Dietary supplement use

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Dietary supplement use

Reasons, decisions, and health communication

Dissertation

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by
Emília Margit Pajor

Promotor
Prof. dr. H. de Vries

Copromotores
Dr. A. Oenema
Dr. S. M. Eggers

Assessment Committee
Prof. dr. S. P. J. Kremers (chair)
Prof. dr. C. A. W. Bolman (Open University, Heerlen)
Prof. dr. F. J. P. H. Brouns
Dr. J. P. van 't Riet (Radboud University, Nijmegen)
Prof. dr. G. D. E. M. van der Weijden

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In loving memory of my Grandmother, *Nagyi*.

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CHAPTER 1

General introduction

"One of the main reasons for my supplement use is just to feel better — because I am doing something for me, for my wellness, not just my illness."[1]

Since the 1980s, dietary supplement use has become increasingly common in many modern and industrialized countries. For instance, in the Netherlands 40% and in the United States 50% of the general population takes dietary supplements on a regular basis (Bailey et al., 2010; van Rossum et al., 2016). Dietary supplements are products that are intended for ingestion in order to add further nutritional value to the normal diet (Ventola, 2010). They contain one or any combination of the following dietary ingredients: vitamins, minerals, herbs or other botanicals, amino acids, animal tissue extracts, essential oils or other dietary substances with a nutritional (e.g., reduce micronutrient deficiency) or physiological (e.g., reduce fatigue) effect (European Food Safety Authority, 2016; U.S. Food & Drug Administration, 2016; Ventola, 2010). Dietary supplements are sold in various forms, such as pills, powders, or liquids. The market of dietary supplements is lucrative: it is valued at 5.4 billion euros in Europe, and at 13.4 billion dollars in the US (Statista, 2017a, 2017b). Moreover, further growth in sales is expected for the coming years (Statista, 2017b). Despite consumers' growing interest in dietary supplements, scholars argue that except for risk groups, dietary supplement use is not necessary in the general population if there is no clear evidence of micronutrient deficiencies (Guallar, Stranges, Mulrow, Appel, & Miller, 2013; Health Council of the Netherlands, 2015). Moreover, some scholars warn for possible adverse effects, such as drug-supplement interactions (Vrolijk et al., 2015). Therefore, it is important that consumers make informed decisions about dietary supplement use.

Currently, knowledge is limited about how consumers actually decide in favour or against dietary supplement use, what factors lead to their decisions, and whether their decisions are well-informed. Consequently, there is inadequate input to develop effective health communication to educate consumers about dietary supplements. In order to fill this gap, it is important to explore consumers' beliefs and motivations for use (or non-use) of dietary supplements. In addition, there is more insight needed into how consumers come to a decision and what a well-informed decision is in the case of dietary supplement use. Lastly, research is needed to determine how consumers could be provided with information on dietary supplements to support their informed decisions. In this thesis, these questions will be addressed.

[1] Quote from an individual interview with a dietary supplement user (Nichter & Thompson, 2006).

Dietary supplement use: past and present

The use of dietary supplements has already a long history. In the first half of the twentieth century, dietary supplements like cod liver oil were administered in order to prevent or cure diseases that were caused by severe micronutrient deficiencies (Webb, 2011). At that time, dietary deficiency diseases such as scurvy (severe vitamin C deficiency), pellagra (severe niacin deficiency), rickets (severe vitamin D deficiency), or goitre (severe iodine deficiency) were highly prevalent even in modern Western countries. Therefore, much research in physiology, medicine, and chemistry focused on the relation of active ingredients in foods (e.g., minerals) and how they could be used to cure or prevent those diseases (Semba, 2012). Moreover, it was discovered that additional intake of active components (e.g., vitamins) can be realized both by simple dietary changes or by taking their purified and concentrated form as dietary supplements (Webb, 2011). During this period, seven Nobel-prizes were given for vitamin-related research. The notion of 'healthy dietary supplements' was born.

Nowadays, individuals living in wealthy and industrialised societies have small chances to get severe deficiency diseases because our diet became more nutritious for instance due to food fortification (Tulchinsky, 2010). Yet the prevalence of dietary supplement use has never been as high as in the last two decades. In the US, Denmark, and Norway about 50 to 60 per cent of the general population uses dietary supplements on a regular basis (Gahche et al., 2011; Kantor, Rehm, Du, White, & Giovannucci, 2016; Skeie et al., 2009). In the Netherlands, Germany, and France regular dietary supplement use is moderate (i.e., not exceeding 50 per cent; Heinemann, Willers, Bitterlich, & Hahn, 2015; Pouchieu et al., 2013; van Rossum et al., 2016), whereas the lowest rates of use were found in Mediterranean countries (i.e., 2 to 12 per cent; Skeie et al., 2009).

As presented in Figure 1.1, in the Dutch general population dietary supplement use has increased from 17 per cent to 42 per cent since the 1980s (Dorant et al., 1993; Hulshof et al., 2004; Ocké, Buurma-Rethans, & Fransen, 2005; van Rossum et al., 2016; van Rossum, Fransen, Verkaik-Kloosterman, Buurma-Rethans, & Ocké, 2011). Dietary supplement use is the highest in young children (75%, 1 to 3 years old), followed by women in the age category of 51 to 79 years old (58%), and by children between 4 to 8 years old (57%; van Rossum et al., 2016). The highest rates of use in young children might be explained by the fact that the Health Council of the Netherlands (2015) recommends parents to supplement their children's diet with vitamin D. During wintertime more individuals take dietary supplements than during the rest of the year. Multivitamins with minerals (MVMs) are the most frequently reported type of dietary supplement (24%), followed by vitamin D (13%), vitamin C (10%), and fish oil/omega-3 fatty acids (6%; van Rossum et al., 2016).

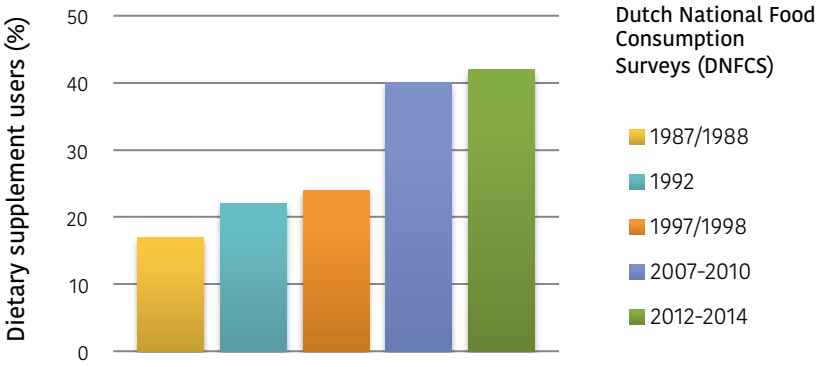

Figure 1.1 Dietary supplement use in the Netherlands over the decades

Nutrition and health claims on dietary supplements

As stated earlier, dietary supplements may help to prevent or cure deficiency diseases. Unfortunately, consumers often incorrectly assume that dietary supplements may prevent the occurrence or progression of non-deficiency diseases such as chronic conditions, as well (Coates, Dwyer, & Thurn, 2007). Yet sufficient evidence from randomized controlled trials supporting these assumptions is still lacking (Fortmann, Burda, Senger, Lin, & Whitlock, 2013; Grodstein et al., 2013; Lin, O'Connor, Rossom, Perdue, & Eckstrom, 2013). In order to protect consumers from misleading claims that may evoke false expectations towards the product, claims used on dietary supplements need to be based on and substantiated by generally accepted scientific data (Verhagen, Vos, Francl, Heinonen, & van Loveren, 2010). The Nutrition and Health Claim Regulation (Regulation (EC) No 1924/2004) distinguishes between two types of claims that are allowed on dietary supplements and on other types of food products in the European Union: nutrition and health claims. Nutrition claims are claims that state, suggest or imply that a food product has particular properties (Eussen et al., 2011). Health claims are statements suggesting that a relationship exists between a food product and a health condition (Eussen et al., 2011). Claims that refer to the prevention, the treatment or the cure of a human disease (i.e. medical claims) are prohibited to use on dietary supplements (Verhagen et al., 2010). In addition, the Food Supplements Directive (Directive 2002/46/EC) sets rules for the labelling of food supplements and introduces specific rules on vitamins and minerals as ingredients of dietary supplements (Verhagen et al., 2010). For each type of content and health claims examples are given in Table 1.1.

Table 1.1 Overview of types of nutrition and health claims in the Nutrition and Health Claim Regulation (Regulation (EC) No 1924/2004)

Main and sub-types of claims	Example of an authorized claim
1. Nutrition claims	
1.1 Content claims (Art. 8)	"This product contains calcium"
1.2 Comparative claims (Art. 9)	"Fat-free", "Reduced fat"
2. Health claims	
2.1 Function claims	
2.1.1 Generally accepted scientific evidence (Art. 13.1)	"Calcium is needed for the maintenance of normal teeth"
2.1.2 Newly developed scientific data (Art. 13.5)	"Daily creatine consumption can enhance the effect of resistance training on muscle strength in adults over the age of 55"
2.2 Reduction of disease risk (Art. 14.a)	"Calcium helps to reduce the loss of bone mineral in post-menopausal women. Low bone mineral density is a risk factor for osteoporotic bone fractures"
2.3. Children's development (Art. 14.b)	"Calcium and vitamin D are needed for normal growth and development of bone in children"

Based on Verhagen et al. (2010) and van Buul and Brouns (2015).

It should be noted, that the Nutrition and Health Claim Regulation explicitly states that health claims must be worded in a form that allows 'an average consumer' to understand the beneficial effects as expressed in the claim (Verhagen et al. 2010, Lähteenmäki, 2013).

Controversies about dietary supplements

Despite the long history of dietary supplements and their widespread use, recent research has shown that dietary supplements may involve risks to health, especially when taken in combination with other dietary supplements or prescription drugs (Vrolijk et al., 2015; Vrolijk, Opperhuizen, Jansen, Bast, & Haenen, 2016). Therefore, consumers should be aware of important safety issues, contraindications, and popular misconceptions.

Dietary supplement use may lead to excessive intakes of vitamins and minerals, since they may contain doses of active ingredients that are several times higher than the recommended daily allowance (RDA; Webb, 2011). Some examples of health risks related to excessive intake are: bone abnormality, skin erythema, nervous abnormalities (vitamin A), sensory neuropathy (vitamin B6), flushing (vitamin B3), stomach upset (magnesium), and muscle pain (manganese) (Hathcock et al., 1990; The Netherlands Nutrition Centre, 2009; Webb, 2011). For 22 micronutrients, the Scientific Committee for Food (SCF) has established upper

levels of intakes (i.e., tolerable upper intake level (UL)) that are unlikely to pose a risk of adverse health effects (EFSA Scientific Committee on Food, 2006). However, legal rules that prohibit selling products containing more than the UL are still imminent in the European Union (Hahn & Strohle, 2014). Hence, it is important that consumers check the dosage on the label and do not buy dietary supplements that exceed the UL.

Despite the fact that dietary supplements are sold without restrictions, consumers should not assume that all products undergo rigorous safety and efficacy checks prior to selling. The European Commission employs an arbitrary rule for which products are obligated to undergo safety assessments and which are not. Dietary supplements that contain 'novel' ingredients (i.e., ingredients that were consumed only after the date when the Regulation (EU) 2015/2283 on novel foods came into force) are required to undergo safety assessments. All other types of ingredients are regarded 'conventional' (e.g., collagen) and no rigorous tests are required. For the latter type of ingredients, adverse health effects may only be discovered if consumers report their health complaints to a pharmacovigilance centre (Eussen et al., 2011).

The concurrent use of dietary supplements and prescription drugs may cause adverse reactions (Tsai, Lin, Simon Pickard, Tsai, & Mahady, 2012; Vrolijk et al., 2015). This may be of concern, since two-thirds of chronically ill patients use dietary supplements concurrently with prescription or over-the-counter drugs (Boyer, 2005). Despite their risk of supplement-drug interactions, fewer than half of supplement consumers report their supplement use to their physicians (Starr, 2015). It should be noted, that besides risks, dietary supplements might also have benefits for certain sub-populations that take prescription drugs. For instance, dietary supplements may help to overcome under-nutrition in the elderly (Gahche, Bailey, Potischman, & Dwyer, 2017). In addition, they may help to support drug therapy, for instance by reducing drug associated side effects during statin therapy (Eussen et al., 2011).

Since botanical preparations are plant-derived food items, they are often associated with 'natural' and as such are considered to be safe (Marinac et al., 2007; Rietjens, Slob, Galli, & Silano, 2008). Indeed, when taken as monotherapy, research has documented potential health benefits (Ernst, 2002). However, herbal remedies have more documented drug interactions and contraindications than any other types of dietary supplements (Tsai et al., 2012).

Who needs dietary supplements: groups at risk of micronutrient deficiency

Despite the controversies described in the previous paragraphs, certain subpopulations may benefit from using dietary supplements since they are at increased risk of micronutrient deficiency. According to the Health Council of the Netherlands (2008, 2009, 2012, 2015), there is sufficient evidence from randomized controlled trials that dietary supplements are effective in preventing micronutrient inadequacy in the following risk groups: infants up to three months old (vitamin D and vitamin K), young children up to age 4 (vitamin D), pregnant women and women who would like to get pregnant (folic acid), men above 70 years old (vitamin D), post-menopausal women (vitamin D), people who are insufficiently exposed to natural sunlight (vitamin D), people with dark skin (vitamin D), and vegetarians (vitamin B12). For other subpopulations, dietary supplements have no added value to the normal diet in terms of beneficial (health) effects, as long as there is no clear evidence of severe micronutrient deficiency (Health Council of the Netherlands, 2015; Kromhout, Spaaij, De Goede, & Weggemans, 2016).

Studies have shown that most risk groups do not comply with the official recommendations of the authorities. For instance, in the Netherlands only 36 per cent of women of childbearing age had full compliance with folic acid use in terms of timing (i.e., starting in the periconceptional period) and dose (500 µg per day) (de Walle & de Jong-van den Berg, 2002). However, 63 per cent knew about the protective effect of folic acid for neural tube defects in new-borns (de Walle & de Jong-van den Berg, 2002). Compared to the Netherlands, full compliance with folic acid supplementation is even lower in Northern Ireland (19 per cent; McNulty et al., 2011), South-Australia (30 per cent; Conlin, MacLennan, & Broadbent, 2006), and England (5.5 per cent; Inskip et al., 2009). Another example of low compliance is vitamin D supplementation in the elderly. In the Netherlands, only 20 to 25 per cent of the elderly takes sufficient levels of vitamin D (20 µg per day) (Ocké et al., 2013). In other European countries, compliance with vitamin D supplementation varies between 30 and 71 per cent in the elderly (Castelo-Branco, Cortés, & Ferrer, 2010; Sanfelix-Genovés et al., 2009; Touskova et al., 2015).

Characteristics of dietary supplement users

Studies have shown that a large proportion of dietary supplement users do not necessarily need to supplement their diet because they already have a healthy lifestyle. In the adult general population, dietary supplement use has been positively associated with having healthy habits (i.e., sufficient nutritional intake,

being physically active; Bailey, Fulgoni III, Keast, & Dwyer, 2011, 2012; Foote et al., 2003; Kennedy, Luo, & Houser, 2013; Kirk, Cade, Barrett, & Conner, 1999) and it has been inversely associated with several types of unhealthy behaviour (e.g., intake of starchy food, smoking, alcohol consumption; de Jong, Ocke, Branderhorst, & Friele, 2003; Foote et al., 2003; Kirk et al., 1999; Rock, 2007; Touvier et al., 2009). In addition, individuals with a higher income and a higher educational level are more inclined to take dietary supplements (Dickinson & MacKay, 2014; Gahche et al., 2011). The phenomenon that individuals who are most likely to use dietary supplements are those who least likely need them, has been termed the 'inverse supplement hypothesis' (Kirk, Woodhouse, & Conner, 1998). This apparent contradiction might be partly explained by consumers' growing health-consciousness and wellness seeking (Dickinson & MacKay, 2014; Frey, Hoffmann, & Heuer, 2017).

Despite the fact that dietary supplement use has been associated with positive perceptions of one's health status and a healthy lifestyle (Dickinson & MacKay, 2014), some (medical) health conditions have often been related to its use as well (Rock, 2007; Satia-Abouta et al., 2003). Dietary supplement use is higher among adults with cancer or other chronic conditions than among adults reporting no illness (Miller et al., 2008; Pouchieu et al., 2015). However, it is important to note that within the group of individuals having chronic conditions dietary supplement users tend to have a healthier lifestyle (e.g., more fruit consumption) than non-users (Pouchieu et al., 2015).

Dietary supplement use is more common in the older than in the younger age groups. Furthermore, in all age groups more females use dietary supplements than males. In the Netherlands, 45 per cent of the elderly (i.e., above the age of 60) take at least one type of dietary supplements (Ocké et al., 2013; van Rossum et al., 2016). This may indicate that the increasing prevalence rates of dietary supplement use may correlate with the increase of the ageing population.

Reasons for dietary supplement use

As described in the previous paragraphs, individuals with a sufficient intake of nutrients and with the lowest need to supplement their food intake are the most inclined to supplement their diet. In contrast, compliance with supplementation guidelines is poor in individuals who would truly benefit from taking dietary supplements. In order to explore why certain groups of individuals succeed in supplementing the diet — even if it is not necessary — while others do not, it is important to investigate their motives for taking dietary supplements.

