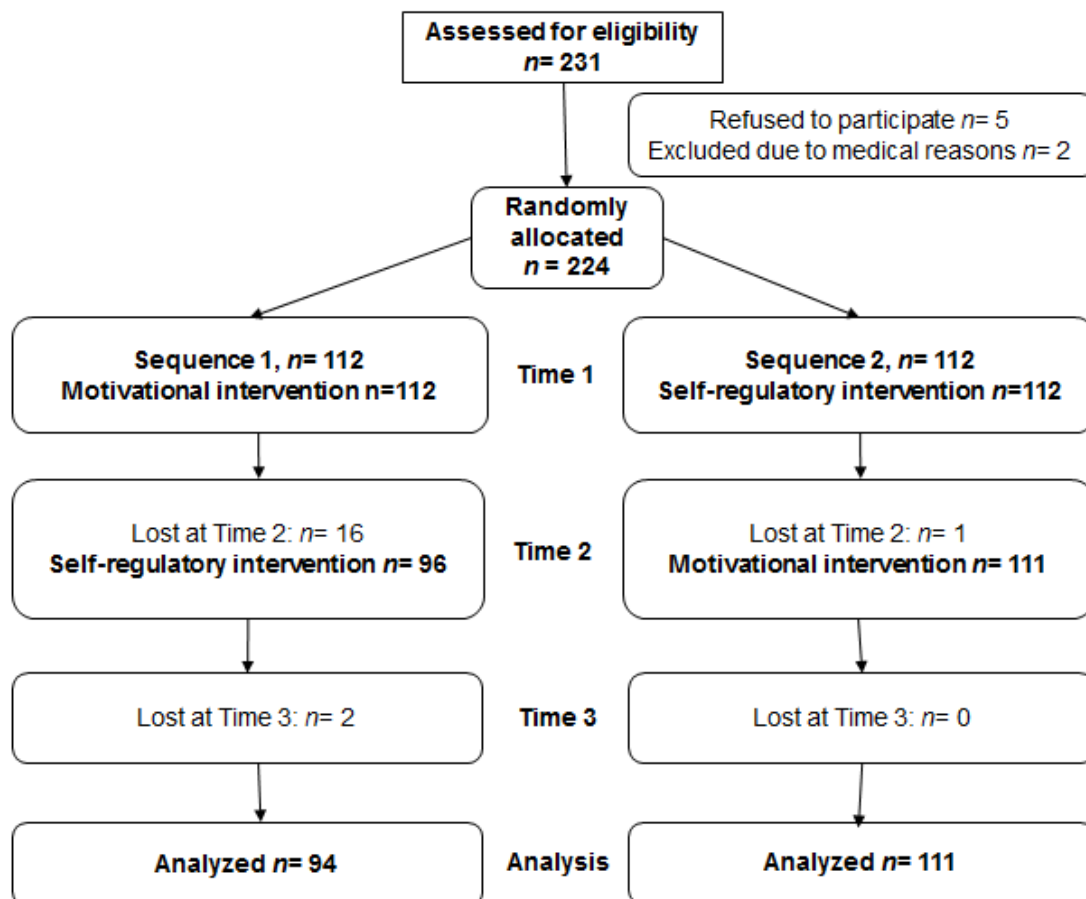


Figure 1. CONSORT flow chart.

*Planning* was assessed with six items ( $\alpha T1 = .80$ ), ( $\alpha T2 = .87$ ), and ( $\alpha T3 = .76$ ), three items measuring action planning (e.g. “I have made a concrete and detailed plan regarding when and where to floss my teeth”) and three items measuring coping planning (e.g. “To keep my flossing habit in difficult situations, I have made a concrete plan regarding what to do if something interferes with my flossing goal”).

*Action control* was assessed with two items ( $\alpha T1 = .70$ ), ( $\alpha T2 = .75$ ), and ( $\alpha T3 = .52$ ) (e.g. “I often had my flossing intentions on my mind”).

All variables were assessed using four-point scales ranging from 1 (*not at all true*) to 4 (*exactly true*)

*Interventions: self-regulatory and motivational intervention conditions*

Both sequence groups received the motivational as well as the self-regulatory treatment. Intervention content is described in terms of the Behavior Change Techniques (BCT; Michie et al., 2013). In the motivational condition, participants received a package with detailed instructions on why and how to perform the behavior (BCT 8). Risk perception: General information about the behavioral risk, and were asked to anticipate three risks of not flossing the teeth, with the example “A risk of not flossing is getting periodontal diseases” (BCTs 1 and 2). Outcome expectancies: the information about the benefits and costs of action or inaction, and were asked to specifically visualize four benefits of flossing such as “If I floss my teeth daily, then I will have healthier teeth for most of my life”. Behavioral intention: finally, they received a prompt to intention formation, encouraging the person to decide to act or set a general goal, for example, to make a behavioral resolution such as “I will floss two times every day” (BCT 4).

In the *self-regulatory condition*, participants received an intervention package that focused on self-efficacy, planning, and action control, following BCT 10, a prompt for specific goal setting, i.e. participants were asked specifically to generate plans for three occasions with specifying the frequency, time, how often, and how self-efficacious they are to floss their teeth. Moreover, they were asked to generate three critical situations which may impede the planned behavior, and coping strategies to overcome the barriers in line with BCT 5 (e.g. “if I forget to floss, then I put the dental floss next to my toothbrush”). Also, in accordance with BCT 11, they were prompted to review their goals, by considering previously set intentions. To enhance self-efficacy, they responded to questions such as “How

certain are you that you can follow these plans?” Furthermore, a calendar was provided to fill in their daily flossing records (action control).

The present study provides both conditions to all participants, either in the hypothesized or in the reversed order (AB vs. BA, see Figure 2).

#### *Analytical procedure*

Repeated measures analyses of variance (ANOVA, type III tests of fixed effects) were performed with SPSS 22. The two-arm intervention (Sequence 1 vs. Sequence 2) was chosen as a between-subjects factor, whereas flossing, self-efficacy, planning, and action control served as dependent variables, measured at three points in time. Moreover, ANCOVAs were computed with sequence groups as between-subjects factor and respective outcomes of flossing, self-efficacy, planning, and action control at T2 and T3 as dependent variables with their corresponding T1 measures as covariates. All assumptions were tested beforehand such as Levine’s test of equality of error variances and Mauchley’s test of sphericity.

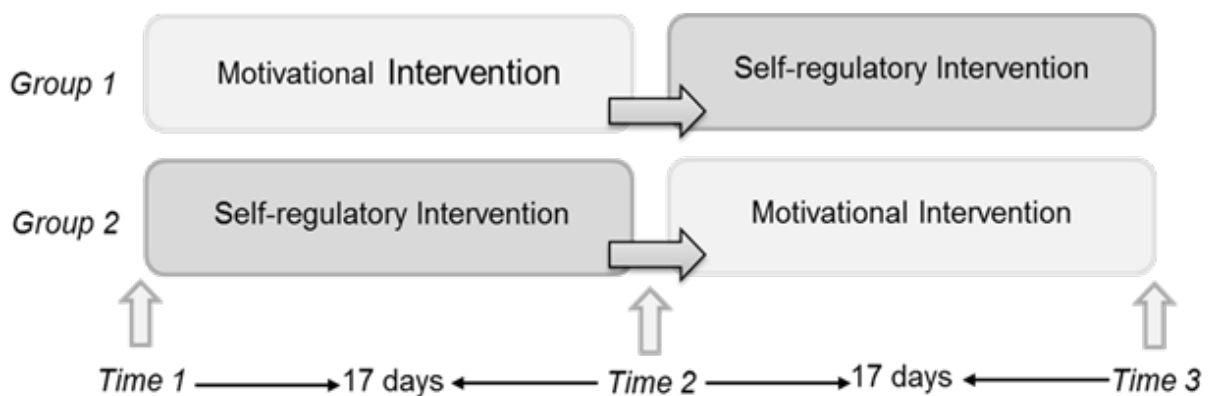


Figure 2. The treatment sequences for two intervention groups.

## **Results**

### *Attrition analyses and missing values*

Participants ( $n = 19$ ) who discontinued after T2 did not differ significantly on T1

variables. They were excluded from longitudinal data analyses. Missings were below 1% for dental flossing at T1 and later (T2, T3), self-efficacy, planning, and action control at T3 had about 1% missings, and none at T1 and T2.

#### *Randomization check*

Results revealed no baseline differences (see Table 2) between the two experimental conditions regarding dental flossing, self-efficacy, and gender (all  $p > .05$ ). At T1 a group difference was found for planning between Sequence 1 ( $M = 11.06$ ,  $SD = 3.40$ ) and Sequence 2 ( $M = 12.28$ ,  $SD = 3.56$ ),  $t(203) = -2.49$ ,  $p = .014$  and for action control with Sequence 1 ( $M = 4.14$ ,  $SD = 2.04$ ) and Sequence 2 ( $M = 4.68$ ,  $SD = 1.87$ ),  $t(203) = -2.00$ ,

$p = .047$ . Analyses involving group differences following the first intervention session has used T1 measures as covariates.

#### *Descriptive statistics*

At baseline, only 6.5% of participants in both conditions reported using dental floss which indicates that there is a lack of oral hygiene even among this highly educated sample.

#### *Intervention effects*

To describe changes in the two intervention sequences across three points in time, repeated measures ANOVAs were computed for flossing and the three social-cognitive variables (planning, self-efficacy, and action control). An independent samples  $t$ -test (two-tailed) was performed comparing the two intervention groups. Means, standard deviations, and group comparison statistics are summarized in Table 2 and displayed in Figures 3–6.

#### *Changes in dental flossing*

A repeated measures ANOVA was applied with flossing as the dependent variable at three points in time, and group as between-subjects factor. An effect of time emerged,  $F(2, 396) = 160.73$ ,  $p < .001$ ,  $\eta^2 = .45$  and a treatment effect as well,  $F(1, 198) = 6.02$ ,  $p < .05$ ,



$\eta^2 = .03$ . Moreover, there was an interaction between treatment and time,  $F(2, 396) = 76.62$ ,  $p < .001$ ,  $\eta^2 = .28$ , (see Figure 3), participants flossed more often when treated with the self-regulatory intervention than when treated with the motivational condition.

Table 2. Means (*M*) and Standard Deviations (*SD*) for Dental flossing, Planning, Self-Efficacy, and Action Control Comparison Between two Intervention Groups at Three Points in Time.

	Sequence 1		Sequence 2		<i>t</i>	<i>p</i>	<i>d</i>
	<i>M</i>	( <i>SD</i> )	<i>M</i>	( <i>SD</i> )			
<i>Flossing</i>							
Time 1	0.17	(0.87)	0.09	(0.35)	0.91	.36	.13
Time 2	0.33	(0.61)	1.53	(0.66)	-13.26	<.001	-1.87
Time 3	1.78	(1.09)	1.18	(0.95)	4.14	<.001	.58
<i>Planning</i>							
Time 1	11.06	(3.40)	12.28	(3.56)	-2.49	.01	-0.35
Time 2	10.91	(2.95)	17.12	(2.70)	-15.71	<.001	-2.21
Time 3	18.12	(3.34)	17.34	(2.50)	1.89	.06	.27
<i>Self-efficacy</i>							
Time 1	13.77	(4.91)	14.41	(4.86)	-0.93	.35	-0.13
Time 2	14.51	(2.34)	17.12	(3.25)	-6.49	<.001	.91
Time 3	19.19	(2.85)	18.11	(3.17)	2.54	.01	.36
<i>Action Control</i>							
Time 1	4.14	(2.04)	4.68	(1.87)	-2.00	.05	-.28
Time 2	4.39	(1.87)	5.90	(1.41)	-6.57	<.001	-.92
Time 3	5.91	(1.51)	6.10	(1.18)	-0.98	.33	-.14

Note: Participants of Sequence 1 received a motivational intervention before a self-regulatory intervention. Participants of Sequence 2 received a self-regulatory intervention before a motivational intervention

In Intervention Sequence 1, flossing increased (.33 times flossing/day at T2 compared to 1.78 times flossing/day at T3). However, in Sequence 2, flossing showed a slight downward trend (1.53 times flossing/day at T2 compared to 1.18 times flossing/day at T3). Group differences in flossing at T2 were also tested with ANCOVA, controlling for the baseline. Sequence 2 with the self-regulation intervention had obtained a higher level of behavior change ( $M = 1.53$ ,  $SE = .06$ ) than Sequence 1 with motivation intervention ( $M =$

.33,  $SE = .07$ ) with  $F(1, 199) = 181.32, p < .001, \eta^2 = .48$ . At T3, ANCOVA yielded  $F(1, 198) = 17.84, p < .001, \eta^2 = .08$ . Sequence 1 had higher flossing levels ( $M = 1.79, SE = .11$ ) after the self-regulatory intervention than Sequence 2 ( $M = 1.18, SD = .10$ ) after completing the motivational intervention.

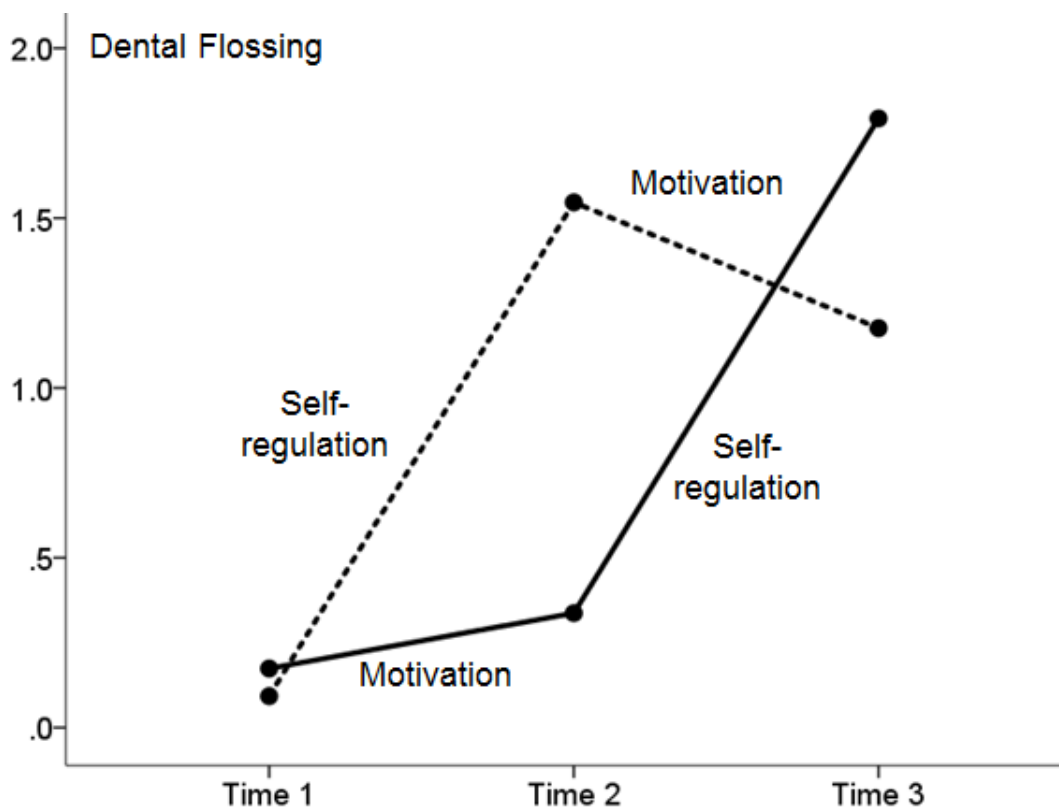


Figure 3. Dental flossing levels at three points in time in two experimental conditions (Sequence 1: first motivation, then self-regulation; Sequence 2: first self-regulation, then motivation).

#### *Changes in self-efficacy*

For self-efficacy, there was an overall treatment effect,  $F(1, 201) = 4.18, p < .05, \eta^2 = .02$  and an effect of time,  $F(2, 402) = 97.45, p < .001, \eta^2 = .33$ . An interaction between treatment and time emerged,  $F(2, 402) = 15.97, p < .001, \eta^2 = .07$ . Figure 4 displays the patterns of differences in self-efficacy changes. Group differences in self-efficacy at T2 were

also tested with ANCOVA, controlling for the baseline. Sequence 2 with the self-regulation intervention had obtained a higher level of self-efficacy ( $M = 17.08$ ,  $SE = .27$ ) than Sequence 1 with the motivation intervention ( $M = 14.56$ ,  $SE = .29$ ) with  $F(1, 202) = 41.06$ ,  $p < .001$ ,  $\eta^2 = .17$ . At T3, ANCOVA yielded  $F(1, 200) = 16.29$ ,  $p < .001$ ,  $\eta^2 = .08$ . Sequence 1 had higher self-efficacy levels ( $M = 19.24$ ,  $SE = .31$ ) after the self-regulatory intervention than Sequence 2 ( $M = 18.07$ ,  $SE = .29$ ) after the motivational intervention.

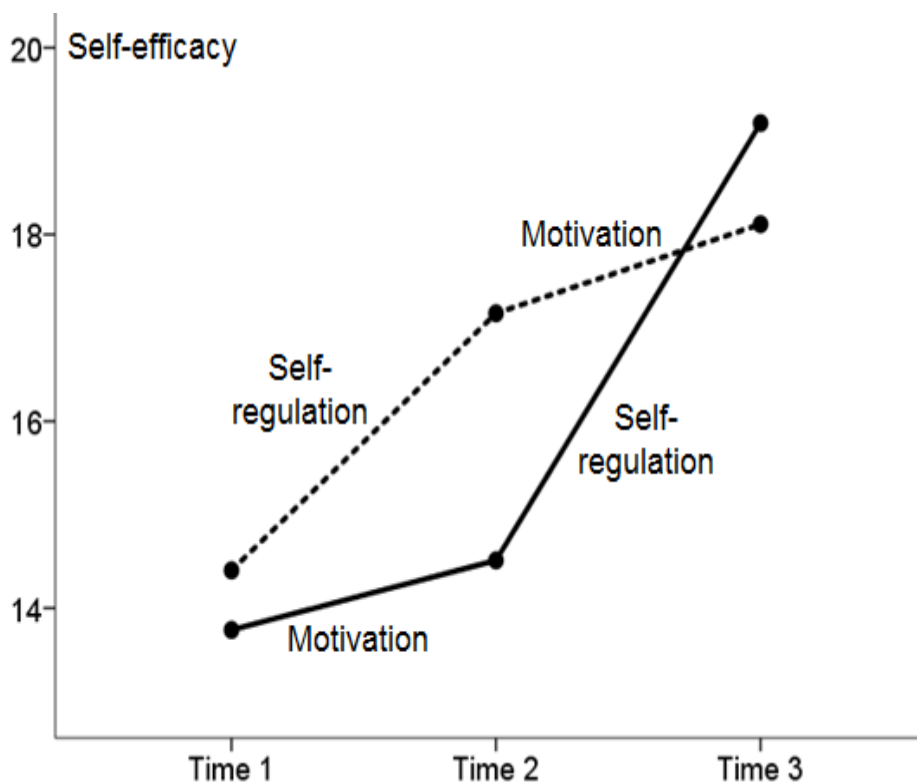


Figure 4. Self-efficacy levels (range: 1–4) at three points in time in two experimental conditions (Sequence 1: first motivation, then self-regulation; Sequence 2: first self-regulation, then motivation).

#### Changes in planning

In planning, an effect of time appeared with  $F(2, 402) = 247.15$ ,  $p < .001$ ,  $\eta^2 = .55$  and a treatment effect,  $F(1, 201) = 56.88$ ,  $p < .001$ ,  $\eta^2 = .22$ . Moreover, a significant interaction effect between the treatment and time was found,  $F(2, 402) = 88.10$ ,  $p < .001$ ,  $\eta^2$

= .31 (see Figure 5). Group differences in planning at T2 were also tested with ANCOVA, controlling for the baseline. Sequence 2 with the self-regulation intervention had obtained a higher level of planning ( $M = 17.00$ ,  $SE = .26$ ) than Sequence 1 with the motivation intervention ( $M = 11.05$ ,  $SE = .28$ ) with  $F(1, 202) = 234.50$ ,  $p < .001$ ,  $\eta^2 = .54$ . At T3, ANCOVA yielded  $F(1, 200) = 10.48$ ,  $p < .01$ ,  $\eta^2 = .05$ . Although Sequence 1 had higher planning levels ( $M = 18.22$ ,  $SE = .30$ ) after the self-regulatory intervention than Sequence 2 ( $M = 17.26$ ,  $SE = .28$ ) after the motivation intervention, however this difference yielded only a significance level of  $p = .06$ .

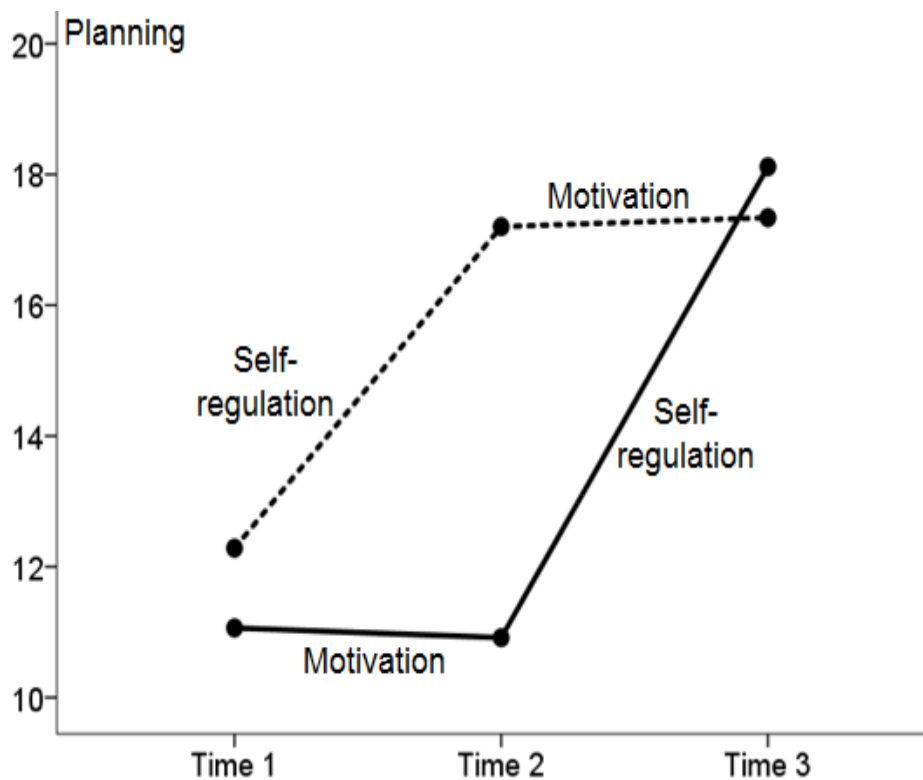


Figure 5. Planning levels (range: 1–4) at three points in time in two experimental conditions (Sequence 1: first motivation, then self-regulation; Sequence 2: first self-regulation, then motivation).