Even though there is some evidence why individuals take dietary supplements, comprehensive and systematic research is very limited. Conner et al. (2001) found for instance that intentions, health value, and susceptibility to illness were significant predictors of dietary supplement use. However, findings are difficult to compare because different research methods have been used, samples have often been selective (e.g., middle aged women), assessments of motives have been restricted, but most importantly: only two studies have tested determinants of dietary supplement use (or intentions to use) derived from theoretical models. Consequently, there is a need to investigate determinants of dietary supplement use with theory-based research. In health communication, theories are used to identify and target the most important psychosocial factors associated with a certain type of health behaviour. In the present dissertation the Integrated Change Model (ICM; de Vries et al., 2003) will be used as the theoretical framework. The ICM has been previously used to identify determinants of dietary behaviours such as eating in moderation (Walthouwer, Oenema, Candel, Lechner, & de Vries, 2015), and fruit and vegetable intake (Schulz et al., 2014).

The ICM is a result of theoretical integration (Noar & Zimmerman, 2005), and incorporates concepts from the Health Belief Model (Janz & Becker, 1984), Social Cognitive Theory (Bandura, 1989), and the Theory of Planned Behaviour (Ajzen, 1991). In addition to the models mentioned, the ICM includes pre-motivational factors (knowledge, risk perception, awareness) as well. As proposed by the ICM, behaviour is directly predicted by intention that is influenced by different motivational factors: attitudes (pros and cons), social influence (modelling, social support, social norms) and self-efficacy (de Vries, Mesters, Van de Steeg, & Honing, 2005; de Vries et al., 2003). Motivational factors are in turn determined by pre-motivational factors: knowledge, risk-perceptions (susceptibility to illness), awareness, and cues to action (internal, external; de Vries et al., 2005). Lastly, predisposing factors (e.g., psychological factors) and information factors (e.g., content of the message) may have an influence on health behaviour indirectly through pre-motivational and motivational factors.

Therefore, the first aim of the present dissertation is to investigate socio-cognitive determinants in a systematic manner. In order to do so, a qualitative research method will be used to explore individuals' beliefs and motives to take dietary supplements. Subsequently, socio-cognitive predictors of the behaviour will be tested. In this manner, input will be generated about what type of information should be disseminated about dietary supplements.

Dietary supplement use as a health decision

Since dietary supplements may have both advantageous and disadvantageous effects on one's health, unambiguous advice against or in favour of dietary supplement use cannot be given. Consequently, it is not the consumer's behaviour that should be targeted but his/her decision-making that should involve a conscious consideration of health benefits and risks. A decision in favour or against dietary supplement use can be regarded valid, as long as the decision is informed. Yet to date no conceptualization of informed decision-making (IDM) exists in the context of dietary supplement use. Therefore, research is needed to explore what can be regarded a well-considered decision and to what extent individuals make informed decisions about dietary supplement use.

The concept of IDM was first used in the context of clinical treatment and (genetic) screening. Decisions in these contexts often involve situations in which no single best therapeutic action exists and choices depend on how patients value benefits versus harms (O'Connor et al., 2007). However, IDM also relates to health decisions that are made outside of a clinical encounter and without any input of a healthcare provider (Hersch, Jansen, & McCaffery, 2018). In contrast to patient decision-making (i.e., discrete health decisions), the field of everyday self-care decision-making (e.g., the use of complementary and alternative medicine) remains largely unexplored (Thorne, Paterson, Russell, & Schultz, 2002). Therefore, research is needed to gain insight into IDM on dietary supplement use.

In the context of patient decision-making, the International Patient Decision Aids Collaboration (IPDAS; Elwyn et al., 2006) gives a clear definition of a well-considered decision. A 'good choice' reflects consistency between the patient's actual decisions and their informed values (i.e., positive and negative features that matter most to the patient; Elwyn et al., 2006). Furthermore, in order to reach choices of high quality (termed as informed choice), the decision-making process should (ideally) involve: the recognition that a decision needs to be made, knowledge about options and their features, understanding that values that are personally important affect the decision, awareness of which option features matter the most, discussing values with practitioners, and the possibility of active participation in the decision-making process (O'Connor et al., 2007). However, there is little agreement on how the concept of IDM should be operationalised (Hersch et al., 2018).

In research on screening uptake, the Multidimensional Measure of Informed Choice (MMIC; Marteau, Dormandy, & Michie, 2001; Michie, Dormandy, & Marteau, 2002) is one of the most widely used measures (Ames, Metcalfe, Archibald, Duncan, & Emery, 2015). The MMIC consists of two components: value-consistency and level of knowledge. The first component reflects the extent to which

individuals' attitudes (positive or negative) towards a decisional option correspond with their actual choice (e.g., screening uptake versus decline). A value-consistent choice becomes an informed choice when made with a sufficient level of knowledge (Marteau et al., 2001). The MMIC is considered a short and easy instrument to use. However, it oversimplifies informed decision-making into a dichotomous variable and does not take cognitive processes (e.g., information elaboration) prior to decision-making into account (Ames et al., 2015).

Despite that existing measurement instruments, such as the MMIC, have not been applied to dietary supplement use yet, Petróczi et al. (2007) found some evidence that users' decisions on dietary supplement use may not be (fully) informed. According to their results, individuals take dietary supplements for other health reasons than their actual, scientific-proven health effects (Petróczi et al., 2007). In a more recent study similar conclusions were drawn: there is a striking difference between evidence-based rationales to use dietary supplements and individuals' actual reasons to use them (Sirico et al., 2018). This means that a lot of dietary supplements are taken for purposes they are not meant for. Therefore, it can be concluded that there is a need for improving individuals' informed decision-making by providing consumers with accurate information.

In sum, when considering taking dietary supplements, individuals need to make well-informed decisions. Yet it is unknown to what extent consumers make rational and informed decisions about dietary supplement use and how a rational choice could be conceptualized. Therefore, the second aim of the dissertation is to explore what informed decision-making is in the case of dietary supplement use and whether decisions on dietary supplement use are informed.

Interactive media: new possibilities to support informed decisions?

Dietary supplement use may involve both health benefits and risks. Consequently, proper understanding of these effects is important. Therefore, communication on dietary supplements should effectively improve understanding and recall of health information (i.e., information on health risks and benefits), which can be considered a first step in the process of informed decision-making. The Internet seems to be a suitable channel to disseminate information because it is one of the most frequently used sources of information about dietary supplements (Owens, Toone, & Steed-Ivie, 2014). Furthermore, in the Netherlands the Internet is easily accessible since 98 per cent of the households have broadband connections and 87 per cent of the inhabitants have mobile access to it (Statistics Netherlands, 2018). Yet empirical evidence is lacking how information about dietary supplements could be effectively presented on the Internet. Some

scholars argue that interactivity, which is one feature of the Internet as a medium, has the potential to support active exploration of the website content through which communicational outcomes such as users' recall may improve (Lustria, 2007). Therefore, the third aim of the dissertation is to gain insight into whether and how interactive features could be utilized in order to improve individuals' recall of health information about dietary supplements.

In health communication, research on interactivity effects is still evolving. To date, the Theory of Interactive Media Effects (TIME; Sundar, Jia, Waddel, & Huang, 2015) is the only model that conceptualizes possible associations between types of interactivity and different communicational outcomes. The TIME differentiates between modality- (i.e., functional on-screen tools), message- (i.e., action-response dynamic between user and website), and source interactivity (i.e., the possibility to select, customize, and generate content; Sundar et al., 2015). It is proposed that these three types of interactivity influence user engagement with the content, through which behavioural and cognitional outcomes are affected. Yet to date empirical evidence is mixed regarding how interactivity affects communication outcomes. Some studies and meta-reviews found that web interactivity is beneficial for message elaboration and recall (Lustria, 2007; Sicilia, Ruiz, & Munuera, 2005), whereas others suggested zero (Willoughby & Niu, 2016) or detrimental effects on recall (Warnick, Xenos, Endres, & Gastil, 2005). In addition, studies suggested that too much interactivity could backfire (Oh, 2017; Sundar, 2004).

Therefore, in the present dissertation more insight will be gained into how interactivity affects recall of health information on dietary supplements. Printed health communication materials, such as decision aids present information in a pre-determined order. Consequently, individuals are guided through the content. However, in an online environment interactive features enable individuals to explore the content in the order and pace they want. Some evidence suggests, that such interactive information systems have the potential to help consumers better match their preferences, improve their knowledge, and make them more confident in their judgement when making a consumer decision (Ariely, 2000). Therefore, the third aim of the dissertation is to gain insight into whether the use of interactive features is beneficial in Internet-based health communication about dietary supplements.

Aims of the dissertation

Dietary supplements have become commonly used products in modern consumers' everyday life, despite existing contradictions regarding efficacy, safety, health risks, and benefits. Therefore, the goal of this dissertation is to explore how people can be optimally informed about dietary supplement use in order to foster informed decision-making. The dissertation has the following specific aims:

(1) to gain insight into socio-cognitive determinants of dietary supplement use;

(2) to explore what informed decision-making is in the case of dietary supplement use and whether decisions on dietary supplement use are informed;

(3) to gain insight into whether the use of interactive features is beneficial in Internet-based health communication about dietary supplements.

Dissertation outline

Two studies are conducted to address the first sub-aim. In chapter 2 and 3 a two-step, systematic approach is applied to discover beliefs and determinants of dietary supplement use. Chapter 2 describes the results of a qualitative study to explore individuals' beliefs towards dietary supplement use. In chapter 3, the socio-cognitive predictors of dietary supplement use are tested in a longitudinal survey study. In addition, differences between users and non-users are discussed. Chapter 4 and 5 address the second aim of the dissertation: what is informed decision-making in the case of dietary supplement use and whether decisions on dietary supplement use are informed. In an international, three-round Delphi study relevant components of informed decision-making on dietary supplement use are explored (chapter 4), followed by looking at whether consumers actually make informed decisions about dietary supplement use (chapter 5). The last aim of the dissertation is to gain insight into whether the use of interactive features is beneficial in Internet-based health communication about dietary supplements. This aim is addressed in chapter 6 and 7. An online experiment was used to investigate interactivity effects on individuals' recall of health information (chapter 6). In addition, with the use of an online tracking tool it was explored to what extent individuals make use of interactive tools (chapter 7). Finally, chapter 8 gives an overview of the main findings, a general discussion, and conclusions. In addition, methodological considerations, implications for practice and future research are discussed. See Table 1.2 for the dissertation outline.

Table 1.2 Overview of studies presented in the dissertation

Chapter	Study aim	Participants	Method	Sample size
Two	To explore salient beliefs regarding dietary supplement use	Selective/purposive sample of users and non-users from the Maastricht-area	Focus group discussions	n = 58
Three	To test predictors of dietary supplement use, to test differences between users and non-users	General Dutch population	Longitudinal online survey	n = 1161
Four	To reach consensus among experts on components of informed decision-making about dietary supplement use	Selective/purposive sample of international experts of (risk) communication of dietary supplements or related fields	Online, three-round Delphi-study	n_{round1} = 38 n_{round2} = 89 n_{round3} = 51
Five	To explore clusters of decision makers regarding dietary supplement use	General Dutch population	Cross-sectional online survey	n = 1161
Six	To investigate different information processing mechanisms, and the role of health literacy and need for cognition	General Dutch population	Online experiment	n = 983
Seven	To test whether user activity moderates the effect of interactivity on recall	General Dutch population	Online experiment	n = 524

CHAPTER 2

Exploring beliefs about dietary supplement use: Focus group discussions with Dutch adults

Based on: Pajor, E. M., Oenema, A., Eggers, S. M., & de Vries, H. (2017). Exploring beliefs about dietary supplement use: Focus group discussions with Dutch adults. *Public Health Nutrition*, *20*(15), 2694-2705.

ABSTRACT

Background: Although dietary supplement use is increasing in Europe and the US, little research involving adults' beliefs regarding dietary supplements has been conducted. Therefore, this study aims to explore and compare users' and non-users' beliefs towards dietary supplements.

Method/design: Thirteen focus group discussions were conducted of which seven groups were dietary supplement users and six groups were non-users. In total 56 individuals participated in the study of which 28 were dietary supplement users and 28 non-users. The average age of participants was 42.9 years. Based on the socio-cognitive factors of the Integrated Change Model (ICM), a semi-structured topic guide was set up. The discussions were audio-recorded and subjected to qualitative content analysis, applying the framework approach.

Results: Dietary supplement users' attitude beliefs were mainly related to mental and physical health enhancement, illness prevention and curative health benefits. Users were critical of the nutritional knowledge of health professionals, and of the quality of food products. Non-users were convinced that the human body does not need any support and that regular food is enough to cover one's nutritional needs. Users and non-users held comparable beliefs regarding the definition and risks of dietary supplements, and perceived social influences.

Conclusions: In their decision about dietary supplement use, both groups were guided to a great extent by their own convictions. Both groups would benefit from improved understanding of the health effects of dietary supplements in order to improve informed decision-making.

INTRODUCTION

Dietary supplement use is increasing and widespread in many European countries and in the US (Bailey, Gahche, Miller, Thomas, & Dwyer, 2013; Skeie et al., 2009). As an example, 51.9 per cent of the US adult population and 40 per cent of the Dutch adult population takes dietary supplements regularly (Briefel & Johnson, 2004; van Rossum et al., 2011). Yet evidence-based recommendations are established only for certain groups of the population (Health Council of the Netherlands, 2015; van Rossum et al., 2011), such as vitamin D and calcium supplementation in the elderly, which lowers their risk of fractures (Health Council of the Netherlands, 2012). There is no scientific consensus regarding the health benefits of dietary supplement use in the general population (Harrison, Holt, Pattison, & Elton, 2004). Therefore, it can be assumed that an individual's decision to take dietary supplements may be mainly a result of factors other than physiological necessity. Yet knowledge on individuals' motives for taking dietary supplements is fragmented and inconclusive. Furthermore, no research has yet addressed the question of why certain consumers consciously choose not to take them (Okleshen Peters, Shelton, & Sharma, 2004). Therefore, the aim of the present study is to gather in-depth knowledge on individuals' beliefs concerning dietary supplements. In addition, users' and non-users' most salient beliefs will be compared.

Dietary supplement use has been shown to be associated with a healthy lifestyle: sufficient fruit and vegetable intake, adequate level of physical activity, low alcohol consumption, and being less likely to smoke (de Jong et al., 2003; Greger, 2001; Kirk et al., 1999). Additionally, women with a higher educational level, higher income and belonging to higher age groups are more likely to take dietary supplements (Bailey et al., 2010; Blendon, DesRoches, Benson, Brodie, & Altman, 2001; Kirk et al., 1999).

Certain motivational factors are also associated with dietary supplement use. Women who have stronger intentions to take dietary supplements, attach more value to their health and are more convinced that dietary supplements make them less susceptible to illnesses, are significantly more inclined to take dietary supplements (Conner et al., 2001). Regarding one's reasons for and beliefs towards dietary supplement use, individuals are convinced that dietary supplements are essential to health and can preserve or improve their overall health condition (Bailey et al., 2013; Blendon et al., 2001; Marinac et al., 2007; Nichter & Thompson, 2006; Okleshen Peters et al., 2004; Rozga, Stern, Stanhope, Havel, & Kazaks, 2013). When comparing dietary supplement users to non-users, the following attitude beliefs differ significantly: dietary supplements 'help me to be healthy'; 'stop me getting ill'; 'are the best I can do for myself'; and 'they don't do any harm'

(Conner, Kirk, Cade, & Barrett, 2003). The studies mentioned above provided relevant but limited evidence since data were collected within the framework of larger projects, such as the National Health and Nutrition Examination Survey (Bailey et al., 2013), or the study used a selective sample (Conner et al., 2001; Conner et al., 2003).

Qualitative research on beliefs regarding dietary supplement use is limited to a couple of studies that did not use a specific theoretical framework. In-depth interviews with ten dietary supplement users revealed that curing an ailment, preventing chronic diseases, gaining 'peace of mind', supplementing a poor diet, saving money on medical care, and achieving cosmetic benefits are the most salient motives (Okleshen Peters et al., 2004). Taking an anthropological approach, Nichter and Thompson (2006) identified the following five main categories of reasons for dietary supplement use: health management/enhancement (e.g., postponing ageing), harm reduction (e.g., counterbalance unhealthy behaviours), resisting illness (e.g., boost immune system), illness management (e.g., slow progress of disease), and ideology (e.g., adoption of 'natural health' philosophy). Four focus group discussions held in Germany revealed the following motives among users: being afraid of having micronutrient-deficiencies, relieving one's mind (e.g., unhealthy eating habits), preventive reasons (e.g., boost immune system), curative reasons (e.g., reduce health complaints), and restoring subjective well-being (e.g., sufficient energy-level; Rehaag et al., 2013). Studies have also shown that most dietary supplement users have multiple reasons at the same time (Nichter & Thompson, 2006; Okleshen Peters et al., 2004).

The studies mentioned above explored users' overall motives for taking dietary supplements, and no attention has been paid to why certain individuals do not use dietary supplements. In order to explore specific beliefs and to be able to compare users and non-users, a socio-cognitive model was used as theoretical framework. One of the socio-cognitive theories that explains (health) behaviours is the Integrated Change Model (ICM; de Vries et al., 2003). The ICM distinguishes between distal, pre-motivational and motivational factors that may influence behaviour. Distal factors, such as behavioural, psychological, and biological factors, have an indirect effect on behaviour that is mediated by pre-motivational and motivational factors. Knowledge, risk-perception, awareness, and cues to action belong to pre-motivational factors. These socio-cognitive determinants influence motivational factors: attitude (pros and cons), social influence (social norm, social modelling, social support) and self-efficacy. Intentions and factors of the motivational phase together influence individuals' health behaviour. The ICM has been applied previously in different qualitative studies on health-related behaviours, such as alcohol use among pregnant women, binge drinking among

young people, and genetics and cancer (de Vries et al., 2005; Jander, Mercken, Crutzen, & de Vries, 2013; van der Wulp, Hoving, & de Vries, 2013).