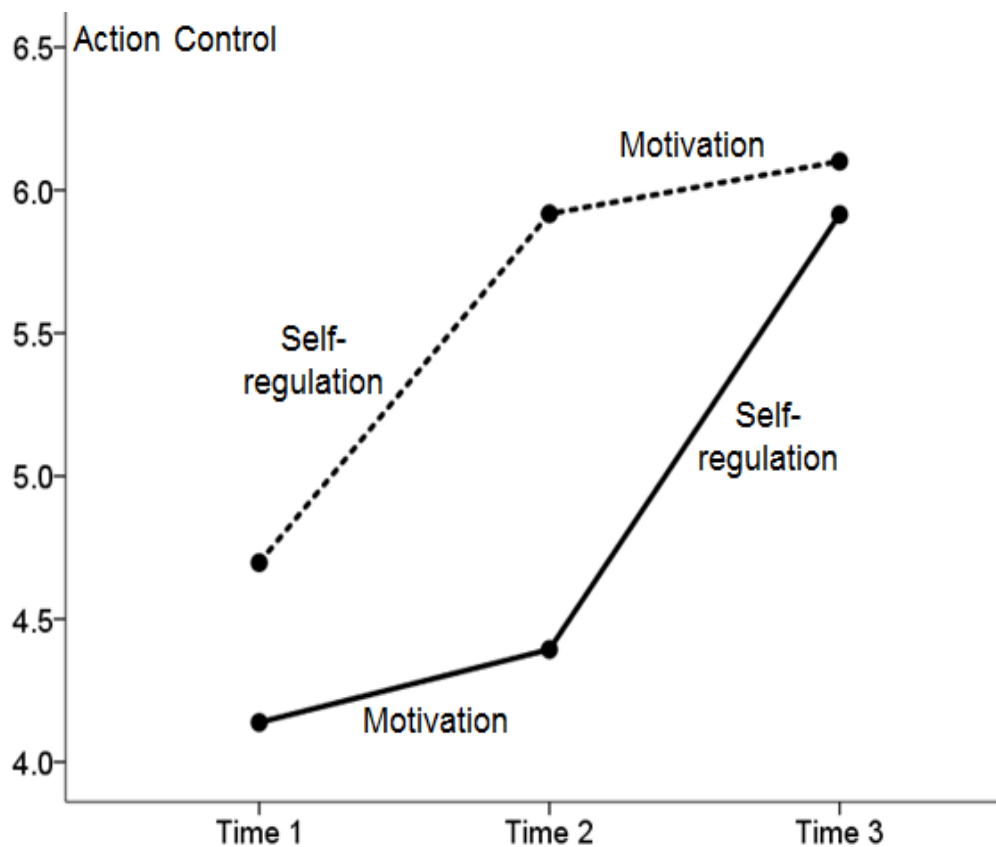


Figure 6. Action control levels (range: 1–4) at three points in time in two experimental conditions (Sequence 1: first motivation, then self-regulation; Sequence 2: first self-regulation, then motivation).

#### *Changes in action control*

For action control, an effect of time emerged  $F(2, 402) = 61.60, p < .001, \eta^2 = .24$  and a treatment effect  $F(1, 201) = 20.73, p < .001, \eta^2 = .09$ . Furthermore, an interaction between treatment and time was found,  $F(2, 402) = 11.59, p < .001, \eta^2 = .06$  (see Figure 6). Group differences in action control at T2 were also tested with ANCOVA, controlling for the baseline, and Sequence 2 with the self-regulation intervention had obtained a higher level of action control ( $M = 5.85, SE = .15$ ) than Sequence 1 with the motivation intervention ( $M = 4.46, SE = .17$ ) with  $F(1, 202) = 38.29, p < .001, \eta^2 = .16$ . At T3, ANCOVA yielded  $F(1, 200) = .48, p = .49$ . Sequence 1 had the same level of action control ( $M = 5.97, SE = .14$ ) after the self-regulatory intervention as Sequence 2 ( $M = 6.05, SE = .13$ ) after the

motivational intervention.

### **Discussion**

This study has examined the effects of an oral self-care intervention in different sequences. In Sequence 1, participants received first the motivation, then the self-regulation intervention. In Sequence 2, they received first the self-regulation, then the motivation intervention. Pre-post comparisons have shown that both groups of participants have improved their oral self-care as reflected by attaining higher levels of dental flossing (Hypothesis 1 supported). They also showed a general increase in self-efficacy, planning, and action control. However, participants in Sequence 1 did not demonstrate a superior pattern of gains over the entire time period in terms of flossing, self-efficacy, planning, and action control, as compared with participants in Sequence 2 (Hypothesis 2 rejected). While participants were in the self-regulation condition, they gained more in terms of the four outcome variables than while being in the motivation condition (Hypothesis 3 supported).

The main differences emerged at T2, which was the point in time when both groups were exposed either to the motivational or the self-regulatory one. At T2, there was a clear superiority of the self-regulatory intervention in terms of all four outcomes. This substantial group difference vanished at T3, after all participants had been exposed to both kinds of interventions.

This research demonstrates that a motivational intervention in itself is not sufficient for behavior change. The more successful approach lies in the acquisition of self-regulatory skills and the development of confidence in one's agency. In the present context, this could be done even without any motivational preludes. Combining self-efficacy, planning, and action control allowed to build up a self-regulatory process that was documented in terms of flossing frequency and also in terms of the indicators of the three intervention ingredients.

Although the health promotion program as a whole has turned out to be effective which justifies its use, it does not allow to identify active ingredients. Another limitation was the lack of objective measures to assess progress in flossing. Assessments were self-reported, and dental flossing was measured retrospectively. One could use on-going behavioral assessments such as a dental calendar that allow for constant record keeping (Schüz et al., 2007), but here the calendars were used as one of the intervention components under the self-regulatory condition but not as a daily assessment tool.

As the baseline weekly flossing rate was almost zero, it was assumed that almost all participants were initially unmotivated to adopt flossing. Therefore, no distinction was made among participants in terms of intenders, non-intenders, and actors of flossing. Future work should consider a segmentation of the audience in terms of non-intenders, intenders, and actors (Schwarzer, 2008) and matched versus mismatched interventions.

Theory-based intervention packages were found to work in one sequence as well as in the other although only the self-regulatory intervention made the difference. However, the motivational intervention may have not been strong enough to show its potential, and future research may want to build more powerful packages along with more measurement points in time to better monitor the effects at each stage. Overall, this study used a theory-based intervention design and has explored in a unique way the sequencing of different health behavior change techniques in the context of oral self-care, using dental flossing as an example. Thus, the present data may contribute to research on the sequencing of health behavior intervention components in general.

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# 4

## Evaluating Brief Motivational and Self-Regulatory Hand Hygiene Interventions: A Cross-Over Longitudinal Design

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Lhakang, P., Lippke, S., Knoll, N., & Schwarzer, R. (2015). Evaluating brief motivational and self-regulatory hand hygiene interventions: A cross-over longitudinal design. *BMC Public Health*, 15:79. [doi:10.1186/s12889-015-1453-7](https://doi.org/10.1186/s12889-015-1453-7)

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### Abstract

*Background:* Frequent handwashing can prevent infections, but non-compliance to hand hygiene is pervasive. Few theory- and evidence-based interventions to improve regular handwashing are available. Therefore, two intervention modules, a motivational and a self-regulatory one, were designed and evaluated.

*Methods:* In a longitudinal study, 205 young adults, aged 18 to 26 years, were randomized into two intervention groups. The Mot-SelfR group received first a motivational intervention (*Mot*; risk perception and outcome expectancies) followed by a self-regulatory intervention (*SelfR*; perceived self-efficacy and planning) 17 days later. The SelfR-Mot group received the same two intervention modules in the opposite order. Follow-up data were assessed 17 and 34 days after the baseline.

*Results:* Both intervention sequences led to an increase in handwashing frequency, intention, self-efficacy, and planning. Also, overall gains were found for the self-regulatory module (increased planning and self-efficacy levels) and the motivational module (intention). Within groups, the self-regulatory module appeared to be more effective than the motivational module, independent of sequence.

*Conclusions:* Self-regulatory interventions can help individuals to exhibit more handwashing. Sequencing may be important as a motivation module (*Mot*) first helps to set the goal and a self-regulatory module (*SelfR*) then helps to translate this goal into actual behavior, but further research is needed to evaluate mechanisms.

*Keywords:*

motivation, self-regulation, handwashing, intention, self-efficacy, planning, young adults.

## Background

More than 100 years of evidence conclusively demonstrates that handwashing reduces the risk of infection [1] and that it is one of the most effective ways of preventing the transmission of infectious agents [2]. However, only 31% of men and 65% of women wash their hands after using a public restroom [3] and handwashing is even less common among young adults [4]. Despite this, non-compliance to hand hygiene is rarely studied in this age group [5]. Particularly in one of the world's largest youth population, India, with around 66% of the total population under the age of 35 [6], handwashing was hardly systematically studied before. Thus, this was one goal of the current study.

In the hand hygiene literature, previous studies were mainly done among healthcare workers (HCW) [2] and very few of them were generalizable to the population of adults, much less to youth. Moreover, these studies were lacking quantitative research methods, and very few could be found testing strategies to enhance handwashing empirically [4]. In one of the few studies addressing a handwashing campaign, education was addressed [7], but it has been shown to be ineffective in handwashing promotion. Authors suggested testing more effective interventions and their differential impact in changing behavior [8] especially in a student residence hall environment and university campus [9,5,10]. Thus, the current study aimed at focusing on university students and promoting handwashing in this sample with theory-based interventions, because interventions are imperative for successful health behavior promotion [11].

### *Motivational and self-regulatory strategies for health behavior change*

The World Health Organization prioritized hand hygiene as an intervention of universal relevance across developed and developing countries in 2005 [12]. Interventions should include the general principles guiding the development of health promotion programs and

employed strategies based on relevant evidence coupled with an understanding of the underlying mechanisms [13,14]. Such evidence-based strategies to enable health behavior change include addressing self-efficacy and self-regulatory skills such as planning [15], as suggested by the health action process approach (HAPA) [16].

According to the HAPA, individuals first need to become motivated to adopt health behaviors, i.e. form an intention. This can be supported by strategies enhancing psychological variables such as risk perception, outcome expectancies, and self-efficacy. The HAPA assumes that after forming a behavioral intention, i.e., as soon as individuals are motivated, they need self-regulatory skills such as planning and further self-efficacy to translate their intentions into actual health behavior and to maintain the behavior over time [16]. A study on fruit and vegetable intake among young adults highlighted the advantage of a self-regulatory intervention over a motivational intervention [17]. This also needs to be investigated in the domain of hand hygiene.

*Motivational factors: risk perception and outcome expectancies*

According to HAPA, *risk perception* can be a starting point for contemplating health behavior change although it is not regarded as a powerful predictor of most behaviors.

*Outcome expectancies* are the perceived consequences of adopting the health behavior, which are supposed to lose their predictive power after a personal decision has been made. To form a behavioral intention, one also needs perceived self-efficacy, which is the belief in one's capability of performing a desired action [18].

*Self-regulatory factors: perceived self-efficacy and planning*

*Perceived self-efficacy* is the confidence in one's ability to execute a difficult or resource-demanding behavior and the capability of performing the actions that are required to attain a desired end state. Moreover, self-efficacious individuals invest more effort into achieving

their goals especially in the face of barriers [19]. The barrier here is not the technical difficulty of hand hygiene, but rather the regular performance of this activity as an integral part of daily life. Self-efficacy predicts a range of health behaviors including hand hygiene [20]. Self-efficacy is not only imperative for setting the goal to change behavior (motivational effect) but also for translating the goal into behavior and maintaining the behavior after the first enactment (volitional effect).

Intention to change a behavior is central to most health behavior promotion programs [21] but intentions can be unstable, and as a consequence people might not actually take up an action, for example, when they lack control over their behavior [22]. The “black-box” nature of the underlying psychological processes that lead from intention to action has been labelled intention-behavior-gap [23]. To bridge this intention-behavior-gap, it has been shown that forming specific *action plans* of when, where, and how to act can increase the likelihood of successful implementation of one’s intention. Two types of planning have been introduced: *action planning* (when, where and how to act) and *coping planning* (to identify barriers and strategies to cope with them) [24]. Much research has documented the pivotal role of planning interventions for the uptake and maintenance of a variety of health behaviors [25,26]. However, its effects on a self-regulatory handwashing intervention in comparison to a motivational intervention, has not been tested before.

#### *Aims and Hypotheses*

The current study explored whether it would make a difference in which order a set of two brief theory-based psychological intervention arms (motivational and self-regulatory interventions) are presented to improve hand hygiene in young adults. It evaluated a unique research design by comparing these two intervention modules. A crossover design was employed: one group of participants received the motivational intervention (Mot) first,

followed by the self-regulatory module (SelfR). The other group received the two modules in the opposite sequence (SelfR-Mot). At the point in time when the order was switched (after 17 days), a second assessment took place allowing to gauge the changes during the first phase. In addition, after another 17 days the third assessment was scheduled to allow for evaluating the final outcomes.

The purpose of this crossover design was to examine whether it made a difference in which order treatments were presented. According to the theoretical assumptions derived from the HAPA, participants should first become motivated before they acquire self-regulatory skills. Thus, the aim is to determine the optimal sequence for motivational and self-regulatory modules, and it is expected that the motivation-self-regulation (MotSelfR) sequence would be superior in adopting the handwashing goal as well as planning this behavior, compared to the opposite sequence (Hypothesis 1: Mot-SelfR > SelfR-Mot).

However, it may be that some participants do not benefit from such a sequence because they feel patronized by the motivational messages or they perceive them as redundant, as they are already beyond that stage. In such cases, a mere self-regulatory intervention without a motivational precursor would be the better and more parsimonious option.

Moreover, the intervention benefits should not only be documented by changes in handwashing but also by changes in mindsets as reflected by higher levels of self-efficacy and planning. This leads to the following hypothesis: participants who received the self-regulation intervention module would gain more in terms of the volitional outcomes (behavior and planning), whereas those receiving the motivational intervention module would show increases in the motivational outcome (intention), no matter at which point in time (Hypothesis 2).



## Method

### *Participants*

University students (n= 206, including 107 women, mean age = 20.71 years, SD = 1.59 with a range from 18 to 26 years) were observed from March 2013 to April 2013 with three assessment points in time over a time span of 34 days. Participants were recruited from a university student residence in New Delhi, India, via a notice by the student council board. Attending the program was voluntary and written informed consent was obtained by the participants. The intervention followed ethical principles regarding research with human participants. The ethics committee, which granted approval, was the Tibetan Youth Hostel Board of Council, New Delhi, India.

### *Research Design and Procedure*

By cluster randomization, participants (N = 225) were allocated to two intervention groups using a cross-over design. Intervention sequences were implemented after the baseline measurement. Intervention sequence group 1 (Mot-SelfR) received a written motivational module after the baseline measurement (Time 1; T1) and a written self-regulatory module 17 days later after the post-test (Time 2; T2). The intervention sequence group 2 (SelfR-Mot) was treated with a self-regulatory module after the baseline measurement, followed by a motivational module after T2.

The interventionist resided with the participants during the whole study period and observed students practicing and engaging in the intervention modules. Soap was provided in all washbasins including rest rooms and kitchen, and signs with standard educational messages were placed in rest rooms. Each intervention session lasted 20 minutes, and the measurement intervals were 17 days from T1 to T2, and another 17 days from T2 to Time 3 (T3). The first author together with four student research assistants, who were blinded

completely and, therefore, were not aware of the aims, intervention content, and any other information that could bias the results, conducted the study.

### *Measures*

*Handwashing* frequency was assessed with three items adapted from a previous handwashing study [27], which examined the frequency of handwashing per day, with plain water, handwashing with soap and water, and frequency of using disinfectant. The item stem, ‘During the last week, I have...’ was followed by the items ‘washed my hands with plain water’, ‘washed my hands with soap and water’, and ‘disinfected my hands with disinfectant’. The responses ranged from 1: 0–5 times; 2: 6–10 times; 3: 11–20 times; 4: more than 20 times.

*Behavioral intention* was assessed with two items (Spearman’s  $\rho_{T1} = .52$ ,  $\rho_{T2} = .65$ ,  $\rho_{T3} = .75$ ); the item stem ‘I intend to wash my hands properly either with soap or with an alcohol-based solution...’ was followed by the items ‘more than ten times a day’, ‘at least ten times a day’. Responses for intention as well as for self-efficacy and planning were assessed using 4-point scales ranging from 1 = *not at all true* to 4 = *exactly true*. Measures of this type were validated in previous studies [16].

*Self-efficacy* was assessed with six items ( $\alpha_{T1} = .72$ ,  $\omega = .72$ , [.60, .80],  $\alpha_{T2} = .70$ ,  $\omega = .68$ , [.56, .76],  $\alpha_{T3} = .75$ ,  $\omega = .74$ , [.65, .80]), such as ‘I am confident that I can start washing my hands immediately on a regular basis even if others do not wash their hands’ and ‘I am confident that I can frequently wash my hands on a long-term basis, even when it takes a long time to make this a part of my daily routine’.

*Planning* was assessed with six items ( $\alpha_{T1} = .73$ ,  $\omega = .74$  [.64, .80],  $\alpha_{T2} = .89$ ,  $\omega = .89$  [.86, .92],  $\alpha_{T3} = .81$ ,  $\omega = .82$ , [.76, .86]), three items measuring action planning (e.g., ‘I have made a concrete and detailed plan regarding when and where to wash

my hands (at which occasion)’ and three items measuring coping planning (e.g., ‘To keep my hand hygiene habit in difficult situations...,’ ‘...I have made a concrete plan regarding what to do if something interferes with my goal of handwashing’).

Responses were rated on a four-point Likert-type scale ranging from (1) not at all true to (4) exactly true. Items on planning and self-efficacy were adapted from [16].

#### *Intervention content: motivational and self-regulatory modules*

Soaps and soap solutions were provided in every toilet and washing areas of the residences during the study period for participants’ use. This was done because providing accessible resources is an obvious necessary component of any hand hygiene intervention [5,28].

Intervention content is described in terms of the *Behavior Change Techniques* [13] (BCT). In the *motivational condition (Mot)*, participants received a package with detailed instructions on why and how to wash hands (BCT 4.1), information addressing risk perception (BCT 5.1) and positive outcome expectancies (BCT 1.3) as well as prompts towards intention formation (BCT 7.1). After providing general information about the behavioral risk, participants were instructed to anticipate risks of not washing their hands properly and were encouraged to write down benefits of washing hands (positive outcome expectancies).

In the *self-regulatory module (SelfR)*, the intervention was focused on self-efficacy (BCT 15), and planning (BCT 1.2 and 1.4). After general instruction, participants were encouraged to generate three action plans specifying the timing, frequency, and technique to wash their hands, yielding a total of nine cells (3 plans x 3 details) to fill out (‘have you made a plan on washing your hands to be free of germs? If so, please indicate here your most important plans regarding... how often to wash hands, ...when to wash, ...how to wash hands’) and three coping plans, which included both barrier identification and problem-

solving ('If I face difficult situations that might prevent me from washing my hands..., then I plan to overcome them by...') with a six-cell design ( $3 \times 2$ : three situations with critical events, each of them with two coping strategies). After each of the three situations (action and coping plans), an item ('How certain are you that you can follow these plans?') instructed participants to rate their perceived ability to follow through with the plan on a 4-point scale. These items were designed to boost self-efficacy. To compare their performance with goals and to increase mastery experience (BCT 2.3), participants were prompted to review and visualize their past successes ('which success experiences had you in washing your hands regularly? Please write here'). The cross-over designed study provided to all participants both types of interventions, the motivational as well as the self-regulatory intervention, either in the theory-based or in the reversed sequence (Mot-SelfR versus SelfR-Mot).

#### *Analytical procedure*

Analyses were conducted with SPSS 22. First, dropout analyses compared retained participants with those lost after T1 and T2 using *t*-tests for continuous measures and  $\chi^2$ -tests for categorical measures. Second, repeated measures analyses of variance (ANOVA, type III tests of fixed effects) were conducted with the two different interventions (Mot-SelfR versus SelfR-Mot) as a between-subjects factor, whereas handwashing frequency served as a dependent variable. Intention, self-efficacy, and planning served as intermediate outcomes.

All variables were measured at three points in time. Moreover, ANCOVAs were computed with the different groups as a between-subjects factor and the respective outcomes of handwashing frequency, intention, self-efficacy, and planning at T2 and T3 as dependent variables with their corresponding T1 measures as covariates. Assumptions on the properties of the data were tested beforehand such as Levine's test of equality of error variances and

Mauchley's test of sphericity.

## Results

### *Attrition analyses and baseline comparisons*

Results at T1 indicated no significant difference between the retained participants and those who discontinued the study after T2 ( $n = 19$ ) regarding the central variables under the study as well as socio-demographic variables (all  $p > .05$ ). Dropouts were excluded from the longitudinal data analyses (see Figure 1).

Missing values were less than 0.5% for handwashing frequency, and less than 1.5% for intention, self-efficacy, and planning at all points in time. Moreover, results revealed no baseline difference (see Table 1) between the two experimental conditions regarding handwashing frequency, intention, self-efficacy, planning, and gender (all  $p > .05$ ). Age differences occurred ( $p < .05$ ), with older study participants assigned to the group SelfR-Mot ( $M = 21.45$ ,  $SD = 1.42$ ) more often than to the Mot-SelfR group ( $M = 19.83$ ,  $SD = 1.28$ ).

### *Intervention effects*

Prior to the intervention, 96% of the participants did not reach the recommended frequency of handwashing (10 times/day). Moreover, means, standard deviations, and ranges for the two groups' comparison statistics for all variables are summarized in Table 1.