In sum, the present study aims to answer the following research questions: 1. What are the most salient beliefs derived from the socio-cognitive determinants of the ICM regarding dietary supplements among users and non-users? 2. What are differences between users' and non-users' beliefs?

METHODS

In order to gather in-depth information on Dutch individuals' beliefs towards dietary supplements, semi-structured focus group discussions were conducted. Focus group discussion is a widely used method in health sciences, since it can provide information about a range of ideas and feelings individuals have about a certain topic of interest (Rabiee, 2004; Stewart & Shamdasani, 2014). Furthermore, focus group discussions can shed light on the differences in perspectives between groups of individuals (Rabiee, 2004). The in-depth information generated was also meant as a preparation for a quantitative study on dietary supplement use. Systematic interpretative content analysis was used as the methodological approach of analysing the data (Hijmans, 1996).

Recruitment and participants

The aim was to include both current dietary supplement users and non-users in the study sample. In order to make a distinction between users and non-users, inclusion and exclusion criteria were set up. Individuals were regarded as dietary supplement users if they took at least one pill per week of one or more types of dietary supplements prior to the recruitment period of the study. Individuals who consumed dietary supplements exclusively for sports-related purposes were excluded. Athletes' needs, reasons, and experiences regarding dietary supplement use may be mostly related to the enhancement of their sport performance, which may not be representative to the general population of dietary supplement users (Rehaag et al., 2013). The only inclusion criterion applied for non-users was that the person had not taken any type of dietary supplements at least for three months prior to the recruitment period.

Online and offline platforms were utilized for recruitment. Digital advertisements were posted on social media and Internet search engines, such as Google AdWords. Hardcopies of brochures and posters were placed on the noticeboards of grocery shops, drugstores, community centres, and general

practitioners' practices in Maastricht. Researchers recruited also through the handing out of flyers at local events, such as the Maastricht book fair.

Individuals who were interested in the study could contact the research team by telephone or e-mail to receive more information. When potential participants applied, they were asked to fill in a brief screening questionnaire to assess eligibility. Based on the answers, participants were allocated either to the dietary supplement user group or to the non-user group. Focus group appointments were made according to respondents' availability.

Convenience sampling was used for recruiting participants until theoretical saturation was reached (i.e., little or no new information was discovered; Glaser & Strauss, 2009). As suggested by Krueger (2014), an initial analysis sample was set to at least four to five focus groups in order to adequately address the research objective (i.e., to explore the most prevalent beliefs; Francis et al., 2010). Additionally, after each session the research team discussed the main points participants made and to what extent those points differed from opinions expressed in previous sessions. Recruitment took place as long as potential participants kept replying to the call for participation.

The focus group interview guide

Based on the ICM, a semi-structured interview guide with open-ended questions was developed. The questions aimed to elicit data on participants' definition of what a dietary supplement is, risk perceptions, attitudes (pros and cons), social environment (i.e., opinion of friends and family), self-efficacy of taking dietary supplements, and response-efficacy. Each topic was introduced by a central question followed by additional prompt-questions to stimulate the group discussion (see Appendix A, B). The semi-structured interview guide gave individuals also the opportunity to talk about additional relevant topics such as (healthy) food.

The interview questions were pilot-tested both in an individual and in a group setting. With the help of pilot-testing researchers can develop and test the adequacy of research instruments (van Teijlingen & Hundley, 2002). The questions used for focus groups with users and non-users were kept as similar as possible, slight changes were only made when needed (e.g., advantages of dietary supplements, users: "What are your most important reasons for taking dietary supplements?"; non-users: "Can you think of reasons why you would take dietary supplements?").

Data collection and procedure

A standardized study protocol was developed to keep the procedures of each session consistent. According to the protocol, after welcoming participants and providing coffee, tea and cake, a short introduction (research team, reason and aims of the study) was given. As stated in the invitation letter beforehand, it was emphasized that taking part in the discussion was confidential, voluntary and withdrawing from participation was possible at any time. Participants were asked to write down their first name on a name badge to enable them to address each other by name. At the same time, individuals received a numerical identifier that was used in the notes and the transcripts. In this manner, it was impossible to trace back participants' real identity based on the data. Before the actual discussion started, participants had the opportunity to ask questions. The focus group discussions were audio-recorded after participants gave permission to do so.

During the focus group discussions the first author (EMP) functioned as moderator and a research assistant took notes. The sessions took place in one of the buildings of the Maastricht University and lasted 70 to 80 minutes on average. At the end of the sessions participants received vouchers at the value of 15 euros and a travel reimbursement. The focus group audio materials were transcribed verbatim. In total, 13 focus group interviews were conducted; seven with dietary supplement users (28 individuals) and six with non-users (28 individuals). The focus group size varied between three to six participants.

Ethical approval

Ethical approval from an accredited regional medical ethics committee in the Netherlands was not needed, since the study did not fall within the scope of the Medical Research Involving Human Subjects Act (WMO): the present research was not of medical-scientific nature and participants were not subjected to procedures or required to follow certain rules of behaviour (Central Committee on Research Involving Human Subjects, 2018). Prior to the focus group discussions, all participants received our brochure and invitation letter with important details about the study. This information was repeated verbally in the presence of participants before the actual group discussion took place. Verbal informed consent was obtained from all of the participants before each session.

Data analysis

Descriptive statistics (i.e., percentages, frequencies) were used to analyse the data of the screening questionnaire with IBM SPSS (version 20). Transcripts of the focus group discussions were analysed by applying systematic interpretative content analysis (Hijmans, 1996), using QSR NVivo (version 9). The analysis process followed the stages of the framework approach involving familiarization, identifying a thematic framework, indexing, charting, mapping, and interpretation (Elo & Kyngäs, 2008; Lacey & Luff, 2007).

In the first stages, inductive coding was applied to the data by two coders independently. This step involved obtaining insight into participants' salient beliefs belonging to the socio-cognitive constructs included in the topic guide (main themes). Coding was then compared and discussed in order to determine the final coding categories for users' and non-users' transcripts separately. Also, decision rules were made to standardize the coding process in the subsequent stages.

In the last stages, through deductive coding, the definite version of the thematic framework was applied to the data by two coders, using QSR Nvivo. This step involved regrouping participants' statements according to the index reference and if needed, new coding categories were made (Spencer & Ritchie, 2002).

In the interpretation phase, data were reduced in order to present results at a reasonable level of abstraction. Through grouping data, the number of (coding) categories was reduced by collapsing those that were closely related into broader categories (Elo & Kyngäs, 2008). In this manner, the most concrete and specific beliefs were at the lowest level of abstraction and they were then brought under integrative categories (sub-themes). At the highest level of abstraction were the socio-cognitive constructs that were regarded as the main themes and consisted of several sub-themes (see Figure 2.1). During data interpretation, users' and non-users' complete thematic framework were put against one another and were searched for differences and similarities at the sub-dimension level.

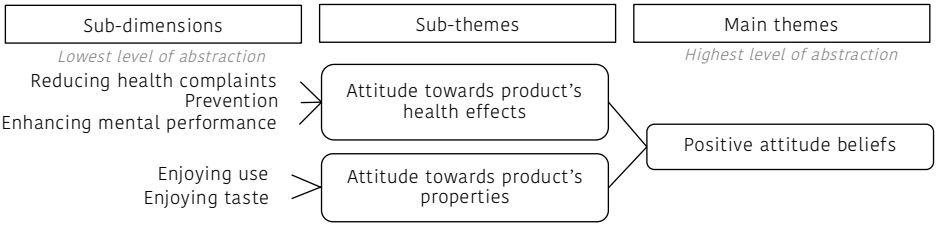

Figure 2.1 An example of the abstraction process (positive attitude beliefs, users).

RESULTS

Participants

In total, 56 individuals participated in the study. The majority of subjects were female (75% of users; 61% of non-users). Users were slightly younger (*M* = 41.6 years, *range* = 20-78) than non-users (*M* = 44.2 years, *range* = 19-68). More than the half of non-users (57.1%) had past experience with using dietary supplements (see Table 2.1).

Table 2.1 Demographic characteristics of participants (*n* = 56)

	Users (*n* = 28)		Non-users (*n* = 28)	
Characteristics	*n*	%	*n*	%
Gender				
Male	7	25.0	11	39.0
Female	21	75.0	17	61.0
Age (in categories)				
18–29	13	46.4	10	35.7
30–39	3	10.7	0	0
40–49	3	10.7	4	14.3
50–59	3	10.7	9	32.1
60 ≥	7	25.0	5	17.9
Mean age	41.6		44.2	
Past experience with dietary supplements				
Former user			16	57.1
No experience at all			12	42.9

A priori and emergent themes from the qualitative data

The following themes were *a priori* included in the topic guide: (I) definition of dietary supplements, (II) positive attitude beliefs towards dietary supplements, (III) negative attitude beliefs towards dietary supplements, (IV) risk perceptions, (V) social environment, (VI) self-efficacy regarding taking dietary supplements, and (VII) response efficacy. Emerging themes from the focus group discussions were: (VIII) attitude towards health professionals and/or dieticians, and (IX) quality of food. In Table 2.2, 2.3, and 2.4 direct quotations are given for illustrating each of these topics. Results will be presented according to the overarching topics outlined above.

A priori themes

Pre-motivational factors

Definition of dietary supplements

Users and non-users held very similar opinions about what a dietary supplement is and what its main functions are (Table 2.2, row A-B). Dietary supplements were described along several product property dimensions, such as their aggregate (e.g. liquid), form (e.g., powders, pills, drops), and the type and nature of ingredients (e.g., vitamins, minerals, synthetic, natural).

Regarding functions that dietary supplements could fulfil, both users and non-users agreed that dietary supplements were by no means a replacement for food, and they should not be used out of pure laziness. The way dietary supplements may help to maintain health and treat micronutrient deficiencies in one's body was also extensively discussed in several groups of users and non-users.

Risk perception (chance and severity of adverse effects)

When speaking about commonly used products (e.g., multivitamins) risks were regarded as negligible by both groups (Table 2.2, row C-D) and participants gave a few examples of possible side effects (Table 2.2, row E). Users and non-users were convinced that most dietary supplements might only cause adverse effects when they are excessively used, when the consumer's body is not functioning properly, or when someone is using inappropriate products (Table 2.2, row D). Users and non-users also believed that dietary supplements undergo rigorous safety checks before being sold, otherwise – as they argued – it would not be permitted to sell those products (Table 2.2, row F).

Table 2.2 Qualitative results from focus group discussions regarding pre-motivational factors among users and non-users of dietary supplements.

Main themes	Sub-themes	Quotes from dietary supplement users	Quotes from non-users of dietary supplements
DEFINITION OF DIETARY SUPPLEMENTS			
A	Characteristics of the product	"It [dietary supplement] is something that you can find in food, but its [dietary supplement] concentration is higher."	"[Dietary supplements are] everything you may need in a pill format or other formats like drops (...), or capsules (...), and they are often produced in a synthetic manner."
B	Functions of the product/purposes of use	**Supplementary function towards food:** "A dietary supplement alone is never enough. (...) It [dietary supplements] must have an additional value [to the diet]."	**Supplementary function towards food:** "The word [dietary supplement] itself already tells you: it is supplementary. So, what you perhaps or definitely don't get enough of [from food], you could supplement with dietary supplements."
		Function towards body: " (...) it [dietary supplement] is something that makes good a (possible) shortage in your body."	**Function towards body:** "Possibly in periods when you suffer from shortcomings. When you have a lack of energy. You may need it owing to doing sports (...) or after being ill for a while."
		Ease: "I do not eat fruit and it is also very expensive. I live on my own and when I buy bananas, it takes a while until I finish them. Then I think to myself: 'perhaps I should take such a pill'."	**Ease and certainty:** "(...) people who are aware of their bad dietary pattern might say: 'Well, with the use of multivitamins I cover my needs, so I know for sure that I'm getting enough [of (micro)nutrients]'."

Table 2.2 (continued)

Main themes	Sub-themes	Quotes from dietary supplement users	Quotes from non-users of dietary supplements
B (continued)	Functions of the product/purposes of use (continued)	**Alternative for medicine:** "Sometimes you have to take medicines, but you do not want to. Then you carry out a search in natural medicine: what could replace it [medicine]? Very often, you end up [the search] at dietary supplements."	**Alternative for medicine:** "I would not immediately take a pill prescribed by the doctor, I would first try a different pill that I can buy myself, you know."
RISK PERCEPTION			
C	Chance and severity	**Low risk:** "Most of the things I have been using have become very well established, like multivitamins. So you already know it does not hurt to try."	**Low risk:** "Most of the vitamins cannot do any harm, even if you took too many of them because they will leave your body through your urine."
		High risk: "(...) when you are using St. John's wort with antidepressants simultaneously, you may die of it."	**High risk:** "Vitamin B6 is a type of vitamin that might become toxic and may attack your nerves."
D	Deteriorating factors	**Excessive use:** "(...) Sometimes people take not only one, but two or three [pills] of [dietary supplement]. (...) It is equal to 600 oranges. (...) It is actually hypervitaminosis."	**Excessive use:** "Vitamin A may have [adverse effects]. You should not take that much of it. It is not good for your liver. It may be stored excessively. And then you might get a high dose."
		Malfunctioning/sensitivity of the body: "It depends on your own sensitivity. Everybody has strong and weak points, right?"	**Malfunctioning/sensitivity of the body:** "It [risks] depends on your own body. (...) If you already have poor health then I think you may notice the consequences of an overdose sooner."

		Characteristics of the product: "You have to pay attention to what you take, because there are so many chemicals in it [dietary supplements]. (…) Everybody takes the cheapest [dietary supplement], (…) but they never look at what is in it."	**Characteristics of the product:** "When I was using dietary supplements, it was stated on the label that you get 600 % of the RDA [with the use of that dietary supplement]. Then I was just wondering: '600% (…) is it necessary? You may get an overdose'."
E	Possible side-effects	"Iron pills, they may colour your defecation black. You may have problems with your bowel."	"I know with iron pills that you may get a lot of troubles with them. You might get stomach ache or diarrhoea from them. And your stools may be a different colour."
F	Safety check/ protection	"I do not think they [possible side effects] are serious. The dose is stated [on the packaging] with small letters. If it was really harmful, it would not be sold unrestricted, or it [dose] would be stated with bigger letters."	"No, you do not get side effects easily when you take a low dose [of dietary supplements], otherwise you should get it [prescribed] from a general practitioner."
		"I do not think about it. It must be good. Otherwise it would be prohibited to sell them. They [government] are already strict."	

Note. Words in capitals are the main themes of the group discussions. A to F: Sub-themes of the main themes. Words in bold are sub-dimensions of the sub-themes.

Motivational factors

Positive attitude beliefs

Regarding reasons for dietary supplement use, reducing health complaints and preventing illnesses were frequently mentioned aspects both by users and non-users (Table 2.3, row A). Users also reported how dietary supplements help them to enhance their mental performance. Also, users indicated enjoying the taste and use of dietary supplements (Table 2.3, row B).

Only non-users discussed micronutrient-deficiency and evidence-based effectiveness of the products as important reasons for considering taking dietary supplements (Table 2.3, row B). In addition, only non-users indicated that, in general, the persuasiveness of commercials or individuals' laziness could also lead to dietary supplement use (Table 2.3, row C-D).

Negative attitude beliefs

Both users and non-users regarded the commercial nature of the dietary supplement industry as a disadvantage (Table 2.3, row E). Also, in both groups concerns were expressed towards product properties, such as high-dosage pills, uncertainty about ingredients, and lack of sufficient evidence of safety (Table 2.3, row E-I). Regarding eating habits, users and non-users agreed that individuals' nutritional intake may decline as a consequence of dietary supplement use (Table 2.3, row F).

While users raised the issue that getting micronutrients from dietary supplements is not natural, non-users went further and regarded dietary supplements as an intervention in the normal functioning of the body (Table 2.3, row F). Concerning necessity, users emphasized the need to think thoroughly about the aims one will achieve with dietary supplements and then decide whether to (continue) to take them (Table 2.3, row G). Non-users approached necessity differently: supplementation is only necessary when suffering from deficiencies and there is no need for dietary supplements if individuals already eat healthily (Table 2.3, row G).

In several groups of users an extensively discussed topic was whether micronutrients from dietary supplements are properly absorbed through the digestive system (Table 2.3, row I).

Social environment

Both users and non-users reported that they are exposed to different social influences at the same time. In participants' social environment, individuals held different opinions about dietary supplement use, ranging from being positive and

encouraging to being negative and discouraging (Table 2.3, row J-N). Besides approvers and disapprovers, in participants' social environment there were also people who considered regular food as a sufficient source of nutrients and therefore they regarded taking dietary supplements unnecessary (Table 2.3, row M). Furthermore, users and non-users often heard from others that dietary supplements are harmless (Table 2.3, row K).

Both users and non-users indicated that their decision about dietary supplement use did not depend on other people's opinions. At the same time, both groups admitted that 'dietary supplement use' is not a common topic to talk about.

Self-efficacy

Users and non-users mentioned situations in which dietary supplement use would be difficult (i.e., barriers; Table 2.3, row P). Some of the situations mentioned by both groups were: having a different (daily) routine than usual (e.g., being on holiday), or not liking the taste of the product. Users also frequently mentioned forgetfulness as a barrier of taking dietary supplements.

Additionally, users and non-users mentioned a few situations in which they would never stop using dietary supplements: when suffering from micronutrient deficiencies and in the case of medical prescription (Table 2.3, row O).