### *Intervention effects on handwashing frequency*

For handwashing, no significant overall difference was observed between the treatment groups,  $F(1, 189) = 3.69$ ,  $p = .06$ ,  $\eta^2 = .02$ . An effect of time emerged,  $F(2, 378) = 128.12$ ,  $p < .001$ ,  $\eta^2 = .40$ , and also an interaction between treatment and time was found,  $F(2, 378) = 10.94$ ,  $p < .001$ ,  $\eta^2 = .06$ . Figure 3 illustrates that after the first intervention module was completed, the SelfR-Mot (self-regulation intervention first) was superior to Mot-SelfR (motivation intervention given first). However, at T3, i.e., after also the second part of the

intervention was provided, Mot-SelfR (motivation followed by self-regulation) appeared slightly superior to SelfR-Mot (self-regulation followed by motivation). To test pairwise comparisons, ANCOVAs were computed to test whether the differences between the groups were statistically significant.

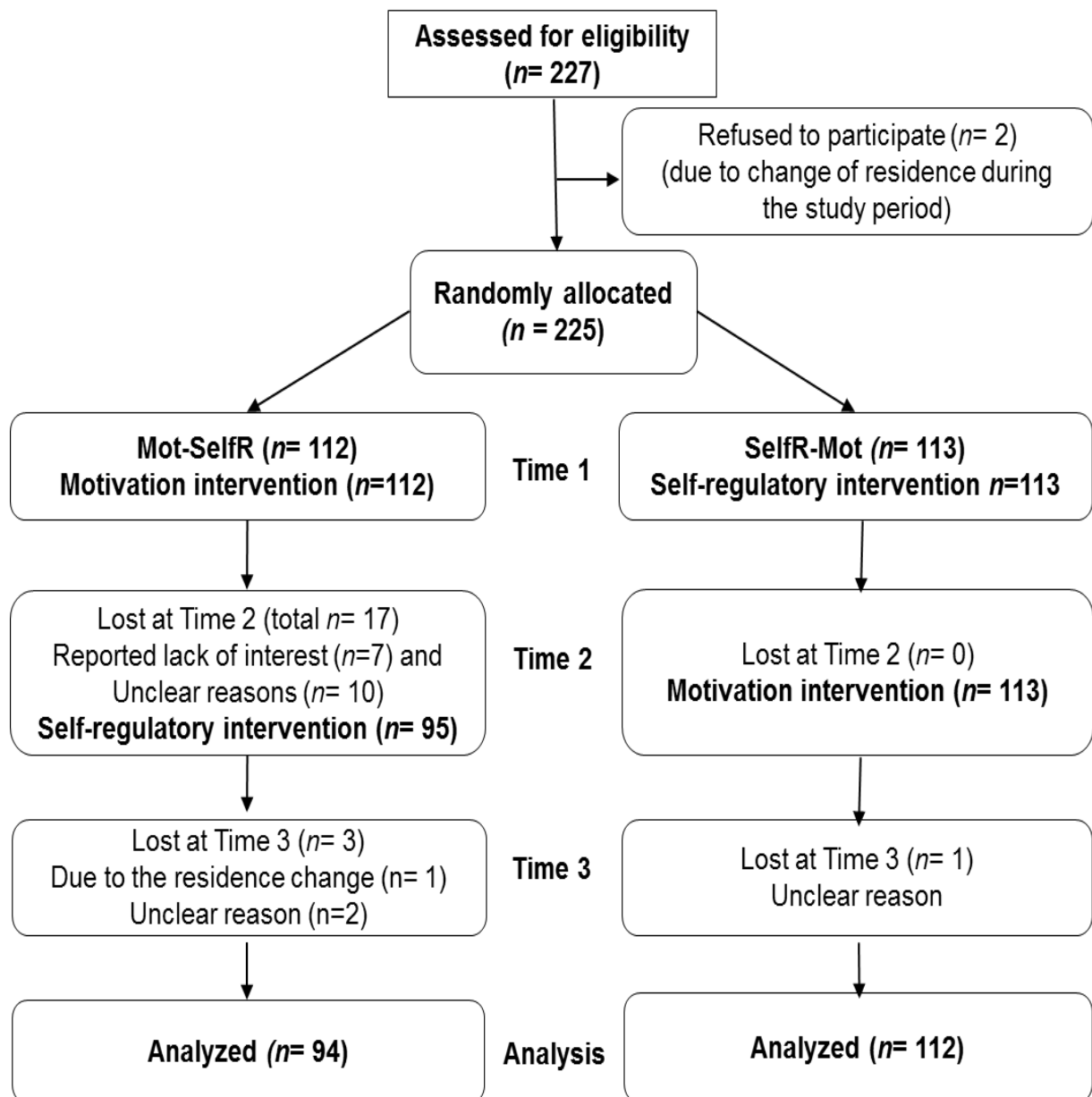


Figure 1. CONSORT flow chart of the study participants

The pairwise comparisons revealed that participants having obtained the SelfR intervention at T2 reported a higher mean of behavior in comparison to persons who had

obtained the Mot intervention at T2 ( $F(1, 191) = 29.82, p < .001, \eta^2 = .14$ ). This validates the findings above. However, at T3, after both groups had received all intervention components (only in opposite order) the difference between the Mot-SelfR group and the SelfR-Mot group was no longer significant  $F(1, 197) = 0.71, p = .40$ .

#### *Changes in intention, self-efficacy and planning*

For *intention*, there was a substantial effect of time,  $F(2, 404) = 95.73, p < .001, \eta^2 = .32$ , and a significant interaction between the treatment and time  $F(2, 404) = 19.02, p < .001, \eta^2 = .09$ . However, there was no significant specific treatment effect,  $F(1, 202) = 2.29, p = .13, \eta^2 = .01$ . The ANCOVA tests at T2 depicted that the Mot intervention resulted in a slightly higher level of intention than the SelfR intervention with  $F(1, 201) = 3.37, p < .06, \eta^2 = .02$ . However, at T3, when SelfR-Mot had received the Mot module, they had developed significantly higher intention levels with  $F(1, 203) = 34.29, p < .001, \eta^2 = .14$  in comparison to the Mot-SelfR group after receiving the SelfR module.

Table 1. *Pairwise Comparisons With Means (SD; Range) Between the Two Intervention Groups at the Different Measurement Points*

Outcomes	Time points	Mot-SelfR (n = 94)	SelfR-Mot (n = 112)	<i>p</i>
Handwashing	Time 1	6.22 (1.99;3–11)	6.21 (1.56;3–11)	>.05
	Time 2	7.25 (1.91;3–16)	8.68 (1.74;4–13)	<.001
	Time 3	9.30 (2.36;3–14)	9.06 (2.72;3–15)	>.05
Intention	Time 1	2.02 (0.86;1–4)	1.95 (0.67;1–3.50)	>.05
	Time 2	2.86 (0.66;1–4)	2.65 (0.84;1–4)	=.06
	Time 3	2.59 (0.84;1–4)	3.18 (0.63;1–4)	<.001
Self-efficacy	Time 1	2.24 (0.65;1–4)	2.22 (0.37;1–3.33)	>.05
	Time 2	2.59 (0.42;1–4)	3.02 (0.58;1.33-4)	<.001
	Time 3	3.07 (0.59;1–4)	3.16 (0.53;1.67-4)	>.05
Planning	Time 1	1.92 (0.62;1–3.33)	1.84 (0.31;1–2.67)	>.05
	Time 2	1.83 (0.48;1–3.50)	2.79 (0.62;1–4)	<.001
	Time 3	2.94 (0.59;1–4)	2.75 (0.63;1–3.83)	<.05

*Note:* T2 took place 17 days after T1, and T3 34 days after T1. There were no baseline differences at T1 ( $p > .05$ ) between the two intervention groups.

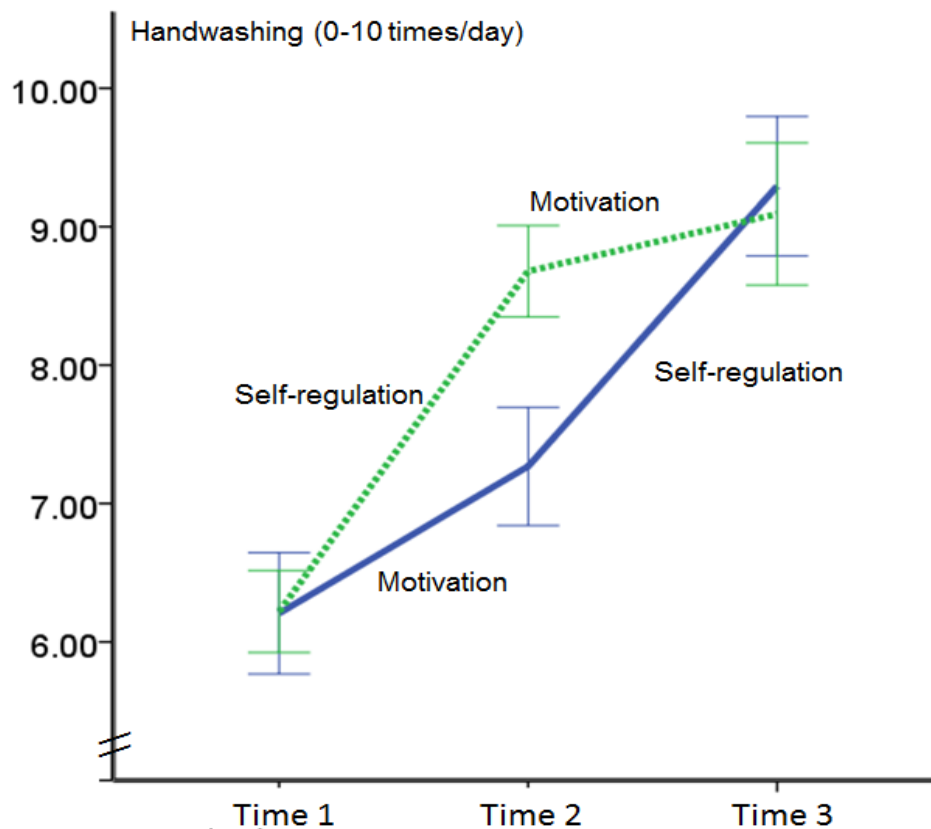


Figure 2. Handwashing frequency levels for two experimental conditions at three measurement points in time (Mot-SelfR: first motivation, then self-regulation; SelfR-Mot: first self-regulation, then motivation).

For *self-efficacy*, a main effect of time emerged,  $F(2, 404) = 184.32, p < .001, \eta^2 = .48$ , as well as a significant treatment effect resulted,  $F(1, 202) = 9.57, p < .01, \eta^2 = .05$ . There was also a significant interaction between treatment and time,  $F(2, 404) = 13.45, p < .001, \eta^2 = .06$ . Figure 3a displays the patterns of differences in self-efficacy. In pairwise comparisons, at T2, the SelfR module had resulted in a higher level of self-efficacy than the Mot module with  $F(1, 201) = 39.17, p < .001, \eta^2 = .16$ . After both groups had received both intervention components, this difference was maintained descriptively at T3; however, the ANCOVA yielded  $F(1, 203) = 1.44, p = .23, \eta^2 = .01$  and the result indicated that the difference was no longer significant.



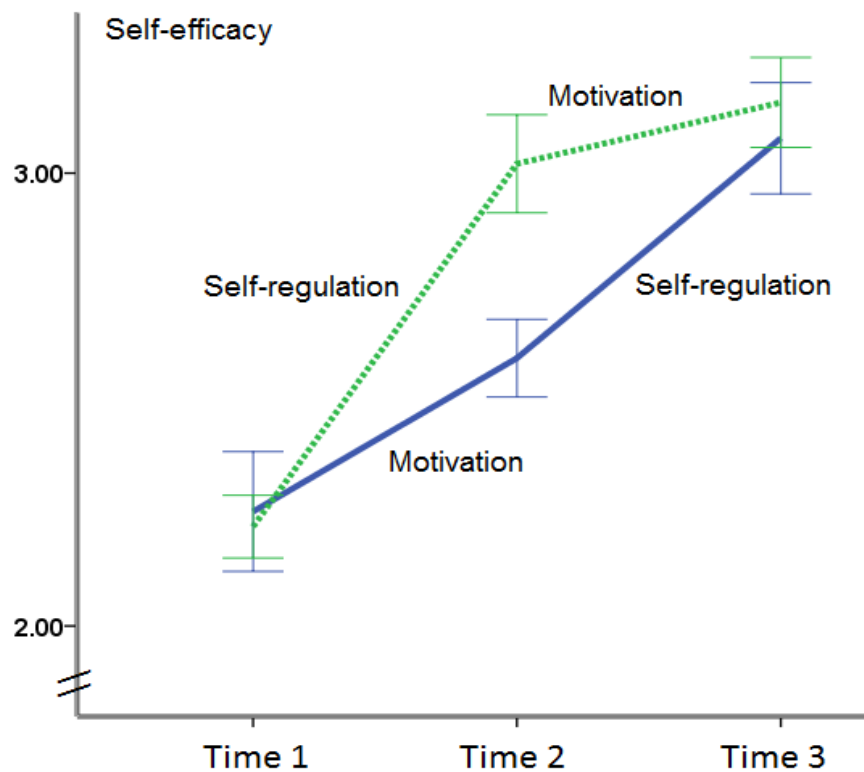


Figure 3. Self-efficacy levels for two experimental conditions at three measurement points in time (Mot-SelfR: first motivation, then self-regulation; SelfR-Mot: first self-regulation, then motivation).

For *planning*, a main effect of time was found,  $F(2, 404) = 199.59, p < .001, \eta^2 = .50$ , along with a significant treatment effect,  $F(1, 202) = 18.24, p < .001, \eta^2 = .08$ . There was also an interaction of treatment and time,  $F(2, 404) = 85.70, p < .001, \eta^2 = .30$  (see Figure 3b).

Pairwise comparisons revealed that at T2, the SelfR module had resulted in a higher level of planning than the Mot module with  $F(1, 201) = 159.21, p < .001, \eta^2 = .44$ . However, at T3, when both groups had received both intervention modules, the Mot-SelfR group developed significantly higher planning levels with  $F(1, 203) = 4.16, p < .05, \eta^2 = .02$ , than the SelfR-Mot group.

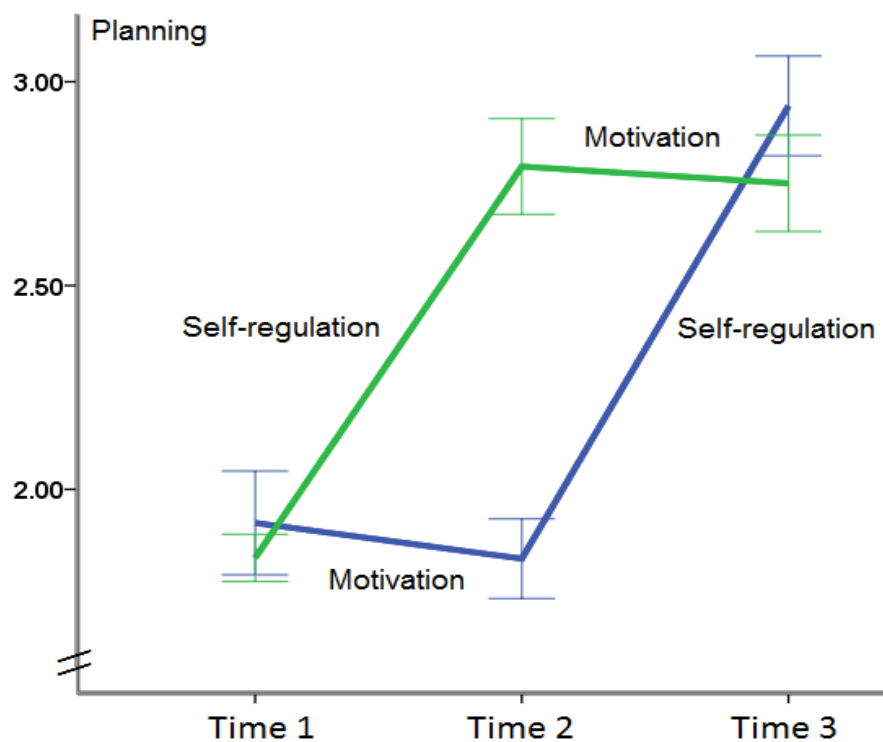


Figure 4. Planning levels for two experimental conditions at three measurement points in time (Mot-SelfR: first motivation, then self-regulation; SelfR-Mot: first self-regulation, then motivation).

### Discussion

This study explored whether it would make a difference in which order a set of motivational and self-regulatory interventions modules are presented to improve hand hygiene in young adults.

The two intervention modules (a motivational intervention and a self-regulatory intervention) were theory-guided, based on the HAPA [16]. Therefore, the intervention modules included psychological constructs such as risk-perception and outcome expectancies (Mot intervention) as well as perceived self-efficacy and planning (SelfR intervention). Two experimental groups were treated with both interventions, but in two different sequences (Mot-SelfR versus SelfR-Mot), testing their differential effects.

The Mot-SelfR proved to be slightly more effective than the SelfR-Mot to promote

handwashing, however, not being significant. This result supports descriptively the first hypothesis and replicates the findings of a previous study on fruit and vegetable intake [17].

Moreover, results yielded that the main differences were observed at T2, when both groups were exposed only to a single intervention, either the motivational or the self-regulatory one. This substantial group difference vanished at T3, after all participants had been exposed to both kinds of interventions. Thus, this research demonstrates that a motivational intervention in itself leads to a mere increase in intention but does not lead to behavior change replicating the previous study [29; 30]. The more successful approach lies in the acquisition of self-regulatory skills and the development of confidence in one's agency confirming the second hypothesis: the motivational intervention component was assumed to only increase the intention of the participants. This assumption was corroborated by the data as intention was higher in both groups right after they had received the motivational intervention.

Hypothesis 2 also assumed that planning and actual change in the behavior would be higher after individuals of both groups had received the self-regulatory intervention component. This especially was supported for planning. Regarding the actual behavior change, the assumption can also be supported as not only the mean level of behavior at the measurement points should be evaluated but also the change in behavior and other test variables. Overall, the motivational intervention, which was mainly educational, did not lead to strong effects in behavior change [31]. It is important that people first set a goal which then needs to be translated into behavior. If individuals have to plan a non-intended behavior, this might have adverse effects. Although it has been frequently shown [32] that conditional planning (if-then) structures such as coping planning are more effective than simply specifying the when, where, and how (action planning), the current study yielded similar

effects of action and coping planning on handwashing behavior. This may be due to the habitual nature of the behavior that is produced by particular cues, often as a part of routine and, thus, these two planning components were incorporated here into one single planning construct.

While the results of the current study support the hypotheses, in contrast to previous studies among university students [7] [10], no gender differences in the handwashing compliance rate was found ( $p > .05$ ). Thus, the interventions were equally effective in men and women.

There are some limitations. Assessments were self-reported and handwashing frequency was measured retrospectively. For more objective assessments, one could use video cameras and Smart Soap (containing accelerometers that record usage) [33]. To examine more potential mechanisms of the two interventions and thus account for the complexity of a behavior-change process, effects on other constructs such as action control (i.e., monitoring one's progress, comparing performance with goals, and investing more effort if needed) should also be tested. To address the stage of change, future work might also consider a segmentation of the audience in terms of the participants' levels of previous behavior and concurrent motivation [16]. Further, it could be tested whether matched interventions work better than the mismatched treatments. However, as in this study the baseline handwashing compliance rate was only 4%, it was assumed that almost all participants were initially unmotivated to adopt handwashing 10 times daily. Therefore, no distinction was made between participants in terms of intenders, non-intenders, and actors. Rather, the effectiveness of two intervention modules (Motivation and Self-regulation) was evaluated and a large proportion of participants seemed to have benefitted from both interventions, independent of their stages of change.

It remains unclear whether the low initial compliance rate was due to lack of awareness, lack of motivation, or lack of self-regulatory skills. We assume that in educated college students, a moderate level of hygiene awareness and motivation is given, which then would mean that the translation of intention is at stake. Under such circumstances, a brief self-regulatory treatment, as provided in this study, might be a useful shortcut towards the target behavior, without the need to provide lengthy educational messages.

In the analyses, we did not address possible mechanisms of behavior change that involve intentions, planning, and self-efficacy because this is beyond the present scope and constitutes a different research question. For example, various studies have examined the moderating role of self-efficacy in the volition phase [34]. An interaction between planning and self-efficacy on physical activity has been found [35] as well as an interaction between intention and self-efficacy on planning [36].

## **Conclusions**

The findings lead to implications for developing health behavior change interventions in public health settings. In promoting hand hygiene among young adults, the implementation of brief self-regulatory skill training appears to be promising, whereas an educational program that provides information to build motivation seems to be less effective. It does make a difference in which order the two intervention modules are presented. The sequence in which individuals were motivated first and then guided to develop their self-regulatory skills appears to be more intuitive and in line with major theories [16] than the opposite sequence, but, on the other hand, behavior change was achieved with the self-regulatory module alone, questioning the usefulness of a motivational prelude to this module.

Overall, this research has explored in a unique way the sequencing of different health behavior intervention modules and elucidated the proximal predictors of changing hand

hygiene behaviors, in this case handwashing, and, thus, contributes to the emerging literature on the developments of health behavior change techniques.

### **Competing interests**

The authors declare that they have no competing interests.

### **Authors' contributions**

PL, RS and SL have contributed to the conception and design of the study. PL performed data collection, PL and RS performed the statistical analyses. SL and NK provided guidance to the presentation of results. All authors were involved in the interpretation of the data and in drafting and revising the manuscript. All authors read and approved the final manuscript.

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# 5

## Combining Self-Management Cues with Incentives to Promote Interdental Cleaning among Indian Periodontal Disease Outpatients

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### **Abstract**

*Background:* Periodontal disease is a significant public health issue worldwide. Motivational techniques in combination with financial incentives are shown to lead to effective behavior change. The current study sought to examine whether a brief oral health promotion program (self-management cues that were based on self-efficacy and self-regulatory skills) in combination with an incentive (free dental treatment) would make a difference in the adoption of regular dental flossing in a population of Indian periodontal disease outpatients.