Response-efficacy

Only users were asked whether they actually experienced the claimed beneficial health effects of dietary supplements (Table 2.3, row Q-Z). Users agreed that taking dietary supplements could help people improve their health. Yet users' opinions differed whether they were able to directly experience the beneficial health effects. Only some of them could precisely indicate whether and how they noticed the advantageous effects but many participants gave a detailed explanation as to why they have doubts about an immediate experience (Table 2.3, row W-Z). Users' doubts were related to the preventive use of the products and the difficulty in determining effectiveness. Furthermore, users were aware of possible placebo effects through which dietary supplements may seem to be effective.

Table 2.3 Qualitative results from focus group discussions regarding motivational factors among users and non-users of dietary supplements.

Main themes	Sub-themes	Quotes from dietary supplement users	Quotes from non-users of dietary supplements
POSTIVE ATTITUDE (advantages, reasons for use)			
A	Attitude towards the product's effects on one's body and mind	**Reduce health complaints:** "I suffer from pain in my shoulders. (...) I hope that it [dietary supplement] will make the situation better (...). It seems I have arthrosis."	**Reduce health complaints:** "People, who are more sickly or weak, or unsure. Those people (...) take dietary supplements very quickly."
		Prevention: "I think you get a stronger immune system with the use of Vitamin C and Echinacea."	**Prevention:** "Well, I think that for example people usually start using it for preventing illnesses."
		Enhance mental performance: "Most products I use are meant for mental well-being, an example is ginseng. It is meant for enhancing my study performance."	**Being at risk of deficiency:** "(...) people who suffer from anaemia need vitamin B12 injections every month. Otherwise you have a deficiency of red blood cells."
B	Attitude towards the use of the product or the product itself	**Enjoying use:** "I like to use this product. It is royal jelly. It is very delightful when I am weak and I don't feel well."	**Effectiveness is evidence-based:** "The reason why I would actually use it [dietary supplement] is that its effectiveness has been confirmed."
		Enjoying taste: "(...) my mother had a very big jar of vitamin C tablets. I was eating it all the time because they tasted so good."	**Control with pills on health:** "It is a typical sign of an affluent society. I mean the idea that people are able to influence their health with pills or dietary supplements."

C	Influence of commercials		"In my opinion it is more the commercial that wants to convince you to take something than that you are in such a need of it [dietary supplements]."
D	Ease		"Sometimes the idea occurs to me that people just find it easier because they are not fond of something and so they take a pill."
NEGATIVE ATTITUDE (disadvantages, reasons against use)			
E	Product properties and sales-related disadvantages	"Lately I bought a jar of 'Guarana 800 mg' – it is quite a high dosage, so I may get hyper[active] from it."	"In my opinion it is a kind of synthetic version of it [vitamin C], because it cannot be literally the same thing as what is in an orange."
		Commercialization: "There are some brands and it is like a 'hype' with lots of advertisements, commercials and marketing."	**Commercialization:** "There is actually a whole industry by which enormous amounts of money can be earned."
F	Consumers' health, functioning, and lifestyle-related disadvantages	**Hinder healthy eating:** "I may easily assume that I eat healthily when I take multivitamins. So it may be an excuse for eating less vegetables and fruits."	**Hinder healthy eating:** "When you are using dietary supplements, I think you are more inclined to leave fruits and vegetables."
		Not natural: "I am using them [dietary supplements]. But you feel like you are doing something unnatural. So you don't let things stand at: 'a varied diet is enough'."	**Normal way of functioning:** "I consider it important that my body nourishes itself, I do not want my body to get habituated [to dietary supplements]."

Table 2.3 (continued)

Main themes	Sub-themes	Quotes from dietary supplement users	Quotes from non-users of dietary supplements
G	(No) necessity	**Conscious use:** "You should only take something when you need it. It is beneficial to investigate critically and experience [the product]. You may leave it [dietary supplements] for a while or try out something new, when it is necessary."	**Need:** "In my opinion you should only use a dietary supplement – which is meant for deficiency – when it is needed." **Healthy diet is enough:** "I think you should eat healthily and varied, this is the best [for yourself] I think. Things like this [dietary supplements] are only needed in exceptional cases."
H	Safety check/investigation	"Some possible side effects have not been properly investigated yet and may become clearer only in the future."	"(…) it is very often claimed that it [dietary supplement] may not be harmful. But it still has not been fully investigated."
I	Lack of (evidence-based) effects	"Maybe the [beneficial] effect is not evidence-based." "Look, some people do not digest vitamin B12. So you can take whatever you want but it won't have an effect."	"Does it [dietary supplement] contain what it should contain? And does it work when you take it? You never know."
SOCIAL ENVIRONMENT			
J	Positive opinion	"(…) my mother says that you can always use something on the side [besides food]. Therefore I take vitamin C (…), but I have never really had any [physical] complaints."	"When I arrived at home and I told I was tired, my parents gave me an iron pill. 'Try this, it may help you'."
		Using dietary supplements: "Well, I think my girlfriend, my parents and my sister are	**Using dietary supplements:** "Yes, friends of mine (…) who feel weak and have to get out

		taking dietary supplements. And some fanatical friends of mine from the gym [are also taking dietary supplements]."	of their bed, then they take vitamin pills or energy boosters."
K	Dietary supplements are harmless	"It [taking dietary supplements] does not hurt to try."	"It [taking dietary supplements] does not hurt to try – they say."
L	Negative opinion	"At the college where I study 'dietary supplement' is almost a nasty word. They are really against it [dietary supplements]."	"When you do not have any symptoms (...) most people think then: 'What is the benefit of it [dietary supplements]'?"
M	(Healthy) food is enough	" (...) my friends are saying all the time: if you simply eat healthily, then they [(micro)nutrients] are all included in it [food]. Then you do not need to take something additionally."	"I have got four sisters and none of them takes them [dietary supplements]. One says: 'I wouldn't even start using them [dietary supplements] because I eat healthily'."
N	No idea	"My environment does not say anything about it [dietary supplements]."	"I have to admit, it is not a topic that is frequently discussed. I have never talked about it."
SELF-EFFICACY			
O	Difficult situations (to quit dietary supplement use)	**Medical reason:** "For me, it [taking dietary supplements] is for medical reasons because my body does not digest everything. So I have to play around with those dietary supplements all the time because otherwise I do not get anything [(micro)nutrients]."	**Medical reason:** "(...) Indeed, if you have a certain disorder or Crohn's disease. Or your body is not able to digest nutrients from your intestine. When people have chemotherapy treatment and do not eat properly. Also, you do not feel well so in that case you could use something extra."

Table 2.3 (continued)

Main themes	Sub-themes	Quotes from dietary supplement users	Quotes from non-users of dietary supplements
O (continued)	Difficult situations (to quit dietary supplement use) (continued)	**Risk on deficiency:** "When you know or feel that your body is not functioning as it should or your body has a deficiency. Then not to take [dietary supplements] would feel like (…) you are wronging yourself or your body."	**Risk on deficiency:** "I am a vegetarian. So you can easily sustain deficiency of iron or vitamin B12. (…) I can imagine that people think 'it is weird not to eat meat' and they are afraid that they do not get enough vitamins. So I can imagine that they would take particular vitamins as a supplementation."
P	Difficult situations (to take dietary supplements)	**External barrier:** "Yes, exactly, being on holiday. (…) It is difficult when you are somewhere else and you don't take them with you, then you cannot take them." **Internal barrier:** "You should not forget to take them [dietary supplements]. I notice immediately when I have forgotten to take them. So my tactic is to put them somewhere so I do not forget them [dietary supplements]."	**External barrier:** "I am not really good at swallowing pills. I had to swallow the [vitamin]pills whole and those were for really big pills. They also tasted very bad, so it did not make it easy to get them down."

RESPONSE EFFICACY (Noticing product efficacy)		
Q	Effect of product is present/noticeable	"(...) when I was diagnosed with arthrosis I was not able to do certain things. For example, when I got on my bike and had to give the first push, it hurt me. (...) After using this product for three months, it [pain] has gone away."
W	Effect of product is absent/unnoticeable	"My [vitamin] B12 level was considerably lower than the lower boundary of [vitamin] B12. (...) I took vitamin B12, I took a vitamin B complex product. I have been checked several times for vitamin B12. But taking the pill [vitamin B complex] had no effect or result."
Z	Doubt/uncertainty about effectiveness or noticing effects	**Placebo effect:** "But even if it is a placebo effect, it doesn't matter. Of course it's not worth the money. But when it [dietary supplement] has a placebo effect and I am able to walk again from here, then I am fine with it." **Effect is difficult to determine/measure:** "I have tried a lot of things to get rid of my energy shortage. I also did something with aloe vera so I cannot indicate it [what helped] precisely because I did not use them consecutively but simultaneously."

Table 2.3 (continued)

Main themes	Sub-themes	Quotes from dietary supplement users	Quotes from non-users of dietary supplements
Z (continued)	Doubt/uncertainty about effectiveness or noticing effects (continued)	**Prevention:** "If you use them [dietary supplements] for preventive purposes then you do not know. You do not know whether you otherwise had noticed something [symptoms] or got an illness. (...) You may prevent something, but you don't know."	

Note. Words in capitals are the main themes of the group discussions. A to Z: Sub-themes of the main themes. Words in bold are dimensions of the sub-themes.

Emergent themes

Attitude towards health professional and/or dietician

One of the unprompted discussion topics raised both by users and non-users was their experience with and opinion towards physicians (Table 2.4, row A-B). Several users have had unfavourable experiences with their physician, such as not being able to diagnose a health problem. Users also did not confide in dieticians and labelled their recommendations as 'old-fashioned' or 'inappropriate'. However, several users consulted regularly with so-called anthroposophical general practitioners (i.e., adherents of a spiritual philosophy aiming to optimize physical and mental health, and well-being) who gave them advice about lifestyle and diet, including recommendations for dietary supplements. In contrast, the majority of non-users held a positive attitude towards their physician (Table 2.4, row A).

Quality and safety of food

An additional frequently discussed topic by users and non-users was food quality (Table 2.4, row C-D). Very often, a comparison was made between food nowadays and 50-100 years ago regarding quality, supply, and food industry practices. The majority of users were convinced that the quality of food products has gone downhill recently and food contains considerably lower amounts of vitamins and minerals (Table 2.4, row D). As users further argued, quality deterioration is a result of poor practices of the food industry.

Non-users acknowledged that the quality of food products might have declined a little recently. Yet food products still may contain a sufficient amount of vitamins, minerals, and other important nutrients. Moreover, compared to 100 years ago, there is more opportunity to eat healthily as a result of the enriched variety of supply of fruits and vegetables (Table 2.4, row C).

Table 2.4 Qualitative results from the focus group discussions' newly identified themes among users and non-users of dietary supplements.

Main themes	Sub-themes	Quotes from dietary supplement users	Quotes from non-users of dietary supplements
ATTITUDE TOWARDS HEALTH PROFESSIONAL OR DIETICIAN			
A	Positive attitude, trust	"I trust my general practitioner and also the dietician, but I am a very critical person."	"When I do not feel well I am more inclined to go to a (health) professional like 'I do not feel well (…) how come?' And then you can decide to take something against it [illness]."
B	Negative attitude, distrust	"Very often it [advice on diet] is done at a general level (…). The person [dietician] keeps giving the same advice while perhaps someone is sitting in front of you who perhaps needs something totally different. (…) I know more about it [diet] than the person on the opposite side of the table. And that person suggests things, which [food pyramid] are old old-fashioned." "I never consult with a dietician. I would have an argument with them immediately. Simply because, generally speaking, I do not agree with their recommendations."	

QUALITY/SAFETY OF FOOD, PRACTICES OF FOOD INDUSTRY			
C	Positive attitude		**Better supply:** "Nowadays, if you look around you see how many cherry tomatoes or mini-cucumbers or salads people eat in the afternoon. In my opinion you have more opportunities to eat healthily than about 50 years ago when the supply was more restricted. Then you had only vegetables of the actual season." "I think that the supply of food, including industrial food, is quite good and it is rich enough in minerals, and is very low in harmful substances on the surface." **Quality of food is good enough:** "I think too that in certain cases it could be that it is less [micronutrients in food], but you have to ask yourself: 'is the amount that much less (...) that I get nothing or not enough [of micronutrients from food]'?"
D	Negative attitude	**Poor quality of food:** "It is awful what they sell in supermarkets. For example, spinach is full of some kind of substance to let it grow better. I do not eat spinach anymore because it is such a mess."	

Table 2.4 (continued)

Main themes	Sub-themes	Quotes from dietary supplement users	Quotes from non-users of dietary supplements
D (continued)	Negative attitude (continued)	"If you make a comparison between now and 100 years ago… for example in our spinach – there are less nutrients than 100 years ago." **Poor practices of food industry:** "I think the ground can become depleted. If the ground is depleted, then you get fewer minerals from it [ground]."	

Note. Words in capitals are the main themes of the group discussions. A to Z: Sub-themes of the main themes. Words in bold are dimensions of the sub-themes

DISCUSSION

The present study sought to explore and compare users' and non-users' salient beliefs related to dietary supplement use, applying the ICM as its theoretical background. Users' and non-users' beliefs were comparable regarding the risks of dietary supplements, how they define dietary supplements, and their decision regarding whether or not to take dietary supplements being independent from their social environment. Users' and non-users' beliefs differed substantially regarding their attitude beliefs towards dietary supplements, trust in health professionals, and judgement on the quality of food products.

The majority of users and non-users defined dietary supplements as products that are intended to supplement the normal diet. Both groups considered the risks of dietary supplements as low and assigned the occurrence of possible adverse effects more to the consumer (e.g., excessive use, being ill) than to the product. How dietary supplements are judged by significant others (e.g., family, friends) did not seem to influence participants' own decision about whether or not to use dietary supplements.

Users considered dietary supplements as a potential tool to improve their health. Users' most frequently mentioned reasons for taking dietary supplements can be grouped into three overarching categories: preventive reasons (e.g., to avert getting the flu); mental and physical health enhancement (e.g., to enhance mental performance); and curative benefits (e.g., to reduce health complaints). Users' motivations were most commonly related to certain (health) complaints that they suffered from. This finding is in line with previous research that suggests that health problems such as joint pain, muscle cramp, osteoporosis or arthritis are frequently mentioned motives for taking dietary supplements, especially among the elderly (Bailey et al., 2013; Brownie & Rolfe, 2005).

In contrast, non-users put emphasis on investigating the necessity of use first when discussing reasons for taking dietary supplements. As they argued, nutritional deficiencies can be detected, for example with the help of a blood test. Non-users indicated that a healthy, balanced and varied diet would be of sufficient quality for most people to cover their nutritional needs. Additionally, most non-users were convinced that the human body is able to regulate properly all the different biological processes on its own. Therefore, they considered supporting the normal functioning of the body with dietary supplements as unnecessary. Hence, non-users did not feel the need to improve their health as much as users did.

Most dietary supplement users were critical of general practitioners' and dieticians' knowledge on nutrition, whereas the majority of non-users did not

have such a critical view of their physician. Research has shown that 44 per cent of frequent dietary supplement users believed that their own physician knows little to nothing about nutrition (Blendon et al., 2001). The distrust towards health-care providers was also revealed by previous research showing that dietary supplement users often took control of their own health by seeking alternative forms of medicine, including dietary supplements (Greger, 2001).

Users' and non-users' beliefs regarding food quality and safety also differed considerably. Whereas users estimated food quality as poor, non-users still considered food products as a sufficient source of nutrients. Evidence suggests that dietary supplement users tend to have a healthy lifestyle and sufficient nutritional intake (Bailey et al., 2011; Bailey et al., 2010; Kirk et al., 1999). The fact that dietary supplement users feel the need to supplement their nutritious diet might be explained by their distrust in food quality.

It is important to note that many users were uncertain whether they actually experienced any of the advantageous health effects of dietary supplements. Despite these doubts, users still believed that dietary supplements help improve their health. High levels of response efficacy may explain a contradictory result of a previous study: about 70 per cent of dietary supplement users would still take dietary supplements, even if the government or the U.S. Food and Drug Administration (FDA) announced that dietary supplements are ineffective (Blendon et al., 2001).

The findings mentioned above may imply that both users and non-users base their decisions regarding dietary supplement use mainly on their beliefs. In order to facilitate consumers' informed decision-making about dietary supplement use, users' and non-users' understanding of dietary supplements' health effects should be improved.

Limitations

As with many qualitative studies, the sample may be biased since convenience sampling was used to recruit participants. Therefore, future research should assess individuals' motives towards dietary supplement use quantitatively, using a representative sample. The semi-structured topic guide made it possible to standardize the study procedure and the topics discussed. But due to the predefined nature of the discussions, participants had limited opportunities to discuss relevant topics that were not included in the topic guide. With regard to theoretical saturation, the research team evaluated each session in terms of differences and similarities in beliefs compared to previous sessions, but some aspects of dietary supplement use may be still undiscovered. As an example, in

contrast to previous studies compensation for unhealthy eating habits was not raised as a reason for taking dietary supplements by users (Nichter & Thompson, 2006; Rehaag et al., 2013).

Implications for future research

Data were collected among a selective sample of Dutch individuals in the region of Maastricht. Therefore, the study should be extended to more areas in the Netherlands and to other countries as well.

Several salient beliefs regarding dietary supplements, food and health have been discovered in the present study. However, it is impossible to investigate the predictive value of those beliefs regarding dietary supplement use based on qualitative research. Therefore, future quantitative longitudinal studies should assess to what extent socio-cognitive factors determine dietary supplement use and non-use, and address the question of, for example, whether decreased trust in physicians and negative judgement on food quality may indeed lead to dietary supplement use.

Some salient beliefs identified by the current study can be related to existing theoretical constructs, such as mental and physical health enhancement and illness prevention, which correspond to the two motivational needs distinguished by the Regulatory Focus Theory (Higgins, 2002). In addition, the differing needs of users and non-users for managing their own health can be related to Rotter's Locus of Control Theory (Rotter, 1966). Therefore, the predictive value of relevant socio-cognitive and psychosocial factors of such theories should be tested statistically in a representative sample of the Dutch population.

Conclusion

The aim of the present study was to explore and compare dietary supplement users' and non-users' beliefs towards dietary supplement use through applying the ICM as its theoretical background. Users' and non-users' beliefs corresponded to a large extent with regard to their definition of dietary supplements, the evaluation of the risks of dietary supplements, and the influence of the social environment. Users' and non-users' beliefs differed considerably regarding their attitude beliefs towards dietary supplements, their trust in health professionals, and their trust in the quality of food products.

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CHAPTER 3

Why do Dutch people use dietary supplements? Exploring the role of socio-cognitive and psychosocial determinants

Based on: Pajor, E. M., Eggers, S. M., Curfs, K. C. J., Oenema, A., & de Vries, H. (2017). Why do Dutch people use dietary supplements? Exploring the role of socio-cognitive and psychosocial determinants. *Appetite*, *114*, 161-168.

ABSTRACT

Background: In the Netherlands, the prevalence of dietary supplement use has doubled (from 17 to 40 per cent) since the 1980s. Yet limited data are available on which socio-cognitive factors are associated with dietary supplement use. Therefore, the purpose of the study is to explain dietary supplement use with determinants deriving from the Integrated Change Model (ICM) and from formative research.

Method/design: Socio-cognitive and psychosocial factors were measured among users and non-users of dietary supplements in a longitudinal survey study, with measurements at baseline (n = 1448) and at one-month follow-up (n = 1161). Negative binomial regression analysis was applied to the data.

Results: Intention emerged as the main predictor of dietary supplement use (OR = 1.99). Further predictors of dietary supplement use with smaller effect-sizes were: health regulatory focus (promotion, OR = 1.46), social modelling (OR = 1.44), positive attitude (pros, OR = 1.37), negative attitude (cons, OR = 0.87), health locus of control (OR = 0.77), and risk perception (i.e., chances of getting ill, OR = 1.22).

Conclusions: Individuals tend to use dietary supplements if they are promotion oriented, notice dietary supplement users in their social environment, estimate their chances of getting ill higher, and have positive attitudes towards dietary supplements. In contrast, non-users believe that factors outside their control affect their health, and hold negative attitudes towards dietary supplements.

Practical implications: Mapping out individuals' socio-cognitive profile may contribute to the development of online health communication. Based on socio-cognitive and demographical factors, personalised advice can be given about dietary supplement use.

INTRODUCTION

In the past decades, the use of dietary supplements has become increasingly popular in the United States and other developed countries (Gahche et al., 2011; Skeie et al., 2009; Stein, 2015). According to studies concerning nutrition intake, 50 per cent of the US population (Bailey et al., 2013), and more than 30 per cent of the UK, Danish, Swedish, Norwegian, and Dutch population uses at least one type of dietary supplements regularly (Skeie et al., 2009; van Rossum et al., 2011). However, evidence suggests that deficiency on micronutrients rarely occurs among healthy individuals in wealthy industrialised countries (van Rossum et al., 2011; Webb, 2011) and dietary supplements are only recommended when one is suffering from or is at risk of micronutrient deficiencies (Health Council of the Netherlands, 2015). Hence, there may be no immediate reason to take vitamin C even during wintertime – like 13 to 21 per cent of the Dutch adults do – because inadequate vitamin C intake from food is uncommon in the Dutch population (van Rossum et al., 2011).

Notwithstanding the fact that dietary supplement use has been increasingly popular in Europe and in the US (Gahche et al., 2011; Skeie et al., 2009), representative data on people's motives for taking dietary supplements is still limited (Bailey et al., 2013). Consequently, input for evidence-based health communication about dietary supplements is currently lacking. Therefore, further research is needed to examine which socio-cognitive factors are associated with dietary supplement use.

Previous research has identified several background factors which may be associated with dietary supplement use. Research has shown that dietary supplement use is the highest within groups of the population that are the least likely to need supplementation to their diet, since their nutritional intake from food is already sufficient (Bailey et al., 2011, 2012). For example, women with a healthier lifestyle (e.g., sufficient fruit- and vegetable intake, physically active, low alcohol consumption, not smoking) and high socio-economic status are the most inclined to take dietary supplements (Conner et al., 2001; Kirk et al., 1999; Vatanparast, Adolphe, & Whiting, 2010). The paradox that people who need supplementation to their diet the least are the most likely to use them has been termed as the 'inverse supplement hypothesis' (Kirk et al., 1998). Ironically, research has also shown that groups who are at risk of developing certain micronutrient deficiencies – such as young children and women above 50 years old – do not sufficiently supplement their diet with vitamin D. Only 60-75 per cent of young children and about one third of women above 50 years old actually take vitamin D supplementation (de Nooijer, Jansen, & van Assema, 2012; van Rossum et al., 2011).

Previous research has investigated the predictive value of different socio-cognitive factors regarding dietary supplement use and intentions to use. Women having higher intentions, attaching higher value to their health, and regarding dietary supplements as an effective tool of disease prevention, are dietary supplement users (Conner et al., 2001). Regarding intentions, Cox, Koster, and Russell (2004) found that individuals with a higher perceived response-efficacy of dietary supplements and higher self-efficacy of taking dietary supplements are more intended to use dietary supplements. Chung et al. (2012) and Conner et al. (2001) found evidence that attitude, subjective norms, and perceived behavioural control are also significant predictors of (purchase) intentions.

The present study uses the Integrated Change Model (ICM; de Vries et al., 2003) as its theoretical framework. The ICM is a result of theoretical integration (Noar & Zimmerman, 2005), and incorporates concepts from the Health Belief Model (Janz & Becker, 1984), Social Cognitive Theory (Bandura, 1989), and the Theory of Planned Behaviour (Ajzen, 1991). In addition to the models mentioned, the ICM includes pre-motivational factors (knowledge, risk perception, awareness) as well, therefore the phase preceding the development of motivation can be better investigated (Eggers, 2016). The ICM has been previously used to identify determinants of behaviours regarding diet: eating in moderation (Walthouwer et al., 2015), and fruit and vegetable intake (Schulz et al., 2014).

As proposed by the ICM, behaviour is directly predicted by intentions which are influenced by different motivational factors: attitudes (pros and cons), social influence (modelling, social support, social norm) and self-efficacy (de Vries et al., 2005; de Vries et al., 2003). Motivational factors are in turn determined by pre-motivational factors: knowledge, risk-perception (susceptibility to illness), awareness, and cues to action (de Vries et al., 2005). Lastly, predisposing factors (e.g., psychological factors) and information factors (e.g., content of the message) may have an influence on health behaviour indirectly through pre-motivational and motivational factors.

Based on formative research, the following pre-disposing factors relevant to dietary supplement use have been identified: health locus of control, health regulatory focus, and health value. Health locus of control (HLC) is the governing perception an individual has concerning his or her health (K.A. Wallston & Wallston, 1981). Previous research suggested that users of dietary complementary and alternative medicine (CAM) have a slightly stronger governing perception regarding their health than non-users (Tokuda et al., 2007). In contrast, non-users tend to believe that external factors, such as health professionals or faith may exert the most influence on individuals' health (Schäfer, Riehle, Wichmann, & Ring, 2003; Tokuda et al., 2007).

Other studies investigated the role of health value in dietary supplement use (J.-E. Chung et al., 2012; Conner et al., 2001). Health value can be defined as the degree to which an individual regards his or her health as important (Lau, Hartman, & Ware, 1986). Conner et al. (2001) found evidence that individuals who place high value on their own health are more inclined to take dietary supplements by way of precaution.

It can be argued that individuals' regulatory focus (promotion vs. prevention) may also influence the way they use certain health related tools, such as dietary supplements (Gomez, Borges, & Pechmann, 2013). Promotion focused individuals tend to apply approach strategies in their life, such as making use of opportunities for advancement, whereas prevention oriented individuals tend to apply avoidance strategies, such as avoiding losses (Higgins, 2002).

The aim of the present study is to gain insight into which socio-cognitive factors explain dietary supplement use. For this purpose, we investigated the explanatory value of the predisposing, pre-motivational and motivational determinants of the Integrated Change Model.

This study adds to the literature in the following ways. First, it moves beyond the more conventional way of explaining behaviour and tries to identify additional determinants besides motivational factors (e.g., attitudes), such as health locus of control, health value, and health regulatory focus. Second, the present study was set up to investigate socio-cognitive factors which are related to dietary supplement use in more detail. In previous studies, data regarding beliefs about dietary supplements were often collected with limited lists of questions within broader projects, such as national nutritional examinations, or in selective samples of individuals, such as women. Third, to our knowledge, this is the first study that applies a longitudinal design to investigate socio-cognitive determinants of dietary supplement use.

METHOD

Study design and participants

In this study, a longitudinal design with a baseline measurement of socio-cognitive determinants (T_0) and a 1-month follow-up measurement of behaviour (T_1) was applied. An *a priori* power analysis was conducted using the software package GPower (Faul, Erdfelder, Lang, & Buchner, 2007). The effect size used for this assessment was small (i.e., $f^2 = .02$; J. Cohen, 1988), with $p < .05$ alpha level, .80 power, and 24 tested predictors. According to the power analysis, at least 1085 participants were needed for detecting small effects. Respondents were recruited among members of an Internet research bureau (Flycatcher, the Netherlands).

Participants were intentionally recruited in such a way that the distribution of dietary supplement users and non-users was equal in the sample. Individuals were eligible to participate in the study when they were older than 18 years old, and had access to the Internet. In the case of dietary supplement users, individuals indicating to use dietary supplements exclusively for sports related purposes were not included in the study. Pregnant women were also excluded from the study. This exclusion was established since athletes' and pregnant women's motives (e.g., to aid recovery from training, to prevent neural tube defect in an unborn) to take dietary supplements may differ from those of the general population.

At baseline, 1998 respondents were randomly selected to participate in the study, of which 1448 (72.50% response rate) completed the questionnaire. At follow-up, 1161 respondents (80.18% response rate) filled out the questionnaire.

Questionnaire design and analysis

Dietary supplement use

Dietary supplement use was assessed in two different ways, both at baseline and at one-month follow-up. First, respondents were given a definition of dietary supplements: dietary supplements are "products which are intended to supplement the normal diet. Dietary supplements bear or contain one or more dietary ingredients in a concentrated form. These nutrients may have physiological effects on the human body, such as supporting the digestive system etc." (Dietary Supplement Health and Education Act of 1994, Food Supplements Directive 2002/46/EC). As a further description of dietary supplements, respondents were information given about: possible ingredients, composition, and appearance. In addition, respondents were informed that products belonging to the normal diet should not be considered as dietary supplements. Then, respondents were asked whether they used dietary supplements as defined above, with the following response options: (1) "Yes, I use dietary supplements during the whole year and at least for six months", (2) "Yes, I use dietary supplements during the whole year but no longer than six months", (3) "Yes, I use dietary supplements, but only during certain periods, such as wintertime", (4) "No, I do not use dietary supplements at all". Based on the answers, a dichotomous variable of dietary supplement use was calculated with the following values: 0 (= *non-user*), 1 (= *user*).

Respondents who ticked one of the 'yes'-options for the previous question, received further questions about the manner of dietary supplement use by asking the type of dietary supplement(s) used on a list with the most commonly used

types of dietary supplements among Dutch adults (e.g., vitamin C): "Please indicate which of the dietary supplements listed below you consume!". Additionally, respondents were asked about the frequency of use (i.e., "How often do you take the dietary supplement(s) you indicated?") with response options: (0) "Never or rarely", (1) "few times a month", (2) "1 day a week", (3) "2 days a week", (4) "3 days a week", (5) "4 days a week", (6) "5 days a week", (7) "6 days a week", (8) "7 days a week". This measurement method of dietary supplement use was based on the assessment method used in the Dutch National Food Consumption Survey of 2007-2010 and of 2012-2017 (National Institute for Public Health and the Environment, 2016). A continuous variable of dietary supplement use was calculated: the scores of frequency of use were added up per each type of dietary supplement that was listed. In this manner, a total dietary supplement intake was calculated for each respondent, ranging from 0 to a possible maximum value of 154.

Socio-cognitive and psychosocial determinants of dietary supplement use

The ICM was used as framework for including determinants of dietary supplement use. Intention and dietary supplement use were measured at baseline and at one-month follow-up, all other socio-cognitive and psychosocial determinants were measured only at baseline. Determinants of the ICM were operationalised as described by de Vries (2013). Health locus of control, health regulatory focus and health value were operationalised as described by Wallston and Wallston (1981), Gomez et al. (2013), and Lau et al. (1986). Items of the measurement instruments were generated based on transcripts of 13 focus group discussions about dietary supplements (Pajor, Oenema, Eggers, & de Vries, 2017). For each determinant, except for knowledge, a scale was computed by calculating a mean score of all corresponding items. Details of the measurement scales (examples of items, number of items, answering categories, mean scores, and Cronbach's alphas) are presented in Table 3.1.

Table 3.1 Overview of number and examples of questions, answering categories, mean scores and Cronbach's alphas

Determinant	Number of questions	Examples of questions, answering points, and range	Mean (*SD*)	Cronbach's alpha
Health locus of control	11	"No matter what I do, if I am going to get sick I will get sick." *Strongly disagree* (1) to *strongly agree* (5)	3.15 (0.42)	0.69
Health regulatory focus: promotion	4	"I do not hesitate to embrace new experiences if I think they can improve my health." *Strongly disagree* (1) to *strongly agree* (5)	3.29 (0.69)	0.84
Health regulatory focus: prevention	3	"I frequently think about the health problems I may have in the future." *Strongly disagree* (1) to *strongly agree* (5)	2.82 (0.67)	0.67
Health value	4	"If you don't have your health, you don't have anything." *Strongly disagree* (1) to *strongly agree* (5)	3.73 (0.73)	0.74
Knowledge[a]	9	"Eggs, fish, and dairy products contain vitamin K." *True* (1), *false* (2), *I do not know* (3)	3.58 (1.44)	
Risk perception: severity of getting ill	4	"If I got ill next month, I would find it (...)" *Not severe at all* (1) to *very severe* (5)	2.68 (0.75)	0.91
Risk perception: chance of getting ill	4	"My chance of getting ill next month is (...)" *Very small* (1) to *very big* (5)	2.37 (0.68)	0.88
Risk perception: severity of getting unwanted side-effects	2	"If dietary supplements caused side effects, those would be (...)" *Not severe at all* (1) to *very severe* (5)	3.12 (0.71)	0.59
Risk perception: chance of getting unwanted side-effects	2	"If dietary supplements influenced the effects of medication, it would be (...)" *Very small* (1) to *very big* (5)	2.58 (0.70)	0.63
Perceived nutritional insufficiency	5	"Every day I get the most important nutrients for my body from regular food" (R) *Strongly disagree* (1) to *strongly agree* (5)	2.54 (0.76)	0.86

Cues to action: internal	5	"Being unsatisfied with appearance (broken nails, hair loss)." *Not at all* (0) to *to a very great extent* (4)	2.01 (0.84)	0.79
Cues to action: external	6	"Information through media." *Not at all* (0) to *to a very great extent* (4)	0.94 (0.72)	0.75
Cues to action: product-related	5	"Price of dietary supplement." *Not at all* (0) to *to a very great extent* (4)	1.86 (0.81)	0.83
Positive attitude (pros)	10	"When using dietary supplements every day, my physical complaints will decrease (...)" *Not at all* (1) to *with a great extent* (5)	2.37 (0.86)	0.96
Negative attitude (cons)	10	"Using dietary supplements every day is (...)" *Not expensive at all* (1) to *very expensive* (5)	2.66 (0.81)	0.93
Social norms	5	"Using dietary supplements is (...) by my friends/colleagues/family members/partner/general practitioner." *Strongly advised against* (1) to *strongly advised* (7)	16.94 (6.27)	0.81
Social support	5	"Using dietary supplements is (...) by my friends/colleagues/family members/partner/general practitioner." *Not stimulated at all* (1) to *strongly stimulated* (5)	7.07 (4.03)	0.82
Social modelling	5	"My friends/colleagues/family members/partner/general practitioner take/takes dietary supplements every day." *Strongly disagree* (1) to *strongly agree* (5)	9.77 (4.67)	0.81
Self-efficacy	6	"Taking dietary supplements every day, when I am tired is/would be:" *Very easy* (1) to *very difficult* (5)	3.16 (0.84)	0.90
Intention	3	"I would like to take/to continue taking dietary supplements every day." *Strongly disagree* (1) to *strongly agree* (5)	2.42 (1.33)	0.97

[a] A total score was computed by counting up each correct answer given per respondent.

Statistical analyses

The statistical analyses were conducted using SPSS (IBM) version 21. Sample characteristics were analysed applying descriptive statistics on the data, e.g., frequencies, crosstabs. Bivariate Pearson correlations were calculated to describe the strength of associations between variables. Independent samples t-test was used to explore differences between users and non-users on the independent variables. Logistic regression was applied using the dichotomous outcome variable. Negative binomial regression was applied using the continuous outcome variable. The latter regression analysis will be presented since it gave a more accurate indication of the effects (i.e., confidence intervals were narrower). According to ICM's distinction between pre-motivational and motivational factors, corresponding variables were entered stepwise into the model: demographics (step 1), distal psycho-social factors (step 2), pre-motivational factors (step 3), motivational factors (step 4), and intentions (step 5). For all statistical analyses a significance level of .05 (two-tailed) was applied.