*Methods:* One hundred and twelve participants (n = 55 oral health promotion intervention group; n = 57 control group) were assigned to the intervention (self-management cues + incentive) or control groups, and follow-up assessments were performed three weeks later. Flossing frequency, behavioral intentions, and perceived self-efficacy served as dependent variables. Data were analyzed with mixed models, ANCOVAs, and path analyses.

*Results:* The intervention yielded effects on flossing frequency ( $p < .01$ ) and flossing intentions ( $p < .01$ ) at follow-up. Women developed stronger intentions than men. Moreover, by path analysis a sequential mediation chain was found that demonstrated an indirect effect of the intervention on flossing via self-efficacy and intentions: the intervention predicted changes in self-efficacy which, in turn, were associated with changes in intentions, predicting flossing frequency at follow up, while controlling for baseline behavior, gender, and age.

*Conclusions:* Combining incentives with minimal self-management cues has been found effective in improving interdental cleaning intentions and habits in periodontal disease patients, and the facilitating role of dental self-efficacy has been demonstrated.

*Key words:*

dental cleaning, flossing, motivation, self-efficacy, intention, incentives

## **Background**

The World Health Organization's (WHO) World Oral Health Report 2003 states that dental caries affects 60-90% of schoolchildren and the vast majority of adults [1]. Similarly, the WHO databank on periodontal disease reports 10% to 15% of adult populations suffering from the most severe forms of the disease, whereas gingival bleeding and calculus are the most prevalent [2]. Dental caries and periodontal disease are major causes of tooth loss, which then impacts on people's quality of life in terms of functionality, self-esteem, and social relationships [2]. Both are attributed to poor oral hygiene, with non-compliance to protective measures and patient behavior leading to unnecessary diagnostic and treatment procedures thus resulting in substantial social, health, and economic costs [3].

Interdental cleaning is an effective preventive measure, which will impact on both dental caries and periodontal disease. Interdental cleaning is the practice of removing trapped food between the teeth and the biofilm of bacteria (dental plaque) that forms around the teeth and gums. Traditionally, dental floss has been used to achieve this and a systematic review concluded that flossing, in addition to toothbrushing, reduces gingivitis compared to toothbrushing alone [4]. Another systematic review on the effect of interdental brushing on oral diseases in adults reported the beneficial effects of interdental brushing reducing gingivitis, but insufficient evidence is available to determine whether interdental brushing had any benefit towards dental plaque when compared to flossing [5]. Furthermore, regular dental flossing is an effective adjunct to toothbrushing as its benefits outweigh any potential harm in avoiding plaque formation [4].

Regular interdental cleaning, such as daily dental floss use, is an uncommon behavior [6], practiced by few individuals worldwide including in India [7], resulting in a large proportion of people who floss their teeth less than the recommended time or not at all. Given

that both dental caries and periodontal disease are largely preventable, it is likely that decisions informing individuals' behavior to prevent these oral diseases have psychological origins. Prior research has shown that lack of self-efficacy and self-regulatory skills are associated with a disinclination to change dental flossing behavior [8, 9]. Raising people's self-efficacy and providing them with sufficient skills (such as setting goals) is likely to increase their motivation translating into action. Thus, adopting such a strategy may be effective in improving people's flossing habits. In addition, a number of countries (see e.g., 10] have adopted healthcare policies providing individuals with financial assistance for their dental care needs with the aim to promote good oral hygiene habits. Previous research has found financial incentives to facilitate behavior change [11, 12]. Furthermore, meta-analytic research has found motivation and extrinsic incentives to jointly predict behavior, suggesting that the two are not necessarily antagonistic (in that incentives erode motivation) but should rather be considered simultaneously [13].

### **Motivation and Self-regulation toward Interdental Cleaning**

A close examination of the major motivational theories that have been applied to the understanding of health behavior assume that a motivation to act or intention formation (i.e., the amount of effort one invests in order to pursue an action) is the most proximal predictor of behavior. In the initial stage of health behavior change, people need to develop a motivation [14]. Psychological constructs such as self-efficacy and self-regulation often serve as a theoretical backdrop to motivation formation [15, 16]. Perceived self-efficacy is the confidence in one's ability to execute a difficult or resource-demanding behavior [17]. The difficulty here is not a technical demand of interdental cleaning but rather its regular performance as an integrated part of people's daily life. Self-efficacy has been shown to predict a wide range of health behaviors including oral self-care [18, 19]. Moreover, to adopt

or maintain regular interdental cleaning, one can be motivated by self-efficacy followed by self-regulatory skills, such as planning and action control, to translate motivation into actual dental cleaning performance [8, 15, 20]. Studies have reported beneficial effects of such self-regulatory skills on dental flossing [21, 22], and a combination of self-efficacy and planning has been found to be associated with higher frequency in performing dental self-care [23]. In a cluster randomized controlled trial with Iranian adolescent girls, Gholami et al. [24] identified positive effects of a brief self-regulatory intervention on dental flossing, in which changes in self-efficacy mediated between treatment conditions and outcomes.

### **Incentives to Promote Interdental Cleaning**

Behavioral incentives are motivating rewards, including anything provided by an external agent contingent on performance of target health behaviors (e.g., free or subsidized costs for specialized health services, awards, healthcare benefits and recognitions) [25]. Incentives demonstrate to people that they are viewed as worthy of being helped, and work particularly well when targeting groups who need extra support to remove some of the financial barriers faced in trying to change health behaviors [11]. A systematic review found that financial incentives, in particular, were 1.2 to 2.5 times more effective for promoting behaviors than no intervention or usual care [11]. The acceptability of such incentives, however, rests on the incentive being fair to all recipients and members of the public and is given as a voucher rather than as cash [12]. To conclude, financial incentives are shown to have beneficial effects on people's behavior change. Moreover, considering techniques to increase motivation in addition to providing incentives as part of a behavior change program is suggested to provide most effective results [12, 13].



### **The Aim of the Current Study**

The current study investigates an educational oral health promotion program to improve motivation and interdental cleaning habits among periodontal disease outpatients. The program consisted of two components: a worksheet with self-management cues and free dental treatment as an incentive. To evaluate the effectiveness of the program in terms of changes in behavioral intention and dental flossing, a passive control group was randomly selected. It was expected that participants in the health promotion intervention group compared to the control group would attain higher scores in intention (Hypothesis 1) and behavior (Hypothesis 2) at the follow-up assessment three weeks later. In addition, self-efficacy, as the putative active ingredient, was expected to be higher at follow-up in the health promotion group compared to the control group (Hypothesis 3); and that self-efficacy and intention would serve as mediators between intervention conditions and flossing at follow-up (Hypothesis 4).

## **Method**

### **Participants and Procedure**

The study adopted an experimental 2 (condition)  $\times$  2 (time) research design with a three week follow-up. The study received ethical approval by the hospital's internal review board. Study participants were recruited between October and December, 2014 during regular outpatient visits at the Dental College and Hospital, Shimla, Himachal Pradesh, India. A blinded research associate (third author) invited the outpatients to participate voluntarily in a study on preventive oral hygiene. To participate, patients needed to be 18 years of age or older and clinically diagnosed with having periodontal disease. Informed consent was obtained prior to participation, and anonymity was assured by the use of an identification code. Researchers had no access to patients' health records. One hundred and eighteen

participants were assessed for eligibility of which two declined to participate. A total of 116 patients were recruited and allocated to either an intervention ( $n = 58$ ) or a control condition ( $n = 58$ ) by cluster randomization. Participants were blinded about the allocation throughout the study. Three patients from the oral health promotion intervention group were lost at baseline; thus, a total of 113 patients (67% female; Mean age = 27.05 years, SD = 12.75, ranging from 18 to 69 years) participated in the study. Three weeks later, patients were re-invited to complete the follow-up questionnaire. One participant from the control group was lost at follow-up. Final analyses, therefore, were based on 112 participants ( $n = 55$  health promotion intervention group;  $n = 57$  control group). See Figure 1.

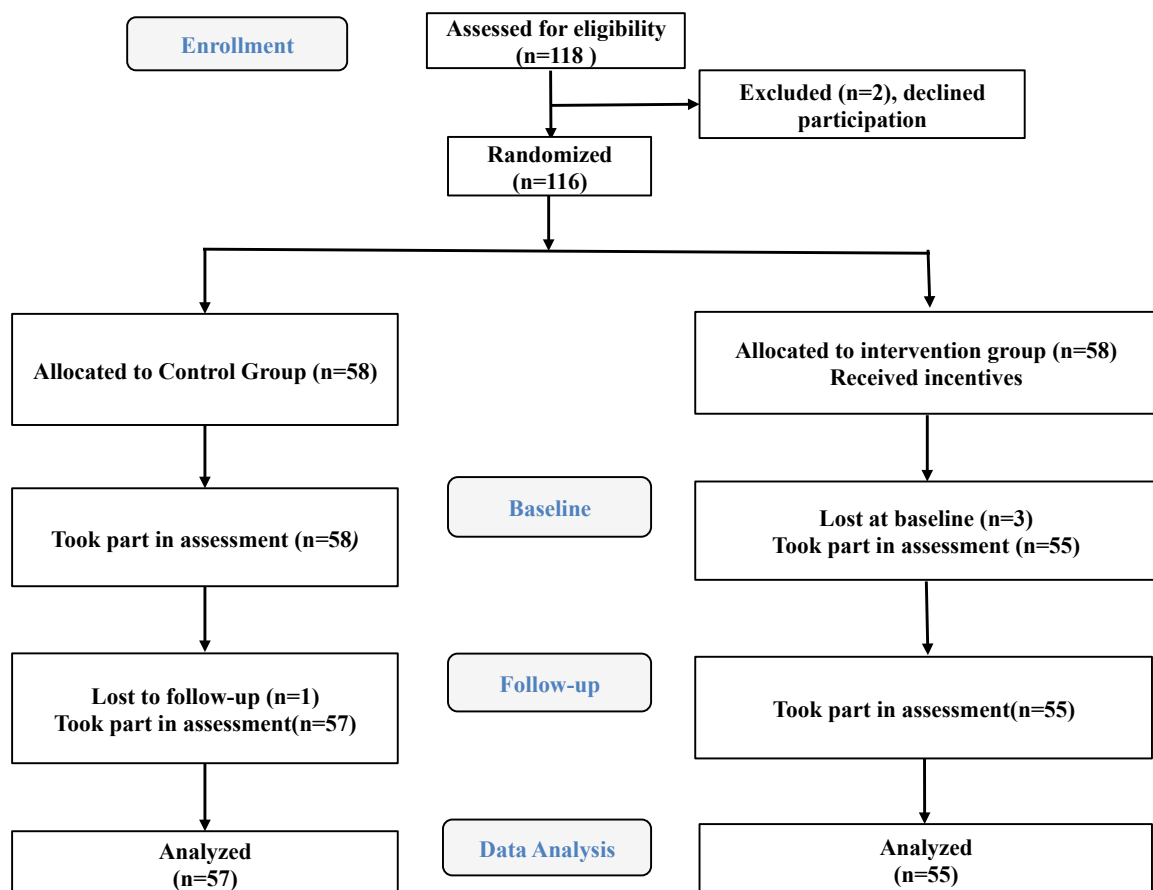


Fig. 1: CONSORT flow diagram

*Figure 1.* Flow diagram outlining participant allocation into the dental flossing health promotion group or the control group.

## **Intervention Content**

Only the intervention group received the intervention package after baseline measurement. The intervention consisted of two components: a brief psychological component of self-management cues and an incentive-based component. The self-management cues comprised strategies targeting self-efficacy and self-regulatory skills [see 26] and consisted of a two-page leaflet that included information about oral hygiene (i.e., what it is, why it is done, how it is done, and the health consequences), along with a goal setting exercise (planning when, where, and how to floss) and instructions on how to practice oral self-care. The purpose was to explore the feasibility of a very brief intervention following an idea by Sniehotta et al. [22] who conducted a one-minute intervention for changing oral self-care behavior. The incentive component comprised a financial dental care assistance incentive in the form of a free dental treatment including checkups, dentures, removing of caries, fillings, and dental aids free of charge during the study period. This was made available from a scheme called Muskan Yojna, launched by the Department of Public Health Dentistry with the purpose of giving easy oral care access to patients below the poverty line. Participants in the control group received no intervention; neither free dental aids nor instructions on what, why, and how to perform their oral self-care. They were allocated to the study during their usual dentist visits for which they cover the cost themselves, and responded only to the questionnaires at the two assessment points.

## **Measures**

### **Behavior**

Dental flossing behavior was assessed at baseline (Time 1) and follow-up (Time 2). Participants were asked to indicate the number of times they had flossed their teeth in the previous week; “During the last week, I have flossed my teeth \_\_\_\_\_ times per day”.

### **Intention**

Intention was measured at Time 1 and Time 2 with the stem item: ‘How often do you intend to floss your teeth per day?’, followed by responses ranging from *do not intend to floss at all* (0), *intend to floss once per day* (1), *intend to floss twice per day* (2) to, *intend to floss three times per day* (3)”.

### **Self-efficacy**

Flossing self-efficacy was assessed with two items at Time 1 (Spearman’s  $\rho = .88$ ) and Time 2 (Spearman’s  $\rho = .83$ ). The item stem “I am confident that I can floss my teeth this week on a regular basis...” was followed by the items “...even if it is time consuming” and “...even when it takes a long time to become part of my daily routine”. Responses were scored on a four-point Likert scale ranging from *not at all true* [1] to *exactly true* [4]. The two items were averaged to form the flossing self-efficacy scale.

### **Analytical Procedure**

Using SPSS 22, independent-sample *t*-tests,  $\chi^2$  test and MANOVA were used for attrition analysis. Intervention effects on changes in flossing as well as flossing intentions are tested with the SPSS MIXED procedure using linear 2-level models with time points nested in individuals. Flossing as well as flossing intentions are level-1 dependent variables, whereas intervention conditions serve as a between-subjects covariate (level-2), and time as a within-subjects factor. The group by time interaction (cross-level interaction) will be the main test of the primary hypotheses. In a linear mixed-effects model, the responses from participants (e.g., flossing rates) are thought to be the sum of fixed and random effects. Random effects contribute only to the covariance structure of the data. The fixed effects are of primary interest, but adjustment for the covariance structure makes the results more accurate [27]. Moreover, univariate analyses of covariance (ANCOVA) are computed with

Time 2 flossing as well as flossing intentions as dependent variables, intervention conditions and gender as between-subjects factors, and baseline scores as well as age as covariates.

A sequential mediation model was conducted by means of the SPSS Process macro Hayes [28]. Intervention conditions were specified as the most distal antecedent, dental self-efficacy served as the first mediator whereas the behavioral intention served as the second mediator in a row, which also constituted the most proximal predictor of Time 2 dental flossing. This sequential model was extended by inclusion of three covariates to control for individual differences in baseline flossing, age, and gender. Confidence intervals (95%) were generated by bootstrapping with 5,000 re-samples. Bootstrapping is a non-parametric re-sampling procedure that allows generating confidence intervals for statistical inference where normality assumptions about the sample distribution are not required. It is recommended for mediation analyses, including serial multiple mediation models [28]. The entire analysis was then replicated by structural equation modeling using AMOS 21 with full information maximum likelihood (FIML). The latter procedure provided the standardized parameter estimates (betas).

## **Results**

### **Preliminary Analyses**

Demographic details of the study participants along with the means, standard deviations, and group comparison statistics are summarized in Table 1. Correlations between the study variables are summarized in Table 2. Age differences occurred ( $p < .01$ ), with greater numbers of older patients assigned to the health promotion intervention group ( $M = 31.58$ ,  $SD = 14.05$ ) than to the control group ( $M = 22.76$ ,  $SD = 9.68$ ). No gender differences between groups were found ( $p > .05$ ).

Table 1. Means and Standard Deviations (SD) of Study Variables and Pairwise Comparisons between the Two Groups at Two Measurement Points in Time

Variables	Time points	Control Group	Intervention Group	<i>p</i>	Effect size <i>eta</i> <sup>2</sup>
		(n=57)	(n=55)		
		Means (SD)			
<b>Flossing</b>	Baseline	1.00 (0.80)	1.11 (0.74)	.46	0.01
-	Follow-up	1.02 (1.01)	1.89 (0.90)	<.001	.18
<b>Self-efficacy</b>	Baseline	2.03 (0.92)	1.64 (0.75)	.02	0.05
-	Follow-up	2.45 (0.95)	2.63 (0.99)	.35	0.01
<b>Intention</b>	Baseline	0.96 (0.94)	1.16 (0.66)	.20	0.02
-	Follow-up	1.33 (1.30)	2.09 (0.87)	<.001	0.11
<b>Age</b>	-	22.81 (9.76)	31.58 (14.05)	<.001	0.12
<b>Gender (Female/Male)</b>	-	42/16	34/21	.26	0.01

### Intervention Effects

**Dental flossing.** Two-level linear mixed models were computed with time points nested in individuals, using flossing frequencies at both time points as the level-1 dependent variable and intervention conditions (groups) as well as gender as level-2 covariates. The results revealed neither a main effect of gender nor an interaction of gender and time. Therefore, we report the corresponding analyses without the covariate gender (see Table 3). The intercept of 1.02 describes the ending status of the control group (flossing, Time 2). The group estimate of 0.87 ( $p < .01$ ) reflects the difference to the treatment group which means that  $1.02 + 0.87 = 1.89$  is the Time 2 mean for the treatment group. The time estimate of -0.02 reflects the initial status of the control group ( $1.02 - 0.02 = 1.00$  at Time 1). The cross-level interaction estimate indicates that there was a steep increase for the treatment group over time

(0.76,  $p < .01$ ). The estimates of covariance parameters signify no variance at Time 1 and a large variance at Time 2 ( $p = .01$ ). Also, the variance component of 0.28 ( $p < .01$ ) at the person level (level 2) is significant.

Table 2. *Pearson Correlations of Dental Flossing, Intention, Self-efficacy, Age, and Gender*

Variables	2	3	4	5	6	7	8
1. Flossing T1	.21*	.63**	.37**	.10	.14	.12	.25**
2. Self-efficacy T1		.17	.01	.26**	-.06	-.08	-.03
3. Flossing Intention T1			.27**	.06	.26**	.07	.21**
4. Flossing T2				.34**	.59**	.21*	.08
5. Self-efficacy T2					.50**	.00	.08
6. Intention T2						.14	.15
7. Age							.29**
8. Gender							

Note: \* $p < .05$ ; \*\* $p < .01$ ; T1 = Time 1, T2 = Time 2

### Flossing intentions

The same type of 2-level linear mixed models were computed for flossing intentions as dependent variable, including gender as an additional level-2 covariate because preliminary analyses revealed significant gender effects (see Table 3). The intercept of 1.12 describes the ending status of the control group (flossing intentions, Time 2). The group estimate of 1.04 ( $p < .01$ ) reflects the difference to the treatment group which means that  $1.12 + 1.04 = 2.16$  is the Time 2 mean for the treatment group. The time estimate of -0.38 reflects the initial status of the control group ( $1.12 - 0.38 = 0.74$  at Time 1). The cross-level interaction estimate indicates that there was a steeper increase for the treatment group over time (0.56,  $p = .02$ ).

Table 3. *Estimates of Linear Mixed Model Over 20 days for Flossing and Flossing Intentions as a Function of Intervention (N=112)*

<b>Model parameters for flossing</b>				95% CI	
Fixed effects (intercept, slopes)	Estimate (SE)	<i>t</i>	<i>p</i>	Lower Bound	Upper Bound
Intercept	1.02 (0.13)	8.04	< .01	0.08	1.27
Group	0.87 (0.18)	4.84	< .01	0.52	1.23
Time	-0.02 (0.13)	-0.14	.89	-0.27	0.24
Group x Time	-0.76 (0.18)	-4.15	< .01	-1.13	-0.40
<b>Estimates of covariance parameters for flossing</b>				Wald's z	
Repeated Measures Var1	0.04 (0.13)	0.28	.78	0.00	38.06
Repeated measures Var2	0.35 (0.14)	2.56	.01	0.17	0.76
Intercept + time (subjects)	0.28 (0.08)	3.71	< .01	0.16	0.47
<b>Model parameters for intentions</b>				95% CI	
Fixed effects (intercept, slopes)	Estimate (SE)	<i>t</i>	<i>p</i>	Lower Bound	Upper Bound
Intercept	1.12 (0.16)	7.09	< .01	0.80	1.43
Group	1.04 (0.22)	4.70	< .01	0.60	1.47
Time	-0.38 (0.18)	-2.19	.03	-0.73	-0.04
Gender	0.77 (0.26)	2.98	.003	0.26	1.28
Group x Time	-0.56 (0.23)	-2.44	.016	-1.02	-0.11
Group x Gender	-0.93 (0.28)	-3.37	.001	-1.48	-0.38
Time x Gender	0.06 (0.25)	0.23	.821	-0.43	0.54
<b>Estimates of covariance parameters for intentions</b>				Wald's z	
Repeated Measures Var1	0.36 (0.17)	2.16	.03	0.15	0.90
Repeated measures Var2	0.84 (0.20)	4.28	< .01	0.53	1.33
Intercept + time (subjects)	0.14 (0.08)	1.68	.09	0.04	0.44

The gender estimate of 0.77 ( $p < .01$ ) indicates that men



The gender estimate of 0.77 ( $p < .01$ ) indicates that men (coded 1) had a follow-up mean score of 1.89 (independent of intervention conditions). The group x gender estimate of -0.93 ( $p < .01$ ) signifies the difference between intervention conditions for women as opposed to men. The time x gender interaction, on the other hand, was not significant. The covariance parameter estimates signify substantial variance at both time points whereas the person level (level 2) variance component is no longer significant due to the inclusion of level-2 covariates.

### **Gender differences**

ANCOVA results implied that women benefitted more from the intervention than men resulting in higher levels in flossing frequency and flossing intentions (see Figure 2). Using univariate analysis of covariance (ANCOVA) with baseline (Time 1) flossing, age, and gender as covariates, it was found that there were group differences for flossing at follow-up (Time 2),  $F(1, 106) = 12.77, p = .001, \eta^2 = 0.11$ . The intervention group obtained a higher level of flossing frequency,  $M = 1.79, SE = .13, 95\% CI [1.53; 2.04]$  than the control group,  $M = 1.11, SE = .13, 95\% CI [0.85; 1.37]$ . This finding confirms the Hypothesis 1. Group means, adjusted for the covariates, are displayed in Figure 2 (right panel). For flossing intentions, ANCOVA with the same covariates also yielded group differences at follow-up (Time 2),  $F(1, 106) = 3.94, p = .05, \eta^2 = 0.04$ . The intervention group obtained higher levels of flossing intentions,  $M = 2.01, SE = .15, 95\% CI [1.71; 2.31]$  than the patients in control group,  $M = 1.57, SE = .16, 95\% CI [1.26; 1.88]$  confirming Hypothesis 2. Group means, adjusted for the covariates, are displayed in Figure 2 (left panel).