To test multicollinearity, the Variance Inflation Factor (VIF) and the tolerance were computed. We did not detect any multicollinearity in our data because the VIF's did not exceed the value of 10 (Neter, Wasserman, & Kutner, 1989) and the tolerance values all exceeded the value of 0.2 (Menard, 1995).

RESULTS

Participants

The sample of the present study consisted of both users (n = 616, 53.1%) and non-users (n = 545, 46.94%) of dietary supplements (see Table 3.2). The men-women ratio (46.75 % vs. 53.25%) was more balanced among dietary supplement users than among non-users (62.02% vs. 37.98%). The mean age was around 50 years old in both groups (M_{users} = 49.88, $M_{non\text{-}users}$ = 51.88). The mean Body Mass Index (BMI) of both groups was around 26.41 (SD = 5.29) which can be interpreted as slightly overweight (World Health Organization, 2016).

Within the group of users, respondents were evenly distributed across all gross household income levels (minimum or below modal: 24.51%, equal to modal: 25.32%, once or twice as high as modal: 25.49%), but among non-users most respondents belonged to the 'once or twice as high as modal' group with 28.82%, compared to minimum or below modal: 20.73% and equal to modal: 24.22%. Regarding educational level, most users had a medium educational level (42.12 %, low: 33.60%, high: 24.18%), whereas among non-users most respondents had a low (38.72%) or a medium educational level (36.69%, high: 24.59%).

The drop-out logistic regression analysis showed no significant associations between the completion of the follow-up measurements and any of the demographic characteristics.

Table 3.2 Sample characteristics

	All respondents (*n* = 1161) (%)	Users (*n* = 616, 53.06%)	Non-users (*n* = 545, 46.94%)
Gender			
Male	626 (53.9%)	288 (24.8%)	338 (29.1%)
Female	535 (46.1%)	328 (28.3%)	207 (17.8%)
Mean age (*SD*)			
	50.82 (16.57)	49.88 (16.36)	51.88 (16.75)
Educational level			
Low	418 (36.0%)	207 (17.8%)	211 (18.2%)
Middle	460 (39.6%)	260 (22.4%)	200 (17.2%)
High	283 (24.4%)	149 (12.8%)	134 (11.5%)
Annual gross household income			
Minimum or below modal	264 (30.5%)	151 (17.4%)	113 (13.0%)
Equal to modal	288 (33.3%)	156 (18.0%)	132 (15.2%)
Once or twice as high as modal	314 (36.3%)	157 (18.1%)	157 (18.1%)
Do not know/do not want to tell	295 (25.41%)	152 (13.09%)	52 (2.15%)
BMI			
Underweight	16 (1.4 %)	11 (0.9%)	5 (0.4%)
Healthy weight	499 (43.1 %)	272 (23.5%)	227 (19.6%)
Overweight	416 (35.9 %)	205 (17.7%)	211 (18.2%)
Obese	228 (19.7 %)	127 (11.0%)	101 (8.7%)
Unknown	2 (0.17%)	1 (0.09%)	1 (0.09%)
Mean BMI (*SD*)			
	26.41 (5.29)	26.52 (5.86)	26.29 (4.55)
Chronic illnesses			
Yes	505 (43.5%)	301 (25.9%)	204 (17.6%)
No	656 (56.5%)	315 (27.1%)	341 (29.4%)

Dietary supplement use

The average use of dietary supplement was 10.10 (*SD* = 19.86) at baseline, and 9.78 (*SD* = 18.23) at one-month follow-up. The most used dietary supplements were: multivitamins with minerals (*n* = 251, *M* = 2.24, *SD* = 3.02), vitamin D (*n* = 196, *M* = 1.87, *SD* = 2.96) and vitamin C (*n* = 155, *M* = 1.33, *SD* = 2.55). When taking only weekly users into consideration (i.e., taking dietary supplements at least once a week), the weekly average use ranged from 4.57 to 6.21, depending on the type of dietary supplement.

Differences between users and non-users

In Table 3.3, differences in socio-cognitive factors between users and non-users of dietary supplements are shown at follow-up (T_1). There were no significant differences between users and non-users regarding health value, knowledge, risk perception concerning chance of getting illnesses, and risk perception concerning severity of illnesses. Dietary supplement users had stronger intentions to use dietary supplements, perceived more cues, held more positive attitudes, and had higher levels of self-efficacy. Furthermore, dietary supplement users also regarded their own nutritional status as more insufficient, perceived more social support, were more convinced that dietary supplement use is socially desirable (social norm), and recognized more dietary supplement users in their social environment (social modelling). Also, dietary supplement users were more promotion and prevention oriented, and had a lower external health locus of control.

Non-users held more negative attitudes and perceived more risks regarding unwanted side effects (both chance and severity).

Table 3.3 Comparison of socio-cognitive factors between users and non-users of dietary supplements (Mean, SD)[a]

Determinant	Users (n = 616)	Non-users (n = 545)	t (1159)	Mean difference
Health value	3.78 (0.73)	3.66 (0.73)	− 2.69	− 0.12
Health locus of control	3.11 (0.43)	3.20 (0.41)	3.06	0.08**
Health regulatory focus (promotion)	3.45 (0.68)	3.11 (0.67)	− 8.58	− 0.34**
Health regulatory focus (prevention)	2.92 (0.68)	2.72 (0.65)	− 5.14	− 0.20**
Knowledge	3.63 (1.28)	3.52 (1.61)	− 1.30	− 0.11
Risk perception (interaction chance)	2.45 (0.66)	2.74 (0.72)	7.31	0.30**
Risk perception (interaction severity)	3.03 (0.71)	3.23 (0.70)	4.71	0.20**
Risk perception (chance of getting ill)	2.40 (0.71)	2.35 (0.64)	− 1.33	− 0.05
Risk perception (severity of illness)	2.71 (0.76)	2.64 (0.73)	4.71	− 0.07
Perceived nutritional insufficiency	2.76 (0.78)	2.30 (0.66)	− 10.65	− 0.45**
Attitude (pros)	2.76 (0.82)	1.93 (0.68)	− 18.85	− 0.83**
Attitude (cons)	2.29 (0.67)	3.07 (0.76)	18.42	0.78**
Social norm	4.30 (0.65)	3.83 (0.63)	− 12.56	− 0.47**
Social support	1.73 (0.80)	1.23 (0.43)	− 13.35	− 0.50**
Social modelling	2.95 (0.54)	2.56 (0.69)	− 10.53	− 0.39**
Self-efficacy	3.38 (0.81)	2.91 (0.80)	− 10.13	− 0.48**
Cues to action: internal	2.12 (0.80)	1.79 (0.82)	− 8.89	− 0.42**
Cues to action: external	1.08 (0.71)	0.78 (0.69)	− 7.26	− 0.30**
Cues to action: product-related	2.10 (0.81)	1.60 (0.72)	− 10.74	− 0.48**
Intentions (T_0)	3.24 (1.20)	1.50 (0.72)	− 30.26	− 1.74**

[a] Independent samples t-tests between users and non-users.
** $p < .01$

Associations between demographics, socio-cognitive factors and dietary supplement use

In Table 3.4, bivariate Pearson correlations are shown between demographic and socio-cognitive variables at baseline (T_0), and dietary supplement use at follow-up (T_1). Gender, age, and educational level were significantly correlated to dietary supplement use. BMI, and fruit and vegetable consumption had no significant association with dietary supplement use.

Among the predisposing factors, only health locus of control was not significantly correlated to dietary supplement use. Of the pre-motivational factors, perceived severity of getting unwanted side effects (chance and severity), perceived nutritional insufficiency, and cues to action (internal, external, product-related) were significantly correlated to dietary supplement use. All motivational factors (i.e., attitudes, social influence, self-efficacy) and intentions were significantly associated with dietary supplement use.

Determinants of dietary supplement use

In Table 3.4, results of the negative binomial regression are shown. In step 1, effects of demographical variables (gender, age, educational level, BMI, having chronic conditions) on dietary supplement use were investigated. Dietary supplement use is significantly lower among male than among female respondents. Individuals with no chronic conditions use dietary supplements significantly less than individuals with chronic conditions. Age was also a significant predictor of dietary supplement use, however its effect was close to 1. Educational level and body mass index (BMI) remained insignificant at step 1.

In step 2, distal factors i.e., health value, health locus of control, and health regulatory focus (promotion, prevention) were added to the model. All of these distal factors were significant predictors of dietary supplement use, respondents with promotion focus were the most inclined to take dietary supplements.

At the next step, variables from the pre-motivational phase of the ICM were added to the regression model. As results show at step 3, perceived nutritional insufficiency and product-related cues were significant predictors of dietary supplement use. However, health regulatory focus (promotion) remained the strongest predictor of dietary supplement use at this step.

In step 4, motivational factors (i.e., attitudes, variables related to social influence and self-efficacy) were added to the model. From these variables, social modelling, positive attitudes (pros) and negative attitudes (cons) showed a significant association with dietary supplement use. Health regulatory focus

(promotion), risk perception (chances of getting ill), perceived nutritional insufficiency, and product-related cues also remained significant.

In the final step, intention to use dietary supplements was entered in the regression model. Besides intention, social modelling, health regulatory focus (promotion), health locus of control, risk perception (chance of getting ill), positive attitudes (pros), negative attitudes (cons) and self-efficacy remained significant.

Table 3.4 Determinants of dietary supplement use (at one month follow-up)

		Step 1	Step 2	Step 3	Step 4	Step 5
	r	*OR*	*OR*	*OR*	*OR*	*OR*
Gender[a]	.12**	.64***	.64***	.64***	.82**	.84*
Age	.06*	1.01**	1.01**	1.01***	1.01**	1.01*
Educational level[b]						
- Low	-.06*	1.02	1.00	.87	.82	.88
- Medium		1.05	1.03	.94	.91	.98
- High		1	1	1	1	1
BMI	.01	1.00	1.00	.99	.99*	.98
Chronic conditions[c]	.15**	.59***	.51***	.53***	.59***	.68***
Health value	.08*		.81***	.88*	.94	.96*
Health locus of control	-.04		.68***	.75**	.79**	.77**
Health regulatory focus						
- Promotion focus	.24**		1.93***	1.76***	1.37***	1.46***
- Prevention focus	.16**		1.26***	0.99	1.02	.96
Knowledge	-.01			1.02	1.07**	1.04
Risk perception: chance	.04			1.20**	1.20**	1.22**
Risk perception: severity	.02			.94	1.06	1.02
Risk perception: interaction chance	-.15**			.65***	0.98	.94
Risk perception: interaction severity	-.14**			.98	1.06	1.08
Perceived nutritional insufficiency	.25**			1.53***	1.14**	.98
Cues to action: external	.21**			1.01	.89	.98
Cues to action: internal	.18**			1.07	1.09	1.01
Cues to action: product-related	.28**			1.54***	1.24***	1.17**
Attitude (pros)	.43**				1.66***	1.37***
Attitude (cons)	-.35**				.55***	.87*
Social norm	.32**				1.01	.94
Social support	.37**				1.23***	1.08
Social modelling	.31**				1.68***	1.44***
Self-efficacy	.28**				1.31***	1.12*
Intentions (T_0)	.55**					1.99***
Bayesian Information Criterion		7614.63	7369.69	7054.38	6489.17	6224.01

Note. n = 1150. r = Pearson correlation. *OR* = Odds ratio.
[a]Gender: 1 = male, 2 = female (comparison category). [b]Educational level: 1 = low, 2 = medium, 3 = high (comparison category). [c]Chronic conditions: 0 = no, 1 = yes (comparison category).
*p < .05, **p < .01, ***p < .001

DISCUSSION

The present study aimed to gain insight into socio-cognitive and psychosocial factors explaining dietary supplement use. For this purpose, we investigated the explanatory value of the predisposing, pre-motivational, and motivational determinants of the Integrated Change Model.

Regarding motivational factors, intention to use dietary supplements was the strongest predictor of dietary supplement use. Social modelling had a moderate influence on dietary supplement use, which means that individuals tend to generate new behaviour patterns similar to the perceived behaviour of important referent individuals (Luszczynska & Schwarzer, 2005). Besides social modelling, perceived advantages (attitude pros) and perceived disadvantages (attitude cons) also moderately predicted dietary supplement use. As expected, seeing more advantages in dietary supplements led to use, and seeing more disadvantages led to non-use. Furthermore, individuals' perception of their chances of getting ill also remained a significant predictor of dietary supplement use; the more probable individuals consider getting ill, the more they tend to use dietary supplements.

It is also important to note, that when taking demographics and lifestyle characteristics into consideration, several factors previously associated with dietary supplement use remained insignificant. Previous studies showed that dietary supplement users tend to be female, with a higher level of education, and lower body mass index (Kirk et al., 1999; Rock, 2007). Except for age and gender, none of the factors mentioned above predicted dietary supplement use in our sample. However, in line with previous research findings having chronic conditions was also associated with dietary supplement use (Dickinson & MacKay, 2014).

Regarding pre-disposing determinants of dietary supplement use, health locus of control and health regulatory focus (promotion) both emerged as significant predictors of dietary supplement use. The use of dietary supplements decreased with increasing external health locus of control: in contrast to users, non-users were convinced that factors outside their control determined their health status. This finding is in line with Schäfer et al. (2003) and Tokuda et al. (2007). However, the present study used a unidimensional scale ranging from 'not externally focused at all' to 'very externally focused' (B. S. Wallston, Wallston, Kaplan, & Maides, 1976) instead of measuring health locus of control as a multidimensional concept, consisting of the following sub-dimensions: internal, powerful others, chance (Multidimensional Health Locus of Control Scale; Kuwahara et al., 2004; K. A. Wallston, Wallston, & DeVellis, 1978).

In the present study, evidence was found that promotion focused individuals are more inclined to use dietary supplements. Although prior studies already suggested associations between seeking health gains (e.g., 'improving overall health') and dietary supplement use (Bailey et al., 2013; Blendon et al., 2001; Okleshen Peters et al., 2004), to our knowledge this is the first study which statistically investigated the relation between health regulatory focus as a construct and dietary supplement use.

Prevention focus did not predict dietary supplement use and this may imply that individuals who are concerned about their health do not consider the taking of dietary supplements as an efficient tool for preventing illnesses. However, this finding is to a certain extent in conflict with the fact that individuals' perception of their future chance of getting ill was slightly associated with dietary supplement use. In other words, people who think they are likely to get ill are somewhat more inclined to take dietary supplements, but it may not automatically mean that they are concerned about getting ill.

In contrast with our expectations, health value remained insignificant in the last step of the regression analysis (after adding intention). Moreover, in the previous steps it showed a significant inverse relation to dietary supplement use (i.e., the less individuals valued their health, the more they tended to use dietary supplements). It could be expected that promotion oriented individuals consider their health as very important, since they strive for health-related gains. However, evidence suggests that health value is more likely to be predictive of preventive health behaviours (Kristiansen, 1985; G. L. Weiss & Larsen, 1990). An additional explanation for this surprising finding could be the exaggerated nature of the measurement instrument (e.g., "If you don't have your health, you don't have anything"), implying that health is a matter of utmost concern in individuals' lives.

Limitations

The results of the present study should be interpreted in the light of the fact that our sample was comparable to but not representative for the Dutch general population, therefore our results are not generalisable.

The outcome variable used for the negative binomial regression analysis is difficult to interpret since the values may have several possible meanings. For example, a score of 8 could stand for: taking two types of dietary supplements, one type two days a week, and the other type four days a week. But score 8 could also mean: taking one type of dietary supplement every day. Evidence suggests that the latter interpretation would better represent reality since the majority of

dietary supplement users (79%) usually stick to one type of dietary supplements and take it consistently every day (Bailey et al., 2010). With the use of different measurement methods (e.g., 24 hours dietary recall) such difficulties of the interpretation could have been prevented.

Dietary supplement use can be also measured in terms of daily dose. Yet accurate administration of daily dose was not feasible with an online survey study. Respondents should have been able to find and administer correctly the product properties on the package. Data collection on dose is more reliable if trained interviewers administer the information at respondents' homes.

The present study did not cover certain types of dietary supplement users, such as sporadic users, or non-users who have tried dietary supplements once. Such detailed comparisons were beyond the scope of the present study. Yet future studies on dietary supplement use could address the question whether those groups differ in terms of socio-cognitive factors.

Implications for practice

The present study shed light on which socio-cognitive factors are associated with dietary supplement use. This may contribute to a better understanding of individuals' motives for using or not using dietary supplements. Implications can be formulated in the light of the 'inverse supplement hypothesis' which states that individuals who need supplementation to their diet the least, are the most inclined to take dietary supplements (Kirk et al., 1998). Through personalised health communication, individuals could get advice regarding their current practice. First, based on demographic characteristics, consumers may get information whether they belong to a certain risk group. Second, the content of information could be adapted to individuals' socio-cognitive profile. As an example, someone belonging to a risk group, but not taking dietary supplements, could get a personalised advice to consider taking dietary supplements. The health message could incorporate elements of inducing individuals' promotion health regulatory focus by emphasizing the need for health improvement, setting a positive goal, and describing health advancements that can be achieved with dietary supplements.

Conclusion

This study sought to identify socio-cognitive determinants of dietary supplement use. Intention emerged as the main predictor of dietary supplement use. In addition, individuals were more inclined to take dietary supplements if they were

promotion oriented, noticed others taking dietary supplements, held positive attitudes towards dietary supplements, and regarded their chances of getting ill higher. In contrast, individuals with negative attitude beliefs and perceiving more external control were less intended to take dietary supplements.