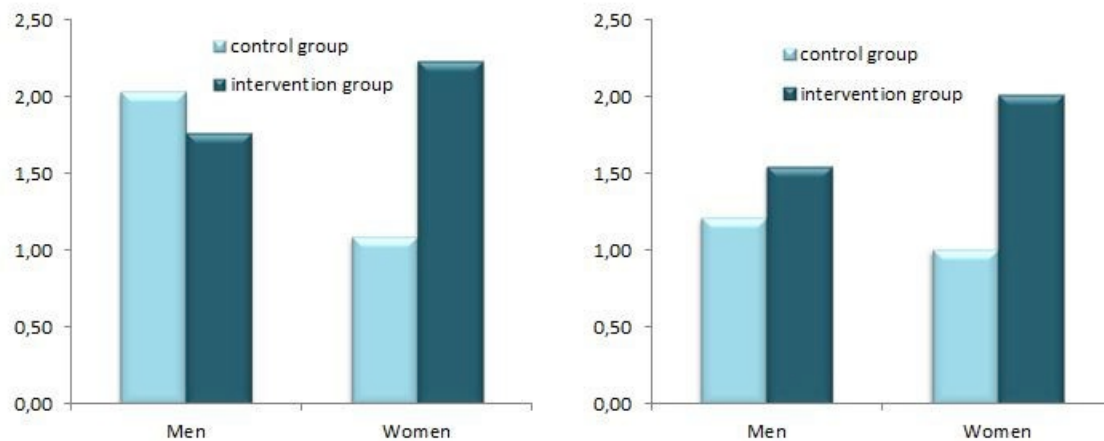
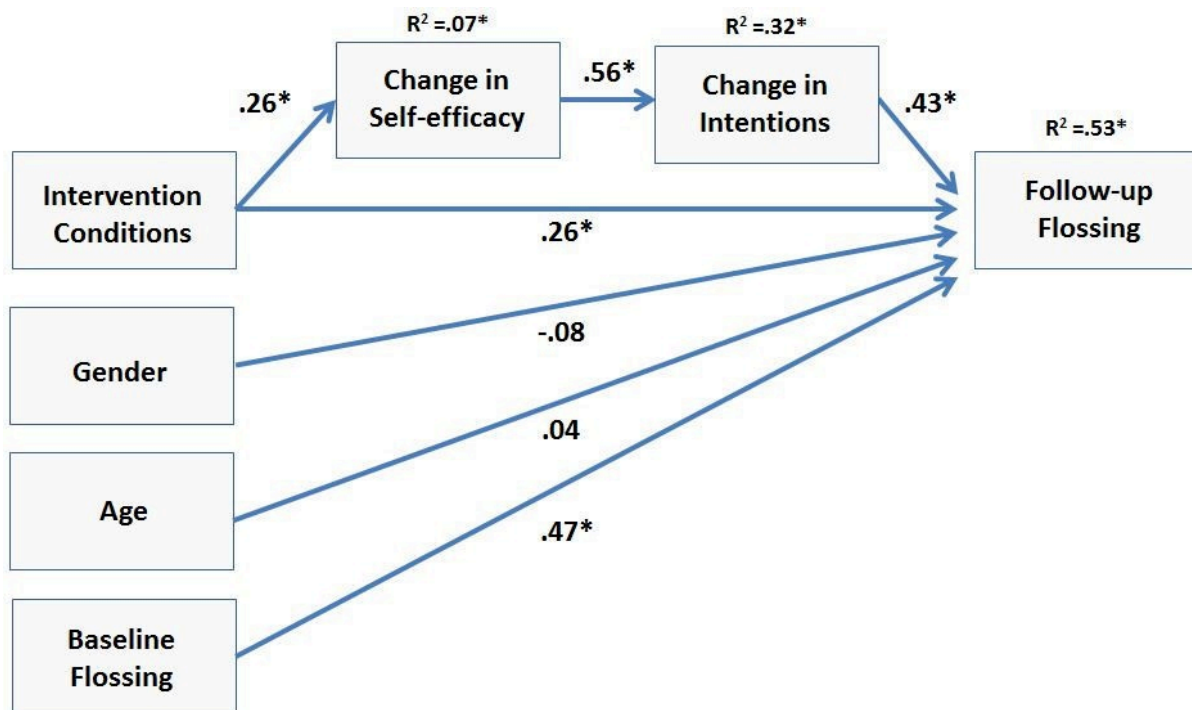


Figure 2. Follow-up means of dental flossing intentions (left panel) and dental flossing frequency (right panel) adjusted for baseline levels and age.

### Testing the Mechanisms: A Sequential Mediation Chain

First, testing the model with manifest variable regressions revealed that there remained a direct effect between conditions and Time 2 flossing,  $p < .01$ , CI 95% [.25, .90]. Also, the covariates age,  $p = .58$ , CI 95% [-.01, .02] and gender,  $p = .09$ , CI 95% [-.65, .05] had no relationship to the target variable. The sequential mediation chain via two mediators yielded an indirect effect,  $p < .05$ , CI 95% [.01, .23] whereas the other pathways did not yield significant indirect effects. Second, structural equation model fit was  $\chi^2 (8 \text{ df}) = 14.4$ ,  $p = .07$ ,  $\chi^2/\text{df} = 1.8$ , CFI = .95, RMSEA = 0.08 [.0, .15]. Figure 3 displays all standardized full information maximum likelihood estimates based on structural equation modeling with AMOS. Of the flossing variance, 53% were accounted for by baseline flossing ( $\beta = .47$ ), intervention conditions ( $\beta = .26$ ), and intentions ( $\beta = .43$ ). Group membership predicted changes in self-efficacy ( $\beta = .26$ ), although there was no significant effect on Time 2 self-efficacy, as found in the previous analyses. Changes in self-efficacy predicted changes in intentions ( $\beta = .56$ ). Control variables age and gender did not contribute to the prediction. Three mediation pathways were tested by bootstrapping: (a) the sequential mediation chain

via two mediators yielded an indirect effect,  $\beta = .10$ ,  $p < .05$ , CI 95% [.01, .23]; (b) the simple mediation path from group via self-efficacy to flossing was not significant; and (c) the simple mediation from group via intention to flossing was also not significant.



*Figure 3.* Mediation chain predicting dental flossing by treatment via changes in self-efficacy and intentions, controlling for baseline flossing, gender, and age. Full information maximum likelihood estimates,  $N = 112$ . Note: Baseline intercorrelations omitted for easier communication. Gender (1 = male, 0 = female), intervention conditions (1 = treatment, 0 = controls), \* =  $p < .01$

## Discussion

Previous research has found motivational techniques in combination with financial incentives lead to effective behavior change [13]; however, further research is needed to confirm such suggestions. Given periodontal disease is a significant public health issue worldwide [1], the current study sought to examine whether a brief health education promotion program (worksheet with self-management cues that were based on self-efficacy

and self-regulatory skills) in combination with an incentive (free dental treatment) would make a difference in the adoption of regular dental flossing in a population of Indian periodontal disease outpatients. Changes in motivation (defined as behavioral intention) and flossing as outcomes were assessed three weeks after baseline.

In the current study, the time x group interaction for self-efficacy did not reach significance, disconfirming Hypothesis 3. However, a significant interaction was found for intention and flossing in which the intervention group improved in terms of these two outcome variables, confirming Hypothesis 1 and 2. Moreover, self-efficacy and intention were specified in a path model as mediators between intervention conditions and subsequent dental flossing behaviours, confirming Hypothesis 4.

The findings revealed a sequential mediator model in which first changes in self-efficacy and afterwards changes in intention mediated between intervention conditions and behavioral outcomes. In their Iranian sample, Gholami et al. (24) identified a similar sequential mediation via intention and self-efficacy on dental flossing. In their study, however, the two mediators were placed in a different order, suggesting first changes in intentions and afterwards changes in self-efficacy mediated between intervention conditions and behavioral outcomes. This difference in ordering may be the result of the type of self-efficacy construct examined and its item wording used in different studies. Self-efficacy as a stage-specific construct can be a predictor of intention in an earlier stage of health behavior change (as in the current study), or it can be a most proximal predictor of behavior at a later stage of change (as in Gholami et al's study). Nevertheless, the sequential mediation chain identified in these studies highlight the fact that both self-efficacy and intention play a significant role in the mechanism that facilitates dental flossing. Results indicate the mediating role of behavioral intention and self-beliefs in predicting the desired health

behavior (dental flossing) in periodontal disease patients. Thus, the findings illustrate that oral awareness promotes the formation of behavioral intentions as well as stronger self-beliefs (self-efficacy) for increased oral health behaviors which, in turn, were associated with better oral health status in dental patients as found in previous studies [18, 3]. Such findings are in line with studies documenting that intention and self-efficacy serve as proximal predictors of dental flossing, and often as mediators [e.g., 29, 21, 30]. *The current study may contribute to develop interventions facilitating dental self-care to improve oral health status* [see review 31]. Finally, although not an explicit research question of the current study, a gender effect on flossing intentions as well as a group x gender interaction was observed in that females benefitted more than males from the intervention. This finding is in line with other research suggesting gender differences are evident for health behaviors [16], including for oral hygiene care behaviors [32, 33].

The current study suffers from some limitations. Assessments were self-reported and dental flossing was measured retrospectively. One could use on-going behavioral assessments such as dental calendars that individuals can deposit in their bathrooms to tick every flossing incident [8]. In addition, flossing intention was assessed by a single item, which limits assessing its reliability. Single item measures, however, are in line with a large number of health psychology studies (e.g., [34]). Furthermore, the oral health promotion program consisted of a multi-component approach involving self-management cues with an incentive and, as such, cannot disentangle the most active ingredient. Finally, periodontal disease patients need daily interdental cleaning for infection control; thus, the short-term follow-up period in the current study needs to be extended to determine the longer-term effects of the program.

## **Conclusion**

Nevertheless, the current study's brief oral health promotion intervention yielded positive effects on dental flossing intentions and behavior in a group already diagnosed with periodontal disease. Moreover, the current study was able to elucidate the mechanisms of changing dental flossing behaviors in a group at risk for further oral disease issues. The findings partly replicate similar studies [20, 24, 33] and, thus, make a contribution to the cumulative knowledge about psychological components in dental hygiene behavior change.

## **List of abbreviations**

CFI comparative fit index

CI confidence interval

MANOVA multivariate analysis of variance

ANCOVA analysis of covariance

RMSEA root mean square error of approximation

## **Competing interests**

NONE

## **Authors' contributions**

PL planned and coordinated the study, participated in the statistical analyses, and prepared a first draft, KH and JK substantially rewrote the paper, NS and SS carried out the study, NK and RS conceived of the study, participated in its design and statistical analyses and helped to draft the manuscript.

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# 6

## General Discussion

### General Discussion

The objective of this thesis was to compare the efficacy of different theory-based intervention components in order to investigate more effective and parsimonious interventions to improve the enactment of dietary intake, oral hygiene, and hand hygiene. These behaviors have to be practiced *regularly* to be effective and therefore pose special challenges for self-regulation as compared to health behaviors with one-off performance (Sutton, 1994) such as vaccination or cancer screening. Moreover, regular compliance with these behaviors is of a great relevance for people's overall physical and mental well-being, and therefore the World Health Organization repeatedly provides guidelines on these behaviors (WHO, 2015).

However, these health behaviors are associated with different social-cognitive factors, and changing them is a complex process, for which psychological theories were necessary. Accordingly, a number of social cognitive theories that were developed to guide the health related-behavior change processes posited that intention was the core predictor of behavior, and neglected the question of the intention-behavior gap (Sheeran, 2002). In other words, it can be assumed that intentions play a crucial role in health-behavior change, its predictive value is limited because the gap between intention and behavior can mainly be linked to individuals who intend to act, but often fail to realize their intentions; they are described as "inclined abstainers" (Orbell & Sheeran, 1998; Sniehotta, Araújo-Soares, & Dombrowski, 2007). To understand the mechanisms governing why and how people change their behavior, further post-intentional processes of goal pursuit must be considered and examined. Thus, many researchers augmented motivational prediction models by adding volitional constructs, such as implementation intention (Gollwitzer, 1999) or planning and action control (Schwarzer, 1999).

The health action process approach (HAPA; Schwarzer, Lippke, & Luszczynska, 2011; Schwarzer, 2008) is comprised of the highly predictive constructs of the model of action phases (Heckhausen & Gollwitzer, 1987) and social-cognitive theory (Bandura, 2001), which explains the intention-behavior gap to improve behavior changes. In addition, the HAPA model can describe, explain, and predict behavior change (as a continuum layer), and it is also useful for the development of behavior change interventions (as a stage layer). Thus, the theoretical rationale for this thesis was inspired by the HAPA model (Schwarzer, 1992, 2008), which serves as an integrated theoretical framework, with assumptions from the continuum and stage models of health behavior. To test the theory-derived hypotheses, four experimental studies were carried out in order to evaluate the impact of interventions derived from the HAPA theory and its appliance in behavior change.

### *Summary of Overall Results*

The following first part of the discussion corresponds to the main research objectives outlined in the introductory *chapter 1*. More specifically, results from the first three studies (*Chapter 2, 3, and 4*) will be discussed under the first subheading; *Motivation and self-regulation: Sequential-interventions do make a difference to change health behaviors*, second subheading; *Obtained patterns in the sequential-interventions: The superiority of self-regulation over motivation intervention*, and third subheading; *What do the first three studies of this thesis (Chapter 2, 3, and 4) add?* The results from the fourth intervention study (*Chapter 5*) will be discussed under the fourth subheading; *A motivational technique combined with an incentive facilitates oral self-care among periodontal patients* and the fifth subheading; *What is new from this study?*

The overarching aim of the current dissertation was threefold. The first aim, addressed in *Chapters 2, 3, and 4*, was to explore the most effective sequential application of the two phases of the HAPA theory into health behavior change intervention development and evaluation. The second aim was to identify the proximal predictors within the motivation and volition phases of the HAPA framework in changing health behaviors. Finally, this thesis investigates the efficacy of motivational techniques derived from the HAPA when combined with financial incentives to promote the adoption and maintenance of an interdental cleaning regimen. The findings of this dissertation are specified and elucidated below.

*Motivation and Self-Regulation: Sequential-Interventions Showed Differences in Changing Health Behaviors*

Prominent theories of health behavior change propose that individuals first need to become motivated to change their health behaviors and only *then* do they need to acquire the accurate skills to translate their intention into action (Schwarzer, 2008; Weinstein & Sandman, 1992), but virtually no health-psychological studies prior to the present thesis have directly tested this supposition. To fill this gap in the literature, the efficacy of two intervention arms, a motivation arm and a self-regulation arm inspired by the HAPA model were compared, in terms of promoting different regular health behaviors. Two intervention arms provided the same content (*Mot*; pre-intentional strategies) and self-regulation (*SelfR*; post-intentional strategies) but they were placed in different sequences (first motivation, then self-regulation; *MotSelfR* versus first self-regulation, then motivation; *SelfRMot*). Hence, through this sequential intervention, it was investigated whether the sequence in which these two interventions are delivered make a difference in changing the health behaviors. We also investigated whether the same sequential design was justified and validated by investigating

multiple regular health behaviors, namely increasing fruit and vegetable (FVI) in *Chapter 2*, promoting oral self-care, taking dental flossing as an example in *Chapter 3*, and improving hand hygiene, focusing on handwashing in this case in *Chapter 4*. The principal findings on testing hypotheses for all included studies are outlined underneath.

### *Sequential-Intervention in terms of Dietary Behavior*

Despite the fact that dietary habits are difficult to change (see review by Adriaanse, Vinkers, De Ridder, Hox, & De Wit, 2011), a good number of studies has documented the effectiveness of motivational interventions and self-regulatory interventions (Gholami, Lange, Luszczynska, Knoll, & Schwarzer, 2013; Kothe, 2014) for the promotion of FVI. Furthermore, the combination of motivational intervention components with self-regulatory ones, such as planning, has proven more effective in the promotion of FVI than a self-efficacy intervention or a mere informational intervention (Stadler, Oettingen, & Gollwitzer, 2010).

In *chapter 2*, an intervention study was conducted to explore the effectiveness of two subsequent intervention components (motivational; outcome expectancies, risk perception, and task self-efficacy, and self-regulatory components; planning and dietary self-efficacy) to increase FVI among young adults in India. Two intervention components were placed in two different sequences and compared their efficacy i.e., MotSelfR versus SelfRMot where the outcomes were assessed at three assessment points. In pre-post comparison, independent of groups, all participants improved their nutritional behavior as reflected by attaining higher levels of FVI and increased in their dietary self-efficacy and intention, although the self-regulatory group improved more. This confirmed that motivational as well as self-regulatory strategies facilitate consumption of FV, hence replicating the findings of the previous studies (e.g., Evans, Kawabata, & Thomas, 2015). With regard to the sequential-interventions



comparison, the sequence of motivational components preceding self-regulatory components proved to be more effective than the opposite sequence i.e., self-regulatory component preceding motivational components, for the promotion of FVI. Moreover, the theoretical model was examined with a structural equation model (SEM) in which changes in intention and self-efficacy were specified as mediators between intervention sequence and subsequent behavior, suggesting that improvement in terms of behavioral intentions and self-efficacy was responsible for the behavioral gain. The working mechanism of these two proximal predictors of FVI as mediators will be explained in the later part of the discussion in detail.

#### *The Motivation and Self-Regulation Sequences in terms of Oral Self-Care (Flossing)*

In the second study in *Chapter 3*, we examined the effectiveness of two sequential interventions, Mot-SelfR versus SelfR-Mot, which were designed similarly to those applied in *chapter 2*, to improve oral self-care regimens. The pre-post comparison analysis of this study showed that majority of the participants did not reach the recommended floss rate based on our measurement prior to the study (i.e., the baseline weekly flossing rate was almost zero), replicating the previous studies on oral hygiene (Grewal et al., 2014; Suresh et al., 2012). Findings from the same analysis showed also that all participants in both groups improved their oral self-care as reflected by increasing their dental flossing level as well as experiencing general increases in self-efficacy, planning, and action control supporting the hypothesis 1.

However, while participants were in the self-regulation condition, they gained more benefits in terms of the four variables than while being in the motivational condition. This highlighted the superiority of a self-regulatory intervention over a mere motivational one to improve dental flossing replicating the findings in *chapter 2* in the context of FVI (Lhakhang,

Godinho, Knoll, & Schwarzer, 2014) and in the context of hand hygiene (Lhakhang, Lippke, Knoll, & Schwarzer, 2015) in *Chapter 4* and thus, supported our third hypothesis. In contrast to the findings for the FVI in chapter 2 and hand hygiene in *chapter 4*, the sequential intervention comparison did demonstrate differences in their effectiveness; however, the pattern of superiority of Mot-SelfR over SelfR-Mot did not remain over the entire period in terms of flossing frequency and the psychosocial determinants. The substantial group differentiation from the effectiveness of two interventions in terms of all four outcomes vanished at Time 3. This was at the point when all participants had been already exposed to both kinds of intervention. In other words, no significant differences were found between the two intervention sequences, hence rejecting hypothesis 2 of the study.

#### *Sequential-Interventions in Hand Hygiene Regimen*

In *chapter 4* of the current thesis, the question of sequential-intervention was cross-examined in the context of hand hygiene. It explored whether it would make a difference in which order a set of motivational and self-regulatory intervention modules were presented to improve hand hygiene in young adults. Here, the Mot module included psychological constructs such as risk-perception and outcome expectancies, and perceived self-efficacy and planning were included in the SelfR-module.

In sequential intervention comparison, the Mot-SelfR sequence proved slightly more effective than the opposite sequence SelfR-Mot in promoting handwashing, however, the differential effects were not significant. Therefore, the hypothesis was supported to a certain extent. This supports the HAPA-based established assumption that a motivational intervention should precede a self-regulatory intervention, and thus partially replicates the findings of a previous study on the FVI (Lhakhang et al., 2014). Furthermore, individuals in both groups

had increased their planning level and improved handwashing compliance after they received the self-regulatory intervention, whereas they showed increase only in their intention level after they received the motivational intervention, no matter at which point in time. This finding supported the second hypothesis of the study. Accordingly, the motivational package was mainly education and therefore, did not lead to strong effects on the participants' behavior in both the groups. This was in line with the established evidence that knowledge alone does not always improve behavior (see reviews by Huis et al., 2012; Pellegrino, Crandall, O'Bryan, & Seo, 2015). Finally, in contrast to the previous studies (e.g., Larson, 2013), no gender differences in the handwashing compliance rate were found. The interventions were equally effective in men and women.

To conclude on the sequential-interventions theme, FVI study in *chapter 2* clearly demonstrated that it does make a difference in which order the HAPA-based two intervention modules are presented. The sequence in which individuals were motivated first and then guided to develop their self-regulatory skills appears to be more intuitive and in line with major theories (Schwarzer, 2008). *Chapter 4* did demonstrate the superiority of intervention sequence where motivational preceded self-regulatory over the opposite sequence in terms of hand hygiene regimen, though the differences in the findings were not significant, thus it partly replicates the FV intake study in *chapter 2*. However, the sequential intervention differences did not apply in terms of oral self-care in *chapter 3*. Moreover, between the individual intervention components, participants benefitted more from the self-regulatory components than the motivational components. The observed patterns in the outcomes from the sequential-interventions within each module are discussed in detail in the following sections.

*Obtained Patterns in the Sequential-Interventions: Self-Regulation and Motivation**Interventions*

The obtained pattern of results from the differential effects from the sequential-intervention effectiveness for the behavior changes in the current dissertation in *Chapter 3*, and *chapter 4* did not demonstrate Mot-SelfR superiority pattern of improvements over the *entire* time period in terms of increases in the concerned behavior level as well as in the social cognitive variables. Looking closely at the obtained pattern of results for changes in oral self-care in *chapter 3*, there was a clear superiority of the self-regulatory intervention in terms of all variables, when both experimental groups were exposed to *only* one kind of intervention, either to the motivational or the self-regulatory one. The motivational intervention itself did not prove sufficient to improve oral self-care.

However, these substantial group differences vanished at follow up measurement, Time 3 (T3), which was the point in time when both groups had been exposed to *both* kinds of interventions. It might be that participants did not benefit from the Mot-SelfR sequence because they might have felt patronized by the motivational messages or they might have perceived them as redundant, as they were already beyond that stage. In such cases, a mere self-regulatory intervention would have been better and more parsimonious without any motivational preludes. Similarly, the pattern of results for changes in hand hygiene in *chapter 4* over three assessment points were found in terms of sequential intervention effects.

Thus, in such case it was demonstrated that the actual behavior changes were achieved with the self-regulatory module alone. The motivational intervention in itself leads to a mere increase in behavioral intention, replicating what was claimed in the literature (Pellegrino et al., 2015). Moreover, it supported the established empirical evidence suggesting that

intentions are precedents of self-regulatory processes like planning (e.g., Schwarzer, 2014; Webb & Sheeran, 2006).

*What Do the First Three Studies of this Thesis (i.e., Chapter 2, 3, and 4) Add?*

The overall results of the theory-guided intervention designs in *chapter 2, 3, and 4* have elucidated the mechanisms for changing health behaviors (i.e., FVI, hand hygiene, and oral self-care) among young adults.

- From the two intervention arms within the HAPA model (motivation or self-regulation), self-regulatory proved more effective in changing health behaviors. This piece of knowledge hence makes a contribution to obtaining comprehensive knowledge about self-regulatory components in health behavior change. Self-regulatory intervention may be particularly useful when it comes to practical projects, as it provides a rationale for choosing the more effective constructs. However, providing only self-regulation interventions in the complete absence of prior motivational input may prompt people to face the downsides of “jumping into the causal chain” (Sutton, 2008). That is what happens when one changes some proximal predictors (e.g., self-regulatory skills such as planning) of behavior change without changing their prior determinants first (e.g., motivational factor such as intention). For example, this was evident in the unsustainable change in the behavior among those participants who received immediate post-intentional treatments without forming an intention to change their behaviors.
- The orders in which HAPA based motivational and self-regulatory intervention modules are presented make a difference to changing regular health behaviors. A sequence of Mot-SelfR (first motivation, then self-regulation) has shown superior

pattern of gains in changing studied health behaviors, as compared to the opposite sequence, SelfR-Mot (first self-regulation, then motivation) in terms of dietary behavior. However, findings from oral self-care and hand hygiene partly supported the predominated assumption of the HAPA (Schwarzer, 2008).

Thus, motivational intervention was expected to increase intention no matter at which time point, whereas the self-regulation condition was expected to increase self-regulatory skills like planning and achieve behavioral change eventually. Nonetheless, the question concerning the usefulness of a self-regulatory prelude to this module cannot be avoided. This finding motivated our interest in the next study, to examine whether a brief self-regulatory technique combined with incentive-based intervention lead to actual health behavior change, dental flossing in this case.

*A brief self-regulatory Technique combined With an Incentive Facilitates the Oral Self-Care among Periodontal Patients*

Periodontal disease is a major public health issue worldwide, and as earlier stated that in India it affects more than half of the population (Grewal et al., 2014; Petersen & Ogawa, 2012). Previous studies found that periodontal diseases are associated with unhealthy habits such as chewing tobacco, smoking, and alcohol. These are commonly practiced in India, together with neglected oral hygiene and a lack of knowledge about dental diseases (Agarwal et al., 2010; Grewal et al., 2014). The prevention and control of this disease depends on daily oral self-care such as interdental cleaning, such as dental flossing. Dental flossing as an adjunct to brushing is traditionally the most commonly recommended self-care recommendation and is an effective preventive measure (American Dental Association, 2015; Sambunjak et al., 2011). Moreover, flossing is the most universally applicable tool in inter-

dental situations that only allow for the penetration of a string of dental floss (Sälzer, Slot, der Weijden, & Dörfer, 2015).

Therefore, *chapter 5* of this thesis examined the effects of a brief health promotion program in combination with incentives to promote dental flossing in an Indian population already diagnosed with periodontal disease. The health promotion program consisted of self-management task cues that were based on self-efficacy and self-regulatory skills and the incentives consisted of free dentures and treatment from the hospital. The baseline findings from this study replicated the literature stating that many people are unfamiliar with dental flossing and thus, it is practiced less frequent than recommended (Agarwal et al., 2010; Lhakhang, Gholami, Knoll, & Schwarzer, 2015).

To discuss the main test of the primary hypotheses explicitly, a significant interaction was found for intention and flossing, where patients in the intervention group obtained a higher level of the two outcome variables—i.e., flossing frequency and behavioral intentions—than the patients in the control group. Hence, this supported the first and second hypothesis respectively and further confirmed that a brief self-regulatory techniques in combination with financial incentives lead to effective behavior change, as in the previous study (Cerasoli, Nicklin, & Ford, 2014). Correspondingly, the present study results supported the notion that incentives are particularly effective when targeting population who face financial problem and therefore need extra support while trying to change their health behaviors (see review by Giles, Robalino, McColl, Sniehotta, & Adams, 2014). Meaning, under the right conditions, incentives could lead to the attainment of sustained health-related behavior changes (see review by Mantzari et al., 2015).

Furthermore, the underlying working mechanisms of the intervention effect were discovered through a sequential mediation model. In other words, self-efficacy and behavioral

intentions were specified in a path model as mediators between intervention conditions and subsequent behavior, i.e., dental flossing. This confirmed the fourth hypothesis, hence revealing a sequential mediation model in which initial changes in self-efficacy and subsequent changes in intention mediated between the intervention conditions and behavioral outcomes. The final mediation analysis was replicated by structural equation modeling to obtain the standardized parameters of the findings, which may motivate the researchers to determine the plausibility of causal relationships between the predictor and the criterion variables, facilitating meta-analysis as stated by Byrne (2013). This finding replicated the previous studies in terms of sequential mediation via self-efficacy and behavioral intentions on dental flossing (e.g., Gholami, Knoll, & Schwarzer, 2015).

#### *What was New from This Study (Chapter 5)?*

In contrast to what was known in the literature that having intentions to change behaviors simultaneously does not seem to lead to actual behavior change in individuals (e.g., Fleig, Küper, Lippke, Schwarzer, & Wiedemann, 2015), the findings in *chapter 5* illustrated that oral awareness promotes the formation of behavioral intention, and stronger self-beliefs (self-efficacy) was related to increased oral health behaviors which, in turn, was associated with better oral health status in dental patients. Such findings are in line with other studies that have shown that intention and self-efficacy are predictors of dental flossing (Anagnostopoulos, Buchanan, Frousiounioti, Niakas, & Potamianos, 2011; Asimakopoulou, Newton, Daly, Kutzer, & Ide, 2015; Buglar, White, & Robinson, 2010; Schwarzer, Antoniuk, & Gholami, 2015; Schüz, Wiedemann, Mallach, & Scholz, 2009; Tonetti et al., 2015). This might be because the incentives complemented the efficacy beliefs and intentions, thus



boosting the people's intrinsic motivation and leading to the behavior change, because incentive contingency has a strong impact on intrinsic motivation (Cerasoli et al., 2014).

Considering the literature (such as Ostberg, Halling, & Lindblad, 2001) suggesting that gender differences are evident for health behaviors, we have intriguingly investigated the gender differences in our samples in *chapter 5* like those health behaviors studies (such as in Leblanc, Bégin, Corneau, Dodin, & Lemieux, 2014). It revealed women benefitted more than men from the dental flossing intervention, which is in line with study 3 in this dissertation in case of oral hygiene among healthy population.

### *Limitations*

This dissertation suffers from some limitations, which we would like to mention so that future researchers or practitioners may become aware of them. Assessments in all studies in this dissertation were self-reported and the three behaviors, namely FV intake, handwashing, and dental flossing were measured retrospectively. Retrospective methods are vulnerable to unintentional misreporting (e.g., due to recall errors). One could use on-going behavioral assessments such as food diaries to monitor daily FVI in *chapter 2* and dental calendars for dental flossing where individuals could deposit in their bathrooms to tick every incident (Schüz, Sniehotta, & Schwarzer, 2007). We gave participants food diaries for FVI and dental calendar for dental flossing, however, they were used as an intervention component, not as daily assessments. For study 3, changes in the rates of handwashing frequency with water and soap after toilets and bathroom visits could be measured with the use of video cameras and Smart Soap or electronic loggers containing devices that record usage (e.g., Wright, Zillmer, Biran, Hall, & Sidibe, 2015). However, the literature

recommended that using apps for education needs additional research that includes behavior theory within the app and improved study design.

The behavior change techniques (Michie et al., 2013) were not isolatedly varied but were combined as a package. Thus, this package turned out to be effective—which justifies its use—but complex interventions of the kind used for *chapter 2*, *3*, and *4* generated challenges for identifying the active and effective components within them. Similarly, in the case of *chapter 5*, the oral health promotion program consisted of a multi-component approach involving self-management cues with an incentive and, as such, it cannot disentangle the most active ingredient. Here, in the case of oral hygiene among periodontal disease patients, they may need daily interdental cleaning for infection control. Accordingly, the short-term follow-up period in the current study needs to be extended to determine the longer-term effects of the intervention.

It was possible that an imbalance in the readiness for the behavior change might already existed across the groups where the role of motivational intervention and the self-regulatory intervention contradicts the participants' mindsets. However, such confounders have been controlled by the random procedures used to assign participants in our studies. Even if that were not the case, it would not threaten the validity of the findings, given that both groups received intervention components that were designed to target people in both stages of change. Moreover, in the baseline measurements taken prior to the interventions, the participants' weekly performance rates were almost zero or less than 5% of the recommendation rate in all studies included in this dissertation. Therefore, it was assumed that almost all participants were initially unmotivated to adopt the new health behavior, and participants were classified into stages according to their intention level. However, future work should consider a segmentation of the participants in terms of non-intenders, intenders,

and actors (Schwarzer, 2008) and matched versus mismatched interventions (Godinho, Alvarez, Lima, & Schwarzer, 2015).

Finally, all the health behaviors examined in the present thesis were habitual behaviors, which are to be regularly performed; therefore, a question remains whether the same pattern of results would emerge for episodic health behaviors, such as screening and vaccination. Therefore, future work should aim to further investigate the effect of sequential-interventions and incentive-based interventions in terms of episodic health behaviors.

The following second discussion part is based on the findings of the empirical chapters discussed above. In this, their implications for theory and intervention development, future research direction, and practice are outlined, followed by an overall conclusion for this dissertation. Moreover, the specific aims, key findings, and conclusions from the four empirical studies included in this dissertation are summarized in Table 1.

Table 1. *Summary of the Findings in This Thesis*

Chapter	Aims	Findings	Conclusions
2	To test participants' fruit and vegetable intake (FVI) level and self-efficacy in pre-post intervention. To explore effectiveness of two different intervention sequences ( <i>motivational components; Mot</i> , and <i>self-regulatory components; SelfR</i> ), placed in different order (Mot-SelfR versus SelfR-Mot) to test their efficacy on promotion of FVI. Working mechanism of intention and self-efficacy in facilitating the FVI are tested.	Sequence wise, Mot-SelfR proved more effective than the sequence SelfR-Mot in increasing FVI. All participants, independent of groups, improved nutritional level reflected by increase in FVI level, although those in self-regulatory improved more. Intention and self-efficacy sequentially mediated the effect of intervention sequence on FVI.	The sequence of cumulative FVI promotion strategies made difference: a sequence that motivates first and then provides them with proper self-regulatory skills afterwards worked best. Effects of intention and self-efficacy showed sequential mediation, thus contributes cumulative knowledge about building intervention components in nutritional intake and health behavior change in general.
3	To test if intervention Mot-SelfR is superior to SelfR-Mot in promoting dental flossing. Intervention will increase participants' level of dental flossing and social constructs in both conditions. Self-regulation condition may prove more beneficial than motivation, regardless of time point.	Pre-post comparison showed increase in dental flossing, planning, and action control in both conditions. Mot-SelfR did not clearly prove superior over entire time period to SelfR-Mot. While participants were in self-regulation, their flossing, self-efficacy, planning, and action control levels increased higher than while in the motivation condition.	Both intervention conditions improved dental flossing although only the self-regulatory made the difference and motivational intervention itself was not sufficient for behavior change. Better approach lies in the acquisition of self-regulatory skills and the development of confidence in one's agency, after intention was formed.

4	<p>To test the differential effects of two interventions provided in different sequences (Mot-SelfR versus SelfR-Mot) to improve hand hygiene. Self-regulation condition would increase behavior and planning, whereas motivational intervention would increase intention, regardless of time point.</p>	<p>Mot-SelfR proved more effective than SelfR-Mot promoting hand washing. Intervention benefits were documented by increase in handwashing frequency and increase in self-efficacy and planning. Whereby motivational intervention in itself led to mere increase in intention, actual behavior change was achieved with the self-regulatory module.</p>	<p>Sequential intervention findings lead to the implications for developing public health interventions on hand hygiene. Educational program only help in forming intention to change the behavior, whereas a brief self-regulatory skill training appeared more effective to improve compliance to regular health behaviors, in this case handwashing.</p>
5	<p>To compare the effects of combining incentives with self-management cues against passive control group in adopting dental flossing among dental outpatients with periodontal disease. Mediating effects of intention and self-efficacy between intervention conditions and behavior was tested.</p>	<p>Intervention group outperformed the control group in terms of improving dental flossing and intention. Moreover, self-efficacy and intention were specified in a sequential path model as mediators between intervention conditions and subsequent dental flossing behavior.</p>	<p>Combining incentives with self-management techniques can improve dental flossing in dental outpatients, who are in risk for developing further oral disease. Self-efficacy and intention played significant role in explaining the mechanism of improving dental flossing. Women benefitted more than men from the intervention.</p>

*Implications*

The findings from the empirical chapters included in the present thesis make an important contribution to designing and evaluating evidence and theory-based diverse interventions inspired by the HAPA to promote *repeatedly practiced* health behaviors in our daily life.

A good intervention study should provide a roadmap for future theory development and evaluation, and therefore, they are often prospective (Thiese, 2014). The general findings along with respective implications concerning the competency of each intervention studied in this thesis are briefly reported below in stand-alone points. Each point is aligned with the four critical settings that I have presented at the opening of the introduction part of this dissertation.

*Motivation Intervention (Educational) was not enough to Change Health Behaviors*

The motivational groups in *chapter 2, 3, and 4* received educational leaflets consisting of instructions on how to perform the respective health behavior and information on the importance of complying with it in their daily lifestyle. The self-regulatory intervention groups received instructions on how to make action and coping plans to perform the desired health behaviors and further performance reminders in the form of behavioral calendars in the case of FVI and dental flossing, in addition to the same educational information as in the educational group. Moreover, the required facilities were provided for the intervention group such as soap and solutions in the case of the handwashing study in *chapter 3* and dental flossing in *chapter 4* for the oral self-care study.

Considering that participants benefitted more when they were in the self-regulation condition than when they were in the motivational condition, demonstrated that motivational

components (i.e., educational components) play a role in mere goal setting but not effective enough to attain the actual behavior change. This supports recent research demonstrating that education alone does a poor job of transferring intention into actual behavior performance and that therefore the self-regulatory skills are needed to overcome problems of goal pursuit (Kersten, McCambridge, Kayes, Theadom, & McPherson, 2014; Mackert, Liang, & Champlin, 2013; Schwarzer et al., 2015; Schwarzer, 2008). This answers the questions presented in the *first scenario* in the introduction of this dissertation. Notably, if individuals (in a self-regulation intervention) have to plan a non-intended behavior, this might have adverse effects. Particularly, in situations where all the participants are in at the non-intentional level (like in case of this thesis), exposing the participants to interventions that fit their intentional level could minimize detrimental effects.

#### *Unique Intervention Design: Sequential-Intervention*

Prior to the study, the participants in this thesis were mainly non-intenders as mentioned earlier in this thesis. This allowed us in examining the effective intervention components and to test if there would be differences in the effectiveness of the intervention based on the sequences in which these components were delivered to the participants. This reflects the challenges presented in *the second scenario* of the opening introduction part, i.e., a unique sequential-specific-intervention (SSI) of motivation and self-regulation to change health behaviors.

The HAPA has frequently been used to explain and predict the range of behavior change in continuous as well as automated behaviors in health psychology (Lauper, Moser, Fischer, Matthies, & Kaufmann-Hayoz, 2015). However, in this thesis, sequential interventions with motivational and self-regulatory derived from the HAPA was applied in

predicting different regular practiced health behaviors in *Chapter 2*, *Chapter 3*, and *Chapter 4*. Findings depicted that putting the people in the self-regulatory process without the motivational process did not lead to strong effects in changing behavior. Thus, the most effective approach seems to be through unique sequential intervention design, where people first get chance to form intention with motivational techniques which then translate into behavior by the acquisition of self-regulatory skills. The possible explanation for such finding could be that, individuals might have improved the adoption of new behavior (e.g., FVI) in response to new self-regulatory skills like planning, but they might have lacked the motivation to keep up this new habit. Accordingly, delivering the motivational intervention after the self-regulatory had a detrimental effect due to the redundancy, as demonstrated by the decrease in FVI in this group at follow up i.e., T3.

In the Mot-SelfR sequence, the motivational intervention at T1 led to more pre-intentional ingredients in the form of deliberative reflection. This might have stimulated the participants to expand their range of possibilities and weigh the costs versus the benefits. They thus formed an intention to adopt this new health habit. Thereafter, the post-decisional behavioral determinants provided at T2 stimulated the individuals to refine and specify their goal-pursuing strategies for the actual behavioral change after self-regulation. Consequently, the findings from sequential intervention comparison, except *chapter 3* in oral self-care, were relatively consistent with the conventional assumption of the HAPA (Schwarzer et al., 2011; Schwarzer, 1999, 2008), however more research with similar intervention designs are needed for the further varification.

#### *Incentive-Based Intervention: Oral Hygiene among Patients*

Considering the fact that predominant studies on health behavior change in Indian population (e.g., Agarwal et al., 2010; Paul et al., 2014) were only cross-sectional studies and



theory-based intervention studies are therefore limited. I have therefore evaluated a component-combined specific intervention (CCSI) in *chapter 5* to work on the *third situation* presented in the introduction part of *chapter 1*. Here, I took the best use of government health resources, e.g., the Muskan Yojna scheme (launched to provide easy oral access to patients below the poverty line), and integrated into our intervention package as incentives. However, the use of incentives may be useful in initiating health behavior change and help in reducing health inequalities, the effects may ultimately dissipate after the removal of incentives and new habits may not be formed (see review by Mantzari et al., 2015). It was therefore combined with a brief self-regulatory techniques inspired by the HAPA.

Accordingly, our findings in *chapter 5* indicated the usefulness of incentive-based interventions in improving the oral hygiene adherence replicating the previous incentive studies (Cerasoli et al., 2014; Sutherland, Christianson, & Leatherman, 2008). Furthermore, in line with the previous studies on dental flossing (Lhakang, Gholami, et al., 2015; Schwarzer et al., 2015; Sniehotta et al., 2007), findings in *chapter 5* elucidated the mechanisms underlying changing dental flossing behaviors in a group at risk for further oral disease issues and therefore partly.

The success of such incentive-based interventions on the particular group of participants could be interpreted that incentive schemes contribute to reducing the health inequalities when given to people in need. The population groups recruited in *chapter 5* were from the below poverty line and who are compelled to come to the urban areas for their dental treatments where the majority of the hospitals with dentists are located, because there is basically no oral health care system in rural areas (population ratio about 1: 200,000 (Agarwal et al., 2010)). It is the first research that I am aware of that demonstrated the efficacy of incentive-based interventions, which was derived from a simple health promotion

program, in improving inter-dental cleaning among dental patients in India. Thus, findings contribute to gaining knowledge about the effective intervention components that proved beneficial in improving the oral hygiene of deprived populations in a cost-effective manner, and thus minimizing the health inequality in the community.

#### *A Good Cross-fit between HAPA Constructs and the Active BCTs for changing Behaviors*

Interventions to change behavior are complex and present challenges for identifying the effective components within many interacting ingredients. Despite this, the existing intervention studies lacked clarity in the context of their intervention contents, and thus, some scholars have called for more precision and details in reporting the intervention component package (Abraham & Michie, 2008; Michie et al., 2013). Particularly in the public health domain, debates among policymakers concerning public health programs are often complicated by unspecified assumptions, where a good theory is needed to clarify the key constructs and its presumed relationships. Furthermore, a single concise theory that is neither overwhelming nor superficial will be very useful for public health practitioners to help them to articulate assumptions and hypotheses concerning their strategies and intervention targets (Glanz & Rimer, 2005). Moreover, some researchers have suggested that giving attention to behavior change techniques would contribute to a fine-tuning of paradigms to change behavior (see review by Dombrowski et al., 2012).

Behavior change techniques taxonomy (v1) (BCTs; Abraham & Michie, 2008; Michie et al., 2013) lays the foundation for the reliable and systematic specification of behavior change interventions. Accordingly, I have reported and defined the HAPA- constructs and intervention-based contents in terms of BCTs taxonomy in this thesis. Furthermore, the risk perception and outcome expectancies are considered to loose their predicting power once the

intention is formed (Schwarzer et al., 2011; Schwarzer, 2008). Congruently, the information-based BCTs group, i.e. shaping knowledge (BCT. 4) and natural consequences (BCT.5) (e.g., information about the health consequences (5.1) were found to be the least promising in contributing to the effectiveness of the intervention (Vestjens, Kempen, Crutzen, Kok, & Zijlstra, 2015). Hence, the HAPA model proved very compatible to BCTs taxonomy v1 (see *Table 2*) and thus adds value to the usage of such theories in understanding the mechanisms of behavior change process and in developing interventions to facilitate the behavior change.