Results showed that besides socio-cognitive determinants which are generally considered as relevant (e.g., intentions, attitudes), other context-specific determinants may be of importance as well (health regulatory focus, health locus of control, risk perception). Dietary supplement users were more focused on health improvement and possible risks on getting ill, whereas non-users regarded health as outside of their own control.

CHAPTER 4

How to foster informed decision-making about food supplements: Results from an international Delphi study

Based on: de Vries, H., Pajor, E. M., Curfs, K. C. J., Eggers, S. M., Oenema, A. (in press). How to foster informed decision-making about food supplements: Results from an international Delphi study. *Health Education Research.*

ABSTRACT

Background: Dietary supplement use is increasing in Europe and in the USA. Despite that they claim to have beneficial health effects they may also involve risks. Therefore, consumers should make informed decisions about their use. Yet to date no study has investigated how informed decision-making (IDM) should be conceptualised in the context of dietary supplement use. Therefore, the present study aimed to reach consensus among a diverse group of experts regarding 1) the most important characteristics of informed decision-making about dietary supplement use and 2) the most important communication factors that can enhance or hinder IDM.

Method/design: In a convenience sample of international experts within the field of (risk) communication about food supplements or related fields an online three-round international Delphi study was conducted. Sample sizes in round 1, 2, and 3 were 38, 89, and 51 respectively. Participants were between 25 and 69 years old.

Results: Experts indicated that in order to make an informed decision concerning the use of dietary supplements one needs to have: knowledge of their positive and negative effects, the ability to compare these effects, knowledge about the alternatives besides supplements, the feeling of being informed, the feeling of being able (i.e., self-efficacious) to make the decision. In addition, the decision should be made voluntarily. Important enhancing factors which may foster IDM were: provision of information about both positive and negative effects and the nature of the effects including scientific evidence, ensuring that the information is easily accessible, well-ordered, tailored and provided by a trustworthy, credible and independent source.

Conclusions: This study contributes to the IDM literature by providing a list of relevant components of IDM on dietary supplement use. In this manner, a first attempt was made to conceptualize IDM outside of the medical/screening context. In addition, hindering and facilitating factors of IDM were explored which may serve as input for health communication about dietary supplements.

INTRODUCTION

Food supplement use is a widespread phenomenon in industrialised countries. In the Dutch general population, dietary supplement use has doubled (i.e., from 17 per cent to 42 per cent) since the first food consumption survey in 1987 (Dorant et al., 1993; van Rossum et al., 2016). In the adult population, dietary supplement use ranges from 30 to 56 per cent: with higher levels of use in the older age categories and in females (Ocké et al., 2013; van Rossum et al., 2016). Dietary supplement use is even higher in the US (49 per cent) and in Northern European countries (e.g., 58 per cent in Denmark; Bailey et al., 2010; Skeie et al., 2009). In the Dutch population, certain groups are at risk of micronutrient deficiency and thus may profit from using dietary supplements, those are: new-borns (vitamin D, vitamin K), young children up to 4 years old (vitamin D), pregnant women and women of childbearing age (folic acid), men above 70 years old and post-menopausal women (vitamin D), people with insufficient exposure to sunlight (vitamin D), people with dark skin (vitamin D), and vegetarians (vitamin B12) (Health Council of the Netherlands, 2008, 2015). In the Health Council of the Netherlands, the consensus is that except for risk groups, dietary supplements have no added value to a normal, balanced diet (Health Council of the Netherlands, 2015).

For non-risk groups, scientific evidence for the efficacy of supplements in promoting health or preventing diseases is uncertain, sometimes conflicting, and some supplements may have both positive and negative health effects (Fortmann et al., 2013; Marik & Flemmer, 2012). Consequently, it is important that potential consumers are adequately advised about its use and its potential effects in order to facilitate them to make informed decisions. Yet the complexity concerning the effects of dietary supplements makes it challenging to provide clear messages detailing the rationale for using a particular supplement. Given this complexity, the question is also how to enable consumers to make an informed decision regarding supplement use instead of (simply) advising in favour or against use. In this context, it is not necessarily the consumer's behaviour and/or choice for a particular supplement that should be targeted, but the process of how a decision was made and whether this decision was well-informed.

The concept of informed decision-making (IDM) stems from the clinical/screening context, in which very often no single therapeutic action exists and choices depend on how patients value benefits versus harms of the options available (O'Connor et al., 2007). However, there are fewer studies regarding self-care decision-making on the use of complementary and alternative therapies, such as dietary supplements (Thorne et al., 2002). Informed decision-making is especially useful in case of (among others) uncertainty regarding effectiveness

and the balance between benefits and harms (of choice options), when balanced information is unavailable, and when controversy exists among health professionals regarding the choice options (Rimer, Briss, Zeller, Chan, & Woolf, 2004). These conditions may also apply to decision-making regarding supplement use (Fortmann et al., 2013; Marik & Flemmer, 2012), suggesting that IDM may be a more appropriate communication strategy than advising in favour or against supplement use. Frequently mentioned characteristics to describe IDM within the medical decision-making literature are: having relevant knowledge regarding the (medical) choice options, actively participating in decision-making, making the decision is in line with one's values, being satisfied with the decision or the process of decision-making, and reduction of one's level of decisional conflict or uncertainty (see Table 4.1; Braddock III, Edwards, Hasenberg, Laidley, & Levinson, 1999; Marteau et al., 2001; Michie et al., 2002; Molenaar et al., 2000; O'Connor et al., 1999; Rimer et al., 2004).

Table 4.1 Characteristics to describe informed decision-making (IDM)

Reference	Definition or elements of IDM
Braddock III et al. (1999)	• Discussion of the patient's role in decision-making • Discussion of the clinical issue or nature of the decision • Discussion of the alternatives • Discussion of the pros (potential benefits) and cons (risks) of the alternatives • Discussion of uncertainties associated with the decision • Assessment of patient's understanding • Exploration of patient preference
Marteau et al. (2001), Michie et al. (2002)	• The decision is based on relevant knowledge • The decision is consistent with the decision maker's values • The decision is translated into behaviour
Molenaar et al. (2000)	• Knowledge or understanding of treatment options (e.g., of the risks and benefits of the options) • Consistency between patients' treatment preferences and provided information • Consistency between patients' treatment preferences and values • Awareness of a choice between treatment options • Willingness to participate in decision-making (decision-making autonomy) • Involvement in decision-making • Self-efficacy related to participation in health care • (Reduced or reasonable) level of decisional conflict • (Reduced) level of decisional uncertainty • Satisfaction with the treatment preference • Satisfaction with the actual decision made • Satisfaction with the decision-making process

O'Connor et al. (1999)	• Knowledge of treatment options and outcomes • An accurate perception of the probabilities of outcomes • An active role in decision making • (Reduced) level of decisional conflict • Satisfaction with the decision • Satisfaction with the decision-making process
Rimer et al. (2004)	Definition / components of IDM: • Knowledge about the risk/seriousness of the disease • Understanding of the disease or condition being addressed • Comprehension of the clinical service: its benefits, risks, limitations, alternatives and uncertainties • More realistic expectations of health care outcomes • Consideration of one's preferences and making a decision consistent with them • Making a decision in line with one's values • Participation in decision-making at the level desired by the decision maker • Satisfaction with the decision-making process • Satisfaction with the decision • (Reduced) level of decisional conflict • (Reduced) level of uncertainty • Adherence to the decision made by the decision maker • (Reduced) level of anxiety, depression or regrets Steps in the process of (informed) decision-making: • Understanding of the clinical service: its risks, benefits, and alternatives • Understanding personal values and preferences • Weighing pros and cons of the clinical service • Clarifying decisional preferences • Finding additional information, if needed • Deciding on an action plan

Concerning dietary supplement use, it is not clear whether these characteristics are also important for stimulating informed decisions regarding its use and how this topic needs to be addressed by health communicators as the need for and effects may be unclear, and dietary supplements may have the potential to be both beneficial and harmful to health (Fortmann et al., 2013; Marik & Flemmer, 2012). Some studies found evidence that consumers use dietary supplements for other reasons than the product's actual, evidence-based health effect (Petróczi et al., 2007; Sirico et al., 2018) Previous research demonstrated that public acceptability of food related uncertainties and adherence to governmental messages can be low when this uncertainty results from conflicting information or disagreements among experts (Frewer et al., 2002; Markon & Lemyre, 2013). Although a wide range of different communication techniques

aimed at improving understanding of probabilities and uncertainties is studied within the risk communication literature (e.g., using different numerical formats, using verbal instead of numerical probability expressions, framing information in terms of gains instead of losses and including benefit information), there is no consensus on which technique results in the best informed decisions in case of uncertain or two-sided information (Berry, 2004). Adequate supplement use requires making well-informed choices. Yet it is unclear what characterises such informed decisions, and which communication strategies may foster informed decision-making about dietary supplement use.

This study was aimed to reach consensus among a diverse group of experts regarding: (1) the most important characteristics of an informed decision regarding the use or non-use of supplements with both positive and negative effects, and (2) the most important factors related to communication about food supplements that can enhance or hinder IDM. We defined food supplements as: products taken orally that contain one or more 'dietary ingredients', intended to supplement normal diet and which are categorized as foods and not as drugs (see for example the Dietary Supplement Health and Education Act of 1994).

METHOD

Procedure and participants

An online three-round international Delphi study was conducted among experts (de Meyrick, 2003; Linstone & Turoff, 1975). Procedures of earlier studies were followed using a three-round method as this has been found to be advantageous, since factors for which no clear consensus has been reached in the second round are offered another time to respondents for a critical review concerning their importance (Elfeddali, Bolman, Mesters, Wiers, & de Vries, 2010; Schneider, van Osch, & de Vries, 2012).

Experts were selected based on two criteria: (a) they have experience in the field of (risk) communication about food supplements or a related field, and (b) the experts come from various fields (e.g., health communication, psychology, etc.) and have diverse backgrounds (e.g., research based, practice based, etc.). They were selected via the following recruitment methods: (1) by approaching contacts of our own network consisting of researchers in the field of health communication, risk communication, health promotion, risk perception and (health) psychology; (2) selection of (co-)authors of scientific papers, books, reviews or reports and speakers on conferences within the field of (risk) communication about food supplements or related fields; (3) visiting websites of commercial, governmental or independent organizations within the field of (risk)

communication about food supplements or related fields (e.g., food safety authorities, dieticians, and scientific societies) and (4) snowball sampling (e.g., suggestions of invited experts and researchers).

Consequently, 91 experts were invited by mail to participate in all three rounds of the Delphi study (Table 4.2). The mail contained a link to the online questionnaire. Respondents had four weeks to complete the questionnaire and non-responders received reminders after two weeks and three days before the end of the study. A total of 38 experts from a variety of professional fields (e.g., health promotion, psychology, health psychology, risk communication) participated in the first round (42% response rate; 22 females, 15 males, and 1 unknown gender; mean age is 41.8 years, *SD* = 10.7).

Table 4.2 Type of expertise in the first, second, and third round

	Round 1		Round 2		Round 3	
Type of expertise	*n*	%	*n*	%	*n*	%
Research-based expertise	20	52.6	42	42.7	22	43.1
Practice-based expertise	1	2.6	4	4.5	4	7.8
Research- and practice-based expertise	15	39.5	39	43.8	24	47.1
Other	2	5.3	4	4.5	1	2.0

First Round

The aim of the first round was to obtain a list of characteristics to describe IDM regarding use of food supplements with both positive and negative effects as well as a list of enhancing and hindering factors for IDM. During the first round we asked a small number of key experts within the field of (risk) communication about food supplements or related fields to answer multiple questions related to informing people about both positive and negative effects of food supplements. Their responses were summarised into a list of unique (non-overlapping) factors.

Questionnaire

The first-round questionnaire consisted of 10 open-ended questions related to informing people about the positive and negative effects of food supplements. Six of these questions were related to IDM. In one of these questions experts were asked to list important characteristics to describe IDM: “What are the characteristics of an informed decision in the case of a food supplement with both positive and negative health effects?”. Five questions were related to enhancing and hindering factors for IDM, for example: “What factors can influence (improve/hinder) informed decision-making in the case of a food supplement with both positive and negative health effects?”. Since the main

topic of this study is IDM and its enhancing and hindering factors, the other questions will not be discussed in this paper.

Data analysis

Two researchers independently listed all unique factors (Elfeddali et al., 2010; Schneider et al., 2012). Similar responses were combined into one factor. Next, responses were clustered in terms of similarity by three other researchers in order to further reduce the number of factors and to result in a second-round questionnaire that could be completed in maximally 30 minutes. The final list consisted of 59 factors of which 13 were characteristics describing IDM regarding supplement use and 46 were enhancing or hindering factors for IDM (see Table 4.3 and 4.4).

Second Round

The aim of the second-round questionnaire was to rate the IDM characteristics identified during the first round on importance and to determine their enhancing or hindering nature for IDM. During the second round, a larger group of experts rated these factors on importance in a structured questionnaire. On the basis of their ratings a group median and consensus score was calculated for each factor.

Procedure and participants

Experts were recruited using the same criteria and recruitment methods as in round one. All participants who were invited for the first round were also invited to participate in the second round, unless they explicitly declined participation. This resulted in a list of 303 experts who were invited by mail to participate in the second and third round of the Delphi study. The online questionnaire was accessible for completion during six weeks. Non-responders received reminders two and four weeks after the first invitation and four days before the deadline for responding to this questionnaire. A total of 89 experts from a variety of professional fields (e.g., health promotion, psychology, risk communication, nutrition) participated in the second round (29% response rate; 55 females, 33 males, 1 unknown gender; mean age is 44.6 years, *SD* = 11.4).

Questionnaire

In the first part of this questionnaire experts were presented with the list of 13 IDM characteristics identified in round 1 and were asked the following question: “Which characteristics are important indicators of an informed decision regarding

the use or non-use of a food supplement with two-sided effects for a particular person?". Experts could indicate the importance of each characteristics using a Likert scale ranging from 1 (= *very unimportant*) to 7 (= *very important*). In the second part of the questionnaire, experts were presented with the list of 46 enhancing or hindering factors for IDM regarding food supplements and were asked the following question: "Please indicate to what extent these factors are hindering or enhancing for informed decision-making in a person." They could indicate the degree to which the factors were hindering or enhancing using a Likert scale ranging from 1 (= *very hindering*) to 7 (= *very enhancing*). See Table 4.3 and 4.4 for more details about the specific factors.

Data analysis

Researchers are recommended to use the median rather than the mean, since the latter may be distorted due to outliers (von der Gracht, 2012). Consequently, for each factor, a median (*Mdn*) score was calculated which is commonly used in Delphi studies, as it is less sensible to outliers. The higher the median, the more important or enhancing experts considered the corresponding factor. The lower the median, the less important or the more hindering experts considered the corresponding factor. A factor was considered to be important or enhancing if the median was six or higher and unimportant or hindering if the median was two or lower.

The degree of consensus among experts on the importance of the factors was measured by calculating the interquartile range (*IQR*) for each factor. The *IQR* is the measure of dispersion for the median and it consists of the middle 50 per cent of the observations (von der Gracht, 2012). The smaller the *IQR*, the higher the degree of consensus. An *IQR* of two or less on a ten-unit scale and an *IQR* of one or less on a four- or five-unit scale can be considered a consensus (von der Gracht, 2012). An *IQR* less than 1 means that more than 50 per cent of all scores fall within 1 point on the scale and this serves as a method of determining consensus. Since we used a seven-point scale, we decided to use an *IQR* of one or less as a cut-off point for consensus (Elfeddali et al., 2010; Schneider et al., 2012).

Third Round

The aim of the third and final round was to generate consensus among experts on the importance of the factors. Experts were therefore asked to rerate the importance of factors on which no consensus was reached during the second round on the basis of the corresponding group median and consensus scores.

Procedure and participants

All experts who participated in the second round were also invited to participate in the third round. This resulted in a list of 89 experts who were invited by mail to participate in the third round of the Delphi study. Respondents had four weeks to complete the questionnaire and non-responders received reminders after two weeks and one week before the deadline for responding to this questionnaire. A total of 51 experts from a variety of professional fields (e.g., health promotion, psychology, communication, nutrition) participated in the third round (57% response rate; 27 females, 23 males, 1 unknown gender; mean age is 45.3 years, *SD* = 11.3).

Questionnaire

During the third-round experts rerated the remaining 7 IDM characteristics and 28 enhancing or hindering factors for IDM on which no consensus was reached during the second round (i.e., factors with an *IQR* greater than one) on importance and the degree of hinder/enhancement, using the same Likert scales as in the second round. Below each factor, the corresponding second-round group median and *IQR* were displayed. This enabled experts to adjust their second-round rating of each factor, based on the group response. See Table 4.3 and 4.4 for more details about the specific factors.

Data analysis

Again, the median and the *IQR* were calculated for each factor. We used the same cut-off points for importance, degree of hinder/enhancement ($Mdn \leq 2$ and ≥ 6) and consensus ($IQR \leq 1$) as in the second round.

Ethics approval and consent to participate

This study was conducted according to the guidelines laid down in the Declaration of Helsinki (World Medical Association, 1964). Under Dutch law, approval of a research ethics committee is only required if participants are subject to procedures or are required to follow rules of behaviour (Central Committee on Research Involving Human Subjects, 2018). Since participants in this study were not subject to procedures or required to follow rules of behaviour, approval of a research ethics committee was not necessary.