Table 2. Summary of Good Cross-Fit of the Health Action Process Approach Constructs With BCTs (v1) in this Thesis

Chapters	Behavior change techniques taxonomy (v1)*		The HAPA model constructs**	Examples (from the studies)
	No.	Label		
2. (Fruit & Vegetable Intake)	a) 4.1 <sup>1,2</sup> b) 5.1 <sup>1,2</sup>  c) 1.1 <sup>1</sup> d) 1.4 <sup>2</sup> & 1.2 <sup>2</sup>  e) 5.2 <sup>1,2</sup>  f) 2.3 <sup>4</sup>	a) Instruction on how to perform the behavior (i.e., the nutritional) b) Information about health consequences c) Goal setting behavior d) Action planning & coping planning/Problem solving e) Mental rehearsal of successful performance f) Self-monitoring of behavior <sup>4</sup>	a) Knowledge b1) Positive outcome expectancies b2) Risk perception c) Intention  d) Action and coping planning  e) Self-efficacy  f) Action control <sup>4</sup>	a) Information on why and how to eat FV, tips regarding what counts in the daily portions to help the participants to plan their FV intake in their daily meal routine (WHO). b1) Exercises to visualize 3 benefits of FVI e.g., “If I take enough fruit or vegetables every day, then I’ll have a balanced physical health” and, b2) 3 risks of non-adherence, e.g., “If I do not eat enough fruit and vegetable, I will have a higher risk of getting heart diseases”. c) Encourage participants to make a behavioral resolution e.g., “I will eat five portions of FV every day”. d) Action planning e.g., “I have made plans to eat an apple and a carrot on Mondays and Wednesday after lunch at home with family” and, coping planning e.g., “If I ran out of vegetables to make salad for lunch, then I will have a fruit at the end of my meal”. e) Exercise to boost their self-efficacy “I am <i>very much certain</i> that I can follow these plans”.  f) “Please find your dietary calendar enclosed and fill your daily FV intake records regularly to help you stick to your plans for the next two weeks”.
3. (Oral self-care e.g., dental flossing)	a) 4.1 <sup>1,2</sup> b) 5.1 <sup>1,2</sup> c) 1.1 <sup>1,4</sup> d) 1.4 <sup>2</sup> & 1.2 <sup>2</sup> e) 5.2 <sup>2</sup>  f) 2.3 <sup>2</sup> g) 3.2 <sup>2,4</sup>	a) "...oral hygiene) b)... "... c) ... "...  d) ... "...    e) ... "...	a) ... "... b1) ... "... b2) ... "... c) ... "... d) ... "... e) ... "... f) Action control <sup>2</sup>  g) Resources <sup>2,4</sup>	a) What is flossing, how (ADA) and why to floss. b1) “If I floss my teeth daily, then I will have healthier teeth for most of my life”. b2) “A risk of not flossing is getting periodontal diseases”. c) <sup>1,4</sup> Encouraging the person to decide to act or set a general goal e.g., “I will floss two times every day”. d) Action planning, e.g., “I plan to floss two times in a day, at least 3 minutes each time after brushing” and, coping planning, e.g., “if I forget to floss, then I put the dental floss next to my toothbrush”. e) E.g., “I am certain that I can follow these plans”.

		f) Self-monitoring of behavior <sup>2</sup> g) Practical social support <sup>2,4</sup>		f) “Please find your dental calendar enclosed and fill your daily flossing records regularly to help you stick to your plans for the next two weeks”. g) Provided 25 m Colgate-Total Waxed dental floss the participants in self-regulatory condition.
4. (Hand hygiene)	a) 4.1 <sup>1,2</sup> b) 5.1 <sup>1,2</sup> c) 1.1 <sup>1</sup> d) 1.4 <sup>2</sup> & 1.2 <sup>2</sup> e) 5.2 <sup>1,2</sup> f) 3.2 <sup>2,4</sup>	a) "...Hand hygiene b).... ".... c) ... "... d) ... "... e) ... "... f) Practical social support <sup>2,4</sup>	a) ... "... b1) ... "... b2) ... "... c) ... "... d) ... "... e) ... "... f) Resources <sup>2,4</sup>	a) Advise participants how to wash the hands properly (WHO & CDC). b1) benefits of washing hands e.g., : “ <i>If I wash my hands after the toilet, then I can offer edibles to others with my clean hands</i> ”. b2) Asking the risks of not washing hands e.g., “ <i>If I don't wash my hands frequently, then I risk of catching the flu</i> ”. c) E.g., “I intend to wash my hands at least 10 times a day”. d) Action planning, e.g., “ <i>I have made plan to wash hands every time after toilet always with soap and a clean towel</i> ” and, coping planning, e.g., “If I forget to wash my hands, then I do not touch food”. e) Asking to visualize the past success experiences e.g., “I used my hand hygiene set while I travel”, and asking to rate participants’ perceived ability “I am <i>probably certain</i> that I can follow these plans”. f) Provided soaps and soap solutions in every washing areas of the residences.
5. (Oral self-care e.g., dental flossing)	a) 4.1 <sup>3</sup> b) 5.1 <sup>3</sup> c) 1.1 <sup>3</sup> d) 1.4 <sup>4</sup> & 1.2 <sup>4</sup> e) 5.2 <sup>3</sup> f) 10.1 <sup>3,4</sup>	a) "... Dental flossing b)....".... c) ... "... d) Action planning & problem solving <sup>4</sup> e) ... "... f) Material incentive (behavior) <sup>3,4</sup>	a) ... "... b1) ... "... b2) ... "... c) ... "... d) Action planning and coping planning <sup>4</sup> e) ... "... f) N/A	a) What is oral hygiene, why and how it is done (ADA). b1) “If I floss my teeth daily, then I will reduce caries in my teeth” & b2) “A risk of not flossing is getting periodontal diseases”. c) E.g., “I will floss at least two times every day”. d) Action planning e.g., “I have made detailed plans regarding <i>how often, when and how long</i> to floss my teeth” and, coping planning e.g., “If I forget to floss ( <i>critical events</i> ), then I put the dental tape next to my toothbrush ( <i>coping strategy</i> )”. e) E.g., “I am <i>very certain</i> that I can follow my plans”. f) Provided free dental check-ups, dentures and treatments.

Note: <sup>1</sup> motivation group, <sup>2</sup>Self-regulation group; <sup>3</sup>Incentive-based intervention group; <sup>4</sup>Intervention components (e.g., calendars) which were included in the intervention packages but not used as assessment tool in this thesis. (Michie et al., 2013)\* and (Schwarzer et al., 2011; Schwarzer, 2008)\*\*

Taking these imperative criteria into consideration, this thesis served *three of the core purposes* of intervention studies: (1) to provide useful details for other researchers to replicate in research, (2) to facilitate implementation in practical applications by helping researchers, practitioners, and decision-makers to better promote the integration of such research findings into practice, and (3) to synthesize systematic literature reviews. This accomplished the *fourth situation* described in the opening part of the introduction, i.e., investigating the best cross-fit model to the well-defined BCTs taxonomy (v1) by Michie et al., (2013).

#### *Explaining the HAPA Constructs that helped Predicting Behavior Changes in this Thesis*

In the diverse interventions used and examined in this dissertation such as the sequential-specific intervention and component combined-specific intervention, some psychosocial factors proved more proximal than the others in bridging the intention-behavior gap. However, neither all motivation constituents were shown to be unfeasible, nor were all the volitional constructs demonstrated to be effective. For example, findings from *chapter 2*, *chapter 3*, and *chapter 4* demonstrated that motivational components such as risk perception and outcome expectancies that provide information to build motivation but seems to be less effective; the more successful approach to health behavior change lies in the acquisition of self-regulatory skills such as planning and action control, and self-efficacy. However, the results in *chapter 5* depicted the motivational factors such as behavioral intention and self-efficacy as proximal predictors in oral self-care regimen (dental flossing in this case). Hence, those constructs from the HAPA model, which demonstrated beneficial effects and their respective role in the context of each study, included in the current dissertation are illustrated below.

*Intention, Self-efficacy, and Planning to Promote Fruit and Vegetable Intake*

Improper dietary behavior coupled with an increasingly sedentary lifestyle is caused by an increased intake of unhealthy fats and a reduced intake of fruits and vegetables (Misra et al., 2011). A sufficient intake of FV (400g per day at minimum) is associated with various health benefits (Fulton, McKinley, Young, Cardwell, & Woodside, 2014). To promote the phrase “*you make one-half of your plate fruits and vegetables*” (Slavin & Lloyd, 2012) in every individual’s life, psychosocial factors have shown to influence the decision that people make concerning their healthy dietary behavior.

Accordingly, *chapter 2* examined the possible predictors that might account for the adherence to consuming enough fruit and vegetables of young adults in India. The role of self-efficacy in both motivational as well as self-regulatory processes in terms of ensuring the initiation and maintenance of FVI by affecting several other determinants is well-documented in literature (e.g., Bandura, 2004; Mosher et al., 2013). Our findings accordingly indicated that intention, self-efficacy, and planning are proximal predictors of FVI. This replicated recent studies where intention and self-efficacy (e.g., Hamilton, Vayro, & Schwarzer, 2015; Reyes Fernández, Warner, Knoll, Montenegro Montenegro, & Schwarzer, 2015), intention and planning (e.g., Lange, Corbett, Lippke, Knoll, & Schwarzer, 2015), and self-efficacy, planning, and action control (e.g., Godinho, Alvarez, Lima, & Schwarzer, 2014; Luszczynska et al., 2015; Zhou et al., 2015) act as proximal predictors in the promotion of FV consumption. Moreover, in the study by Reyes Fernández and colleagues (2015), intention proved to be an even stronger predictor than self-efficacy for FVI.

Moreover, the findings depicted pathway model of mechanism where changes in intention and self-efficacy mediated between intervention and subsequent behavior outcome FVI at follow-up (T3). This sequential model replicated the previous study by Gholami et al.,

(2015) and it was further repeated in a recent study on dietary behavior (Hamilton et al., 2015), but the assessments of variables in the later study were taken at the same measurement point, and thus, it violated the temporal order assumption. Consequently, the results suggested that dietary habit formation involves psychological factors that go over and above mere educational information on nutritional facts. Hence, the role of intention, self-efficacy and planning are important to consider for understanding and predicting the dietary behavior in young adults. They may further help in developing more effective health behavior interventions in general.

#### *Intention, Self-Efficacy, Planning, and Action Control for Oral Self-Care Enhancement*

Daily dental flossing or interdental brushing twice a day in addition to brushing teeth can help to prevent periodontal diseases (Agarwal et al., 2010; Sambunjak et al., 2011). However, it is practiced less frequently than recommended or not at all, despite its positive benefits (Kapoor, Gill, Singh, Kaur, & Kapoor, 2014; Kumar, 2012). Moreover, plaque and dental caries control in patients with periodontal disease is also critically dependent upon oral self-care such as dental flossing (Newton & Asimakopoulou, 2015; Sälzer et al., 2015). In India, there is practically no proper oral health care infrastructure and therefore, lack of easy access for the public at primary health center level (Agarwal et al., 2010). In such conditions, adherence to the practices of oral self-care could be improved by influencing the individuals' psychosocial factors. For example, self-regulatory skills like self-efficacy, planning, and action control are inclined to change the health behaviors including oral hygiene (Schüz et al., 2007; Schwarzer, 2008; Suresh, Jones, Newton, & Asimakopoulou, 2012). Accordingly, in *chapter 3* (in healthy population) and in *chapter 5* (in periodontal outpatients) identified



several psychosocial determinants predicting the dental flossing behavior through two different innovative intervention designs.

In *chapter 3*, attempts were made to explore the effectiveness of motivational and self-regulatory oral self-care interventions with the purpose of exploring the feasibility of the theoretical sequence suggested by the HAPA i.e., the motivational intervention precedes the self-regulatory intervention. Regarding the self-regulatory factors, some research demonstrated that the combination of action and coping planning was more efficacious than action planning alone (Kwasnicka, Pesseau, White, & Sniehotta, 2013). But I have action planning and coping planning in *chapter 3* incorporated into a single construct planning, because no sufficient discriminant validity was found in our findings.

Findings in *chapter 3* indicated that in addition to increase in the behavior, i.e., dental flossing, psychological constructs such as self-efficacy, planning, and action control also reflected the intervention effects. Planning proved as a proximal predictor of oral hygiene replicating the previous studies on health behavior, including studies on oral hygiene among university students (Pakpour, Hidarnia, Hajizadeh, & Plotnikoff, 2012; Schüz, Sniehotta, Wiedemann, & Seemann, 2006). However, when people who plan to act might not act or might not maintain their behavior. To bridge such critical situations, action control proved a crucial factor for the planning-behavior gap. Moreover, self-efficacy has also proven to be a potential predictor of oral self-care along with planning and action control. Consequently, although the outcomes from the sequential-intervention comparison in *chapter 3* did not support the traditional sequential of two modules of the HAPA entirely, findings identified the advantages of self-regulatory factors in improving oral self-care replicating the previous studies (e.g., Chan & Chin, 2015; Newton & Asimakopoulou, 2015; Schwarzer et al., 2015). Nevertheless, self-efficacy is often measured alongside planning intervention components,

and when their effectiveness is compared, research suggested that planning may be more effective than fostering self-efficacy beliefs in the prediction of behavior (Hagger & Luszczynska, 2014).

Thus, our results were consistent with the importance of “planning strategies” to improve oral behaviors across various cultures (Gholami et al., 2014; Schwarzer et al., 2015; Sniehotta et al., 2007; Zhou, Sun, Knoll, Hamilton, & Schwarzer, 2015) and other health-related behaviors in general, such as physical activity (e.g., Barz et al., 2014). Hence, our findings make a contribution to the cumulative knowledge about self-regulatory and social-cognitive components in developing interventions in health behavior change.

In the study in *chapter 4*, we used a self-monitoring tool as action control in the form of dental diaries, hence allowing participants to keep a record of their behavior. The action control intervention was given only when participants were in the self-regulatory condition in the form of dental calendars, which led individuals for constant record keeping (Schüz et al., 2007). Therefore this group obtained a higher level of action control than the one in the motivation intervention, where no action control intervention was given then. Self-monitoring was generally shown to be beneficial only for those individuals who were already somewhat motivated to increase their oral self-care (Schwarzer et al., 2015). However, in our findings, the action control intervention improved the dental flossing frequency regardless of the participants’ mental stage of change, replicating the previous study (Suresh et al., 2012). Thus, the efficacy of self-monitoring was congruent with the HAPA model construct predicting a range of health behaviors and it supports the literature (see reviews by Burke, Wang, & Sevcik, 2011; French, Olander, Chisholm, & Mc Sharry, 2014; Harkin et al., 2015).

Overall, in an effort to investigate the effectiveness of two HAPA modules through a sequential-intervention comparison to promote dental flossing in *chapter 3*, it was found that

the enhancement of such behaviors requires constant deliberative cognitions in the form of self-regulatory efforts, at least until a habit is formed.

The findings from this *chapter 5* indicated efficacy of behavioral intention and self-efficacy in improving the dental flossing replicating the previous study (Cerasoli et al., 2014), where motivational techniques in combination with incentives led to behavior change. Moreover, intention and self-efficacy operated as proximal predictors of dental flossing, and often as mediators (Asimakopoulou et al., 2015) and thus, findings replicated previous studies (Gholami et al., 2015) on dental flossing and (Lhakang et al., 2014) on FVI. The sequential mediation chain identified in these studies highlights the significant roles of self-efficacy and intention in facilitating dental self-care to improve oral health status in a population at risk for further oral diseases (see reviews by Giles et al., 2014; Newton & Asimakopoulou, 2015). Future research may investigate similar interventions in promoting other health-related behaviors.

#### *Intention, Self-Efficacy, and Planning to Increase Hand Hygiene Adherence*

A Cochrane review by Ejemot-Nwadiaro, Ehiri, Arikpo, Meremikwu, and Critchley (2015) found that the infections causing diarrhea are transmitted through person-to-person contact. The review therefore further summarizes that handwashing after defecation and before preparing and eating food can reduce the risk of diarrhoea by about 30% among children and adults of both high- as well as low-income countries. Hence, the promotion of hand hygiene behavior has gone beyond health related workers in hospitals and attempts have begun to promote it among university students, who were reported to perform it less frequently than the recommended level particularly in key situations like before eating or after toilet visits (Mariwah, Hampshire, & Kasim, 2012). Accordingly, theory-and evidence-

based motivational and self-regulatory interventions improved handwashing in *chapter 4* in young adults in India. This goes in line with the other study on FVI (Lhakhang et al., 2014) in *chapter 2* and on dental flossing (Lhakhang, Gholami, et al., 2015) in *chapter 3*.

Moreover, the intervention benefits were not only documented in the form of an increase in the behavior but also in the changes in the participants' mindsets. These mindset changes were reflected in the higher levels of intention from the motivational intervention module and the increase in the levels of self-efficacy and planning from the self-regulation intervention arm. Intention and self-efficacy as potential predictors in promoting hand hygiene replicated the previous studies (Biran et al., 2014; Curtis et al., 2011). People may fail to act on their intentions when the opportunity to act presents itself, self-regulatory skills, such as action control seem to help them in overcoming the challenges face while translating their intentions into action.

The planning intervention findings in this study replicated the previous studies (e.g., Hagger & Luszczynska, 2014; Sniehotta, Schwarzer, Scholz, & Schüz, 2005), where planning helped to improve participants' chances of performing the hand hygiene behavior in the self-regulatory intervention group and thus, supported the literature (see review by Pellegrino et al., 2015). A similar finding appeared in a recent hand hygiene study (Reyes Fernández, Lippke, Knoll, Blanca Moya, & Schwarzer, 2015) though the changes were not sufficient to produce an interaction between time and treatment in hand hygiene behavior in their study. In our present study (*chapter 4*), there was an interaction of treatment and time. There was also a significant main effect of time and the treatment for all three social cognitive variables, i.e., intention, self-efficacy and planning.

*The Commonly shared Psychological Predictor in All Studies: Self-Efficacy*

*Action self-efficacy* helps to execute a behavior in the future, and *volitional self-efficacy* involves the ability to manage the behavior in the face of barriers and challenges (i.e., in a post-decisional manner) (Ochsner, Scholz, & Hornung, 2013; Schwarzer et al., 2011). Since there was no sufficient discriminant validity in this thesis, it was preferred to use the umbrella term “self-efficacy”, referring to the combined construct of action self-efficacy and volitional self-efficacy.

In this thesis, self-efficacy as a potential construct of the HAPA model played a critical role in improving all the studied behaviors. This is in line with most health behavior change theories, which assume a crucial role of self-efficacy (Social Cognitive Theory by Bandura, 1997; The Reasoned Action Approach by Fishbein & Ajzen, 2010; Transtheoretical Model by Prochaska & Velicer, 1997). This finding further goes in line with previous studies (e.g., Vestjens et al., 2015) that identified self-efficacy and intention as more proximal behavior change techniques while viewing other determinants like awareness and knowledge as less promising. Presumably, the barrier is not the technical difficulty of adopting a new behavior most of the time, but rather the difficulty of performing it (be it dietary intake, hand hygiene, or oral hygiene) regularly as an integrated part of daily life, which is not easy for some people (Schwarzer et al., 2015).

Consistent with previous studies in various domains including oral hygiene, hand hygiene or nutrition (Buglar et al., 2010; Luszczynska et al., 2005; Prestwich et al., 2014; Schwarzer et al., 2015), self-efficacy emerged as a significant predictor in this thesis. This indicates that decisions on whether individuals floss (as an example) was influenced greatly by whether they believe that such behavior can be performed successfully. More importantly, targeting improvement in people’s confidence in their ability to perform the desired behavior

may be the best strategies for health practitioners in the public sector. The four main sources of self-efficacy were proposed (i.e., mastery experiences, modeling, verbal persuasion and physiological states) and I have explained them in the introduction of this thesis in detailed (Bandura, 1997; Warner et al., 2014). Moreover, previous studies indicated that social support also contributes to achieve higher self-efficacy in individuals, particularly in recipients (Knoll, Burkert, Luszczynska, Roigas, & Gralla, 2011).

It was no coincidence that the sources of self-efficacy outlined by Bandura and Adams (1977), are reflected in a host of certain behavior change techniques (BCTs) specified by Abraham and Michie (2008). For example, a recent review on self-efficacy by Prestwich et al., (2014) affirmed that self-efficacy could be increased with interventions that incorporated the BCT techniques, such as self-monitoring (e.g., recording the behavior in a diary), providing feedback on performance, reviewing of behavioral goals, and providing contingent rewards or plans for social support (e.g., resource access in the case of this thesis). Moreover, it was further indicated that the BCTs that promote the self-efficacy level may ultimately change behavior because of their impact on self-efficacy. Hence, future intervention studies may therefore consider including the sources of self-efficacy as part of their behavior change intervention packages to promote health behaviors.

### *Intention and Self-Efficacy as Mediators to Promote Fruit and Vegetable Intake and Oral Self-Care*

The formation of intentions is assumed as a prerequisite for entering into the volitional stage (Heckhausen & Gollwitzer, 1987; Schwarzer, 2008). The findings in a recent meta-analysis on intentions and behavior (Sweeney & Moyer, 2014) indicated that the size of effects on intentions was not a significant predictor of the size of effects on behavior.

However, such an analysis does not indicate whether an individual with high intentions is likely to show a large change in behavior. To assess the latter, we found the correlation between intentions and dental flossing in *chapter 5*, and they were highly correlated, indicating that an individual with high behavioral intentions showed high increase in dental flossing performance.

The results on the significant correlation between the intentions and behaviors in these studies made it possible to conduct mediation analyses to test for a causal relationship as suggested by the past reviews of general behavior change (e.g., Webb & Sheeran, 2006). Likewise, the special contribution of the HAPA in understanding health behavior change was strengthened by mediation analyses of intervention-induced behavior change. Accordingly, we discovered the underlying working mechanisms of behavior change processes by inspecting the psychological processes by which the intervention impacts behavior change to increase fruit and vegetable intake (FVI) in *chapter 2* and promote dental flossing in *chapter 5*.

Most previous research has identified a single factor or mediator such as self-efficacy as a mediator (Kreusikon, Gellert, Lippke, & Schwarzer, 2012; Reyes Fernández, Warner, et al., 2015) or moderator (e.g., Lippke, Wiedemann, Ziegelmann, Reuter, & Schwarzer, 2009), however, mediators operating sequentially were rarely investigated. Accordingly, we identified sequential mediations via intention and self-efficacy on dental flossing behavior among dental patients in *chapter 5* and FV intake in *chapter 2* among young adults. Our mediator model serves twofold: it allows for the prediction of behavior, and it explains the assumed causal mechanism of behavior change (Schwarzer, 2014a). Moreover, such a sequential mediation chain highlights the predictive power of both self-efficacy and intention in facilitating health behavior change. This replicated the prior research (e.g., Paxton, 2015;

Reyes Fernández, Warner, et al., 2015), where self-efficacy was significantly associated with intentions in health-related behavior change. Accordingly, the very fact that these studies were conducted in different countries with very different health habits but had similar findings speaks in favor of the external validity of our findings in this study. Therefore, effective interventions should include intention and self-efficacy as potential self-regulatory skills together with planning and action control.

### *Statistical Methods and Application*

From the *methodological prospective*, all the studies in this dissertation report interventional effects assessed at different measurement points. Thus, the results contribute strong evidence for causality in the behavior changes.

Considering *the assessment of different kinds of outcome measures*, findings of the past behavior and psychological states of the participants in this thesis relied on self-reports, which is most the commonly used method in health psychology (Schwarzer et al., 2003). The goal behaviors in this thesis were of *repeatedly performed behaviors*, such as oral or hand hygiene, which have to be performed continually as part of a daily routine in order to be health-relevant. The measures for assessing behaviors in respect of daily consumption (e.g., in FVI) or frequency (e.g., in dental flossing and handwashing) were done with standardized rating scales (e.g., Likert scale) fitting the scopes of the respective studies. Furthermore, the experimental groups were compared in terms of the strength of associations between the dependent variables and the behavior.

In the empirical chapters, the evidence for the effects of intention, self-efficacy, planning in increasing fruit and vegetable intake in *chapter 2* and handwashing in *chapter 4* were found. The substantiation effects of intention, self-efficacy, planning and action control



were found on behavior (i.e., dental flossing) or on the concerned variables in *chapter 3*. Thus, the examination of the intervention effects over the time period, with three measurement points including follow-up measures, makes the evidence for the causal inferences stronger. Additionally, the results found from the experimental tests were further strengthened (e.g., in *chapter 2* and *chapter 5*) by conditional indirect process analysis or through sequential mediation analysis, providing bootstrapped confidence intervals for the direct and indirect effects reported. Such analyses contribute by telling us how one variable may affect another in mechanisms of behavior change in a more adequate manner (Hayes, 2013). The final analyses were then replicated by structural equation modeling, providing the standardized parameter estimates. This may enable replication in across studies facilitating meta-analysis.

Furthermore, in *chapter 5*, intervention effects on changes in flossing as well as other social cognitive variables were tested with the SPSS MIXED procedure using linear 2-level models with time points nested in individuals. Hence, the fixed effects made the adjustment for the covariance structure making the results more accurate. Moreover, MIXED model handled complex situations in which experimental units were nested in a hierarchy and thus extended repeated measures models in GLM to allow for an unequal number of repetitions (Heck, Thomas, & Tabata, 2014).

The health action process is modeled by the *sequencing of the social-cognitive variables* (Schwarzer et al., 2003), from the forming of behavioral intention, planning, and the goal, leading to the action itself. Consequently, the HAPA is designed in such a way that it requires at least two measurement points to investigate its assumptions. Correspondingly, it enables the researcher to compute all constructs at all measurement points in order to control for the baseline or to compute change scores. This peculiar characteristic of the model design

invites the researchers to think about the question of validity—i.e., whether delivering the intervention components derived from this framework in the theorized sequence or the opposite sequence makes a difference in their effectiveness in changing behaviors. Moreover, the idea of sequencing the two modules in two different directions indirectly opened the analysis of predictors at different stages of the model and opened the wider possibility of exploring different patterns of behavior change.

Planning and self-efficacy were constructed as a continuous process in the HAPA theory, and the depth of their cognition elaboration can vary depending the mindsets of the individuals (Schwarzer et al., 2003). Although it has been frequently shown (Prestwich et al., 2014) that coping planning (if-then) structures are more effective than simply specifying the when, where, and how—i.e., action planning. However, results from the different phase-specific planning and self-efficacies did not show sufficient discriminant validity between the different facets of the respective constructs. This could be because of the habitual nature of studied regular behaviors, which are produced by particular cues, often as part of routine. Therefore, collapsing different categories of these variables into two single constructs (as planning and self-efficacy) were in line with the analyses of our chosen approach.

The HAPA model considers action control as one of the potential post-intentional determinants, however the theory was frequently used as a framework exclusive of action control (e.g., Ernsting, Gellert, Schneider, & Lippke, 2013). To elucidate the overall predictive value of volitional factors in the HAPA model, I have included action control for the intervention packages as one of the potential self-regulatory skills to change health behaviors in this thesis, thus making our frameworks more comprehensive and representative of the chosen model. Moreover, the self-monitoring tool as an action control was found to be helpful to remind individuals of their intentions and to recall the plans that the individuals

made in their process of behavior change (Lhakang, Gholami, et al., 2015; Schwarzer et al., 2015). Hence, future effective interventions inspired by the volitional module of the HAPA should include not only planning and self-efficacy self-regulatory skills but also action control as a facilitator in promoting health-related behaviors.

### *Suggestions for Future Research Directions*

Understanding and improving health-related behavior is critical to the well-being of individuals, and therefore it is becoming a dominant concern in the future of public health activities. The results from this dissertation further confirmed the applicability of motivational and volitional determinants of the HAPA and strengthened its sequential principle in predicting health behaviors that must be practiced regularly. However, future studies may apply similar interventions (sequential and combination of the HAPA components) to test *one-off* health behaviors, such as vaccination or cancer screening.

From the *predictive values of the determinants*, risk perception and outcome expectancies (which are basically knowledge) proved only to be distal antecedents of the intention formation process in this thesis. Thus, they may not be as important in comparison with other motivational variables like self-efficacy and intention (Fleig, Küper, et al., 2015; Schwarzer et al., 2011; Schwarzer, 2008). However, planning, self-efficacy, and action control proved to be more proximal self-regulatory skills in this thesis replicating previous studies to promote health behaviors including FVI (Godinho et al., 2015), hand hygiene (e.g., Kwasnicka et al., 2013), and oral hygiene (Schwarzer et al., 2015; Zhou, Sun, et al., 2015). In *chapter 2, 3, and 4*, textual notifications on planning e.g., “The more concrete your plans are, the more likely you will attain your goal”, followed by exercises to make own plans with guidelines, has proved effective in increasing FVI, dental flossing, and handwashing

frequency respectively in young adults. However, we did not address the possible underpinning mechanisms of planning interventions in relation to other determinants or in relation to the behavior itself in behavior change processes—this was beyond the present scope and constituted a different research question. However, future studies may examine role of the planning and self-efficacy as mediators or the moderating role of self-efficacy (Kreausukon et al., 2012; Zhou, Sun, et al., 2015) or action control in the volition phase of behavior change including for FV intake and oral hygiene.

Regarding the *intervention contents*, the findings in this dissertation present a good cross-fit of the potential HAPA constructs with the active BCTs v1 (Michie et al., 2013). This further enhances the suitability of the HAPA as a comprehensive framework for future intervention studies in promoting health related-behaviors. In addition, such studies may add cross-behavior cognitions into this single behavior framework and investigate their contribution in predicting behavior change. This is because transfer cognitions were shown to be positively associated with intentions, action planning, and action control over and above behavior-specific cognitions (Fleig, Ngo, et al., 2015).

On another note it is worth mentioning some suggestions, which are independent of our findings in this thesis. A better social resource status or network reflects perceived support (i.e., the belief that help will be available if needed) and it plays a role in health-related processes (Knoll, Rieckmann, & Kienle, 2007). Therefore, adding such aspects of social support as one of the indicator in the future health behavior research can be useful. Similarly, previous studies on hand hygiene regimens found *habit* (i.e., automatic responses to a particular context) to be one of the powerful determinants of handwashing compliance (Pellegrino et al., 2015). This could be because flossing or handwashing on a regular basis should become a habit, and habit strength is developed by behavioral repetition, which could

hardly have materialized within a one-month time interval (Wiedemann, Gardner, Knoll, & Burkert, 2014). Therefore, future studies on regular health behaviors such as hand hygiene may consider investigating the role of *habits* to explain behavior from more dimensions and they should include a more extended time period for the assessment in order to investigate the long-term effects of such interventions. The interventions to improve dietary behaviors could also use nutrition apps as part of interventions (see review by DiFilippo, Huang, Andrade, & Chapman-Novakofski, 2015).

### *Implications for Practice*

This thesis advances our understanding of a rarely studied sample, Indians, in changing their primary health-related behaviors. Furthermore, it offers evidence on the superiority of one intervention sequence over another, and knowledge on combining incentives with psychological interventions involving multi-components. Such data will help building more effective theory- and evidence-based intervention packages in practice to promote health-related behavior change.

More specifically, considering that the sequence of cumulative health promotion strategies makes a difference, the *main implications* are that interventions aiming to promote *regular health behavior change* such as fruit and vegetable intake (FVI), oral hygiene and hand hygiene, it may be useful to keep in mind in which order whether motivational intervention is delivered first, and then provides them with the proper self-regulatory skills afterwards or the opposite sequence. In addition, the findings firmly suggest including the proximal self-regulatory strategies in the chosen intervention packages, because mere motivational components may not be enough to obtain the actual behavior change. The findings in *chapter 5* suggest the effectiveness of an incentive-based intervention and were

consistent with evidence from previous research that found that financial incentives change habitual health behaviors (see review by Mantzari et al., 2015). Hence, researchers, educationalists, and health practitioners should pool their expertise to promote public health concerned healthy behaviors of public concern such as oral hygiene.

Concerning inter-dental hygiene, I have taken dental flossing as an example of an inter-dental cleaning device. However, in a practice, a recent review (Sälzer et al., 2015) revealed that inter-dental brushes are the most effective devices to remove inter-dental plaque and most importantly the patients appreciate them the best. Therefore, along with oral education, dental practitioners, specialists, hygienists, and oral health promotion staff may consider recommending inter-dental brushes for their patients as well as for the healthy general population for the prevention and treatment of dental caries and periodontal diseases.

Pertaining to the usage of planning interventions in practice, this dissertation draws an attention. Previously, the HAPA-based intervention studies that used complex interventions similar to those used in this dissertation were frequently delivered without expert assistance, such as by email or post or simply via online delivery (e.g., Craciun, Schüz, Lippke, & Schwarzer, 2012; Mak, Chan, Cheung, Lin, & Ngai, 2015). Such delivery methods may offer minimal intensity, easier accessibility, time efficiency or cost-effectiveness, however, intervention providers face the challenge of prompting participants to form meaningful plans and develop appropriate coping strategies (see review by Kwasnicka et al., 2013). Moreover, *in practical settings* making plans appears to be efficacious when plan formation is monitored, supervised or when plans are pre-specified. Similar results were observed in the study that measured long-term adherence to a physical activity intervention and compared telephone-assisted and self-administered coping plans (Evers, Klusmann, Ziegelmann,

Schwarzer, & Heuser, 2012). Older women's adherence to physical activities showed improved when they were given direct support in generating coping plans.

Taking the indications above into consideration, in *chapter 3* and *chapter 4* of this dissertation, the formations of planning interventions (action and coping) were delivered face-to-face by an intervener with structured materials; participants thus received guidance on the implications of those textual guidelines. For this very purpose, the researcher stayed at the students' residence hall during the whole period of the study and was available for the participants if they needed feedback about their plans. The interaction with an intervener during a behavior change intervention may ensure that participants accomplish their interventions as intended. However, it is not a necessary prerequisite as the use of volitional self-care such as self-monitoring surely demonstrated as a plausible facilitator. For example, we therefore provided dietary calendars in *chapter 2* and dental calendars in *chapter 4* during the behavior change self-regulatory intervention condition.

The content of our intervention packages were defined in terms of behavior change techniques. This specifies the theory framework that we used to design our interventions, and the modes of deliver were also accurately stated in this dissertation. I recommend similar in future studies. Thus, our report on the intervention content description and mode of delivery satisfy the suggestion made in the literature (e.g., Abraham & Michie, 2008). Furthermore, our interventions, which were comprised of different components, facilitated understanding of the ability of specific components and how they work in daily healthcare practices and in public health in general. This may contribute to the design of more effective and efficient theory-based interventions matching the most promising BCTs. This will mean that health practitioners can implement them accordingly in their practice.

The overall assessments in all four studies in this thesis have been proved to be satisfactory and in line with the literature, although the findings relied on self-reports. The future measuring of behaviors and the related social cognitive variables may be preferred for objective behavior measures to minimize the limitations of self-reports such as response shifts, recall bias, or social desirability (Michie & Abraham, 2004). However, the usage of objective health parameters is not to be expected in absence of other biases such as technical errors, demanding characteristics, or influence from lifestyle factors. Nevertheless, assessment with self-report was the only way to minimize patients' burden associated with study participation (Knoll, Burkert, Scholz, Roigas, & Gralla, 2012), particularly in case of *chapter 5*.

### *Conclusion*

The current thesis first presented an overview of theory-based pathways to the investigation of psychological determinants of diverse health-related behaviors. Then, the multifaceted-model was carefully chosen for use in frameworks for four interventional studies aiming to explore most effective interventions for behavior change.

Range of studies has documented the advantageous of psychosocial factors derived from the two modules of the health action process approach (HAPA; Schwarzer et al., 2011; Schwarzer, 2008) in changing health behaviors. However, barely any has distinctly incorporated these components in different parsimonious behavioral change interventions (such as motivational or educational, self-regulatory intervention, sequential of motivational and self-regulatory interventions, and self-regulatory combined with incentive intervention) and explored their effectiveness. Thus, the first three studies, *chapter 2*, *chapter 3* and *chapter 4*, investigated the validity of (1) a motivational intervention targeting the putative



determinants of intention and (2) a self-regulation intervention aiming at the most proximal predictors of behavior at post-intentional stage, but in two opposite sequences. The findings depicted that the sequence of cumulative health promotion strategies makes a difference, though some differences were not significant. Therefore, sequential intervention could be structured in a way that motivates to form intention (with motivational self-efficacy, outcome-expectancies, and risk perception), and then guides them to develop proper self-regulatory skills (with volitional self-efficacies, planning and action control) afterwards to perform the actual behavior change. Such sequences in the intervention delivery mode could be successfully applied to predict regular health behavior change; however further research is required for the firm confirmation.

Furthermore, the fourth study in *chapter 5* elucidated the mechanisms underlying changing dental flossing behaviors indicating that a brief self-regulatory strategy involving behavioral intention and self-efficacy combined with incentive (free treatment assistances) facilitate the oral self-care behavior among the dental patients.

In line with the host of empirical studies that have applied the HAPA and confirmed its applicability in a range of health behaviors in different corners of the world (to name some, e.g., Craciun et al., 2012; Gholami et al., 2015; Godinho et al., 2015; Lippke & Plotnikoff, 2014; Paxton, 2015; Reyes Fernández, Warner, et al., 2015; Schwarzer et al., 2015; Warner, Wolff, Ziegelmann, & Wurm, 2014; Zhou, Sun, et al., 2015), this thesis further confirmed the applicability of the HAPA in changing dietary, hand hygiene, and dental behavior in a rarely studied population context, Indians. Hence, our elucidation of the proximal constructs through such interventions further contributes to the emerging literature in developing health behavior change techniques in general and building health behavior change interventions in public health settings.

To conclude, the findings in this dissertation are important for research and practice: Individuals' decisions to engage in healthy behavior change were most effectively influenced by psychological determinants combined with financial incentive interventions (Giles et al., 2014) as I have brought to light in *chapter 5*. Moreover, the good news is that the incentives (which are an external reward) and intrinsic motivation (i.e. motivation that comes from inside) were not found to necessarily be antagonistic, as some critics considered: these two coexist, depending on the type of performance and the contingency of the incentive as documented in a recent meta-analysis (Cerasoli et al., 2014). Moreover, this thesis also demonstrated the advantages of self-regulatory intervention components over motivational components. However, the findings from the HAPA intervention-sequential i.e., delivering the motivational components before and then followed by self-regulatory components afterwards, seems to be even more effective than the only self-regulatory alone. This evidence base from the sequential interventions can be improved in future work by the use of a full-factorial design, where a motivational sequence preceding a volitional sequence (Mot-SelfR) would be tested against a volitional sequence preceding a motivational sequence (SelfR-Mot) and an active control intervention and their effects would be measured over longer period of time points.

Change is incremental, and there will never be a magic bullet to solve the problems of health behavior change (Schwarzer, 2007), because health behavior change is such a complex process involving a multitude of causal factors. Nevertheless, as the saying goes 'where there is a will, there is a way', and every single finding from good research brings us nearer to ultimate goal of predicting behavior change. Correspondingly, our investigation of different proximal predictors through the course of this thesis may guide the development of theory- and evidence-based interventions to promote fruit and vegetable intake, dental flossing, and

handwashing. Furthermore, the potential constructs of the HAPA model in this thesis demonstrated high congruency with the active BCTs taxonomy v1 (Michie et al., 2013). This effortlessly enabled reporting of the intervention contents in terms of the BCTs. This may confirm the *SUIT* (suitability, uniqueness, integrality, and testability) of the HAPA model in developing and evaluating of interventions in future to change health behaviors in general.

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## **Curriculum Vitae**

### **Pempa Lhakhang**

For reasons of data protection,  
the curriculum vitae is not included in this version.



## List of Publications

### ARTICLES IN PEER-REVIEWED JOURNALS (\* indicates those that are part of the thesis)

- \* Lhakhang, P., Hamilton, K., Sud, N., Sud, S., Kroon, J., Knoll, N., & Schwarzer, R. (2016). Combining self-management cues with incentives to promote interdental cleaning among Indian periodontal disease outpatients. *BMC Oral Health*, 16(1), 1. DOI: 10.1186/s12903-016-0164-5
- \*Lhakhang, P., Gholami, M., Knoll, N., & Schwarzer, R. (2015): Comparing a motivational and a self-regulatory intervention to adopt an oral self-care regimen: A two-sequential randomized crossover trial, *Psychology, Health & Medicine*, 20(4): 381-92, Doi: 10.1080/13548506.2014.951368.
- \*Lakhang, P., Lippke, S., Knoll, N. & Schwarzer, R. (2015). Evaluating a brief motivational and self-regulatory hand hygiene interventions: A cross-over longitudinal design. *BMC Public Health*, 15(1), 79. Doi:10.1186/s12889-015-1453-7
- \*Lhakhang, P., Godinho, C., Knoll, N., & Schwarzer, R. (2014). A self-regulatory intervention increases fruit and vegetable intake: A comparison of two intervention sequences. *Appetite*, 82, 103–110. Doi:10.1016/j.appet.2014.07.014
- Lhakhang, P., Juschewitsch, E., & Satow, L. (2013). Intervention engagement promotes smoking cessation: Effect of offering a monetary donation to an online program. *Psychology & Health*, 28, 251-252.

Brief Scales for the Multilingual Assessment of HAPA Variables (Collaboration work).

(2014). Gholami, M., Schwarzer, R., Antoniuk, A., Godinho, C., Lhakang, P., Reyes-Fernández, B., & Zhou, G. Available at: <http://www.psyc.de/hapascales.pdf>

Brief Interventions in English Guided by HAPA (2013). Lhakang, P., & Schwarzer, R. Now available as; Multilingual Brief Interventions Guided by HAPA (2014). Schwarzer & colleagues at: <http://www.psyc.de/hapainterventions.pdf>

**PUBLISHED ABSTRACTS (first authorship only)**

Lhakang, P., Gholami, M., Knoll, N., & Schwarzer, R. (2014). Comparing a Motivational With a Self-regulatory Intervention to Adopt an Oral Self-care Regimen. *European Health Psychologist, 16(S)*, 531.

Lhakang, P., Knoll, N., & Schwarzer, R. (2014). Comparing an Educational with a Self-Regulatory Intervention to Adopt a Dental Flossing Regimen. Identifier: DIV08-OC17004. From: 28th International Congress of Applied Psychology, 8-13 July 2014, Paris, France.

Lhakang, P., Juschkeiwitsch, E., Satow L. (2013). Intervention Engagement promotes Smoking Cessation: Effect of Offering a Monetary Donation to an Online Program. From EHPS 2013 Abstracts, *Psychology & Health, 28 (1)*, p.251, DOI:10.1080/08870446.2013.810851

Lhakang, P., Hamilton, K., Sud, N., Sud, S., Kroon, J., Knoll, N., & Schwarzer, R. (2015). Combining self-management cues with incentives to promote interdental cleaning among Indian periodontal disease outpatients. The Book of Abstracts: from the International Conference on Work, Stress and Health: Recent Perceptions, Future Trends, 26-27th

October, Shimla, pp.94-95. ISBN: 938206864-3. Mohindra Publishing House, Chandigarh, India.

**PRESENTATIONS (first authorship only)**

Lhakang, P., Gholami, M, Knoll, N., & Schwarzer, R. (2014). Comparing a Motivational with a Self-Regulatory Intervention to Adopt a Dental Flossing Regimen. European Health Psychologist Society Conference (EHPS), August 2014 in Innsbruck, Austria.

Lhakang P., & Djourdjin M. (2014). Using the Health Action Process Approach model in the process of reducing carbon emission: a pilot project encouraging people to use Ceramic Water Filter in Rwanda. The Rural Development Interdiocesan Service (RDIS) and Bridge Builders. The Webinar, June 2014 in Republic of Rwanda.

Lhakang, P., Knoll, N., & Schwarzer, R. (2014). Comparing an Educational with a Self-Regulatory Intervention to Adopt a Dental Flossing Regimen. 28th International Congress of Applied Psychology (ICAP), July 2014 in Paris, France.

Lhakang, P., Juschewitsch, E., Satow L. (2013). Intervention Engagement promotes Smoking Cessation: Effect of Offering a Monetary Donation to an Online Program. 27th European Health Psychology Society Conference (EHPS), July 2013 in Bordeaux, France.

## **Field Research Certificate**

For reasons of data protection,  
the field research certificate is not included in this version.

### **Erklärung zur Dissertation**

Hiermit versichere ich, dass ich die vorgelegte Arbeit selbständig verfasst habe. Andere als die angegebenen Hilfsmittel habe ich nicht verwendet. Die Arbeit ist in keinem früheren Promotions- verfahren angenommen oder abgelehnt worden.

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Unterschrift (Pempa Lhakang)

Berlin, November 2015