RESULTS

During the first round, 39 experts identified 13 unique characteristics to describe IDM and 46 enhancing or hindering factors for informed decision-making regarding food supplements. All factors mentioned in the first round were included as items in the second-round questionnaire (see Table 4.3 and 4.4 for more details). In the second round, the 89 participating respondents reached consensus ($IQR \leq 1$) on the importance of 6 out of the 13 IDM characteristics. In addition, consensus on the degree of enhancement or hindrance for IDM was reached for 18 out of the 46 enhancing/hindering factors for IDM. In the third round, consensus was reached on another 5 IDM characteristics and another 20 enhancing/hindering factors by 51 experts.

Characteristics of an informed decision

Important (or very important) indicators ($Mdn \geq 6$) of IDM were: decision makers' awareness of his/her needs for taking the food supplement, knowledge of the supplement's positive and negative effects, their ability to compare the supplement's pros and cons, and knowledge about alternative options besides the use of food supplements.

In addition, experts agreed that it was important that the decision maker should have the feeling of being fully informed, feels able to make the decision, and that the decision should be made voluntarily (see Table 4.3).

Table 4.3 Second- and third round ratings of characteristics to describe IDM regarding dietary supplement use

	Round 2 (n = 89)		Round 3[a] (n = 51)	
Factors[b]	*Mdn*	*IQR*[c]	*Mdn*	*IQR*[c]
• The person is aware of his/her needs for the food supplement	6.0	**1.0**		
• The person knows the negative effects of the food supplement	7.0	**1.0**		
• The person knows the positive effects of the food supplement	6.0	**1.0**		
• The decision concerning the use of food supplements is in line with a person's personal values regarding the use of food supplements	5.0	2.0	5.0	2.0
• The decision to use or not to use the food supplement should be translated into behaviour	5.0	2.0	5.0	2.0
• The person should have the feeling of being fully informed	6.0	2.0	6.0	**0.0**
• The decision should be made voluntarily without social pressures	6.0	2.0	6.0	**1.0**
• The person understands all relevant information about the food supplement	6.0	**1.0**		
• The person can compare the pros and cons of the food supplement	6.0	**1.0**		
• The person feels able to make the decision	6.0	**1.0**		
• The person feels more confident about the correctness of the decision	5.0	2.0	5.0	**1.0**
• The person knows alternative options besides the use of the food supplement	6.0	2.0	6.0	**1.0**
• The person feels more certain about the expected benefits of the food supplement	5.0	2.0	5.0	**1.0**

Note. *Mdn* = Median. *IQR* = Interquartile range.

[a]Factors for which consensus was reached during the second round, were excluded from the third-round questionnaire. For this reason, third-round data for these factors are missing.

[b]Factors were rated on a seven-point Likert-type scale ranging from 1 (= *very unimportant*) to 7 (= *very important*). [c]Bold values represent the items for which consensus was reached (*IQR* ≤ 1).

Enhancing and hindering factors for informed decision-making

One category of enhancing factors (*Mdn* ≥ 6) on which consensus was reached, pertained to the content of information about food supplements and included: information that discusses both the positive and negative effects of a food supplement, provision of scientific evidence for the claimed effects and provision of specific information about the nature of the effects of the food supplement.

Another category of enhancing factors related to the way information is presented: making sure that information is easily accessible, well ordered, and tailored to a person's level of knowledge and characteristics. In addition, one enhancing factor that experts agreed upon was related to the source of the message: provision of information by a trustworthy, credible, and independent source.

Experts also reached consensus (*Mdn* ≤ 2) on a number of hindering factors for IDM: stressing the pros of the supplement more than the cons or vice versa, making too exaggerated claims, absence of contextual information, absence of information about popular misconceptions regarding the food supplement, inconsistencies in the message and too long messages (see Table 4.4).

Table 4.4 Second- and third-round ratings of enhancing and hindering factors for IDM regarding dietary supplement use

	Round 2 (n = 88)		Round 3[a] (n = 50)	
Factors[b]	*Mdn*	*IQR*[c]	*Mdn*	*IQR*[c]
• Information that discusses both the positive and negative effects of a food supplement	6.0	2.0	6.0	**0.0**
• Discussion of risks and benefits of the food supplement in two separate paragraphs	5.0	2.0	5.0	2.0
• Stressing the pros of the supplement more than the cons	2.0	3.0	2.0	**1.0**
• Stressing the cons of the supplement more than the pros	2.0	**1.0**		
• Making too exaggerated claims about the food supplement (e.g., claiming that it prevents you from getting a heart attack instead of claiming that it reduces the chance of getting a heart attack)	2.0	2.0	2.0	**1.0**
• Messages framed in terms of the benefits of using a particular food supplement[d]	4.0	2.0	4.0	2.0
• Messages framed in terms of the costs of failing to engage in using a particular food supplement	3.0	2.0	3.0	2.0
• Inconsistencies in the message	2.0	**1.0**		
• Absence of sufficient contextual information (e.g., explaining what an absolute magnitude means or explaining whether 1% is a small or big effect etc.)	2.0	**1.0**		
• Absence of information about alternative sources/providers where the food supplement can be obtained	3.0	2.0	3.0	2.0
• Absence of information indicating how negative consequences of the product can be controlled	3.0	2.0	2.5	**1.0**
• Absence of information about the costs of the food supplement	3.0	2.0	3.0	**1.0**
• Absence of information about popular misconceptions regarding the food supplement	3.0	2.0	2.0	**1.0**
• Provision of scientific evidence for the claimed effects	6.0	2.0	6.0	**0.0**
• Provision of evidence showing how long the supplement is already existing and working	5.0	2.0	5.0	**1.0**
• Making sure that the communicated information is in line with the legislation	5.0	2.0	5.0	2.0
• Provision of specific information about the nature of the effects of the food supplement	6.0	**1.0**		
• Provision of too complex information	2.0	2.0	2.0	2.0
• Too complex discussion of numerical information (e.g., 30% instead of 3 out of 10)	3.0	**1.0**		
• Too long messages	2.0	**1.0**		
• Too short messages	3.0	2.0	3.0	2.0
• Information is discussed in an abstract way without providing clear examples	2.5	**1.0**		
• Making sure that information about the supplement is easily accessible	6.0	2.0	6.0	**0.0**
• Making sure that the information is well-ordered	6.0	**1.0**		
• Repetition of the most important information	5.0	**1.0**		
• The use of colours in the message	5.0	**1.0**		
• A nice design of the message	5.0	2.0	5.0	**1.0**

• The use of images in the message	5.0	2.0	5.0	**1.0**
• Provision of information by a trustworthy, credible, and independent source	6.0	2.0	6.0	**1.0**
• Provision of personal stories about the experienced effects of the food supplement	4.0	**1.0**		
• Received information or advice about food supplements from significant others	4.0	2.0	4.5	**1.0**
• Provision of information via patient education channels/groups	5.0	2.0	5.0	**1.0**
• Information provided by commercial groups (e.g., food companies)	3.0	2.0	3.0	2.0
• Provision of information via TV commercials	4.0	2.0	4.0	**1.0**
• Provision of information via internet	5.0	**1.0**		
• Empathy for concerns of the person about using the food supplement	4.0	**1.0**		
• Provision of layered information (e.g., hyperlinks providing additional information when needed)	5.0	2.0	5.0	**1.0**
• Tailoring the channel of the information to the person's needs	5.0	**1.0**		
• Tailoring the information to relevant demographic characteristics of the person	5.0	**1.0**		
• Tailoring the information to a person's level of knowledge regarding food supplements	6.0	**1.0**		
• Tailoring the information to specific needs/characteristics of the person (e.g., doing certain sports, being ill)	6.0	**1.0**		
• Tailoring the information to a person's prior/current attitude towards the use of food supplements	5.0	2.0	5.0	**1.0**
• Tailoring the tone of voice of the message to a person's preferences	5.0	**1.0**		
• A person's positive attitude towards health in general	5.0	2.0	5.0	**0.0**
• A person's inclination to want to carefully process all relevant information	5.0	2.0	5.0	**1.0**
• A person's inclination to scan the information superficially and rely on brief statements	4.0	2.0	4.0	**1.0**

Note. Mdn = Median. *IQR* = Interquartile range.

[a]Factors for which consensus was reached during the second round, were excluded from the third-round questionnaire. For this reason, third-round data for these factors are missing.

[b]Factors were rated on a seven-point Likert scale ranging from 1 (= *very hindering*) to 7 (= *very enhancing*). [c]Bold values represent the items for which consensus was reached (*IQR* ≤ 1). [d]For this item, *n* = 87 in round 2.

DISCUSSION

The aim of this study was to reach consensus within a diverse group of experts regarding the most important characteristics of an informed decision regarding the use or non-use of food supplements with both positive and negative effects and the most important enhancing and hindering factors for IDM. Experts reached consensus on the importance of the greater part of the IDM characteristics as on the influence of most enhancing and hindering factors of IDM.

The results regarding characteristics of IDM about supplement use were generally in line with previous research on IDM regarding medical decisions. Important characteristics mentioned by the experts were knowledge (regarding effects or alternatives) and understanding of the provided information (Braddock III et al., 1999; Marteau et al., 2001; Michie et al., 2002; Molenaar et al., 2000; O'Connor et al., 1999; Rimer et al., 2004). In addition, experts agreed that feeling being informed, feeling being able to make the decision and to do this voluntarily is important for IDM. As in other studies, the importance of (the absence of) decisional conflict was also found to be important for IDM (Koedoot et al., 2001; Molenaar et al., 2000; O'Connor, 1995; O'Connor et al., 1999; Rimer et al., 2004). Next, the ability to compare pros and cons was regarded important for IDM, confirming previous findings (Rimer et al., 2004).

Experts did not reach consensus on the following two factors: “the decision should be in line with a person’s personal values” and “the decision should be translated into behaviour”. This finding is in contrast with other literature on IDM describing the importance of consistency between values and decisions and behavioural implementation of the decision (Marteau et al., 2001; Michie et al., 2002; Rimer et al., 2004). Our differences may be explained by the nature of the decisions at stake. We investigated decisions about food supplement use, while most IDM studies concern medical decisions regarding life-threatening diseases (Marteau et al., 2001; Michie et al., 2002; Molenaar et al., 2000; Rimer et al., 2004). With regard to a person’s health, medical decisions may have a greater impact than decisions regarding dietary supplement use. Consequently, the decision regarding food supplement use might not be important enough to consider one’s values and to bring the decision in line with one’s values.

Experts also rated the degree to which a number of factors was enhancing or hindering for IDM. These ratings revealed that experts preferred balanced information over unbalanced information. For example, experts agreed that information on both positive and negative effects is facilitating for IDM, while stressing the pros more than the cons or vice versa and making too exaggerated claims about food supplements was rated as hindering. In addition, provision of

scientific evidence for the claimed effects was considered a facilitating factor. Provision of balanced information and scientific evidence are important quality criteria of so called 'decision aids' (Elwyn et al., 2006; Montori, LeBlanc, Buchholz, Stilwell, & Tsapas, 2013; O'Connor et al., 1999) and thus also relevant for IDM. Inconsistencies in the message were rated as hindering, which is in line with the studies of Frewer et al. (2002) and Markon et al. (2013) who indicated low public acceptability and low message adherence as consequences. Not describing popular misconceptions about food supplements was also mentioned as an important hindering factor, which is relevant as consumers' understanding of nutrition information on labels is suboptimal (Cowburn & Stockley, 2005) and (false) health claims may lead to inaccurate beliefs about supplements (Williams, 2005). Providing information on these misconceptions may prevent these false beliefs.

Experts agreed that tailoring information to a person's level of knowledge and needs/characteristics were facilitating for IDM. Rimer et al. (2004) also concluded that tailoring to (among other things) one's readiness to undergo mammography, knowledge of the procedure and age-specific benefits and limitations (of mammography) led to increased levels of knowledge regarding breast cancer and mammography and more accurate risk perceptions regarding breast cancer compared to usual care. Giuse et al. (2012) found that tailoring communication about hypertension led to greater gains in knowledge than standard care discharge instructions. Hence, tailoring information to needs of the customer may be a promising strategy for improving IDM concerning food supplement use.

Limitations

One limitation of this study may be that experts had to provide overall suggestions without being able to take into account the fact that different supplements may need different strategies, also because supplements differ in effectiveness (Fortmann et al., 2013; Marik & Flemmer, 2012). Hence, IDM promoting strategies for one type of supplement may not work with other supplements. Another limitation is that suboptimal response rates were achieved, ranging from 29 to 42%. Although these percentages are not optimal, they are comparable to other Delphi studies (Abidi, Oenema, Nilsen, Anderson, & van de Mheen, 2016; Elfeddali et al., 2010; Schneider et al., 2012). Finally, consulting consumers in addition to experts may expose important differences between these groups.

Recommendations for future research

Our Delphi study resulted in a list of important IDM characteristics, which provides insight into the end results or outcomes that could be reached with communication about food supplements. To our knowledge no questionnaires or measurement tools exist that specifically measure IDM regarding food supplements. An important next step could therefore be to develop a questionnaire or measurement tool which makes it possible to measure the level or degree of IDM, based on the characteristics identified in this Delphi study. Existing medical measurement tools frequently measure the degree to which the decision is in line with the decision maker's values (Marteau et al., 2001; Michie et al., 2002) which may be less important for IDM regarding food supplements according to the experts in our study. Another interesting direction for future research is to conduct experimental studies, that could shed more light on which identified communication factors actually lead to increased or decreased levels of IDM (as measured by an IDM questionnaire).

Implications

With respect to implications of this study, an important finding of this Delphi study is that experts considered provision of balanced information of both the positive and negative effects together with information about the nature of the effects, scientific evidence for the effects and addressing popular misconceptions important for enhancing IDM regarding supplement use. It is therefore recommended to incorporate this information on the product labels, instruction leaflets, (informative) websites or other communication channels. Furthermore, experts expressed a preference for tailoring communication to a person's level of knowledge or characteristics. A possible way to implement this communication strategy is to design informative websites about food supplements where visitors receive information that is specifically tailored to their personal characteristics by making use of advanced routings. Another advantage of this technique is that irrelevant information is skipped, preventing users from having to read long messages which experts considered an important hindering factor for IDM.

Conclusion

The most important characteristics of an informed decision regarding the use or non-use of food supplements with positive and negative effects are: having knowledge and understanding of the supplements' positive and negative effects, the ability to compare these pros and cons, knowledge of alternatives besides

supplement use, the feeling of being informed, the feeling of being able to make the decision. This latter is a factor reflecting a person's level of self-efficacy. In addition, the decision should be made voluntarily. In order to enhance informed decision making regarding food supplements, balanced and contextualised information should be provided about both the positive and negative effects of supplements, the nature of these effects and popular misconceptions. Moreover, scientific evidence for the claimed effects should be included. In addition, this information should be easily accessible, well ordered, and tailored to a person's level of knowledge and personal characteristics. Finally, the information is preferably provided by a trustworthy, credible, and independent source.

CHAPTER 5

Profiling different groups of decision makers regarding dietary supplement use: A cluster analysis

Based on: Pajor, E. M., Oenema, A., Eggers, S. M., de Vries, H. (submitted). Profiling different groups of decision makers regarding dietary supplement use: A cluster analysis.

CHAPTER 6

Interactivity and recall of health information: Is less more?

Based on: Pajor, E. M., Eggers, S. M., de Vries, H., Oenema, A. (submitted). Interactivity and recall of health information: Is less more?

ABSTRACT

Background: Information that is provided in an interactive way is believed to be engaging because users are provided with the possibility to actively explore the information. Yet empirical findings often contradict this assumption. Consequently, there is still little known about whether and how interactivity affects communication outcomes, such as recall. Therefore, this study investigates mechanisms through which interactivity affects recall of online health information.

Methods/design: In an online between-subjects experiment (n = 983), we manipulated the levels of interactivity by increasing the number of interactive features on a website: control condition (no interactive features), moderate interactivity (dropdown menu), and high interactivity (dropdown menu and responsive infographics). We tested whether and how cognitive involvement, perceived active control, and cognitive load mediated the effects of interactivity on recall. In addition, we examined need for cognition and health literacy as potential moderators of the mediation-effects.

Results: Moderate and high levels of interactivity decreased recall through lowered levels of cognitive involvement, but increased recall through enhanced perceptions of active control. These mediation-effects were more prevalent in the high need for cognition and high health literate groups, as compared to their counterparts. Besides the partial mediations, direct, negative effects of levels of interactivity on recall were found in all analyses.

Conclusions: From a cognitive resources perspective, results indicate that individuals tend to devote more resources to controlling the interactive website than to get involved with the content, especially those who are more motivated and skilled to process the information.

INTRODUCTION

One of the unique features of Internet delivered health information is that it can be provided in an interactive way. Interactive features are thought to create more engagement and involvement with the information, as visitors have the possibility to interact actively with the information (Sundar, 2007). However, clear guidelines are lacking how interactivity could be utilized in health communication (Oh, 2017). Moreover, previous research has resulted in inconclusive findings regarding how interactive features affect communication outcomes. Interactive features may enhance user enjoyment, positive attitudes, and desirable behavioural intentions but they do not necessarily improve cognitive elaboration or information recall (F. Yang & Shen, 2017). The aim of the present study is to investigate whether and how interactivity can be utilized for improving recall of online health information. Given the increasing popularity of dietary supplement use and the complexity of the behaviour (Gahche et al., 2011; van Rossum et al., 2016) the present study focuses on this topic.

Theoretical background

The conceptualization of interactivity

In interactivity research three approaches are distinguished: structural, experiential, and message-exchange. In the structural approach, interactivity is conceptualised in terms of the technical attributes of the medium (Bucy & Tao, 2007). Such technical attributes include on-screen interactive features (e.g., menus) that allow user-to-system or user-to-user interactions (Sundar, Xu, Bellur, Oh, & Jia, 2010). According to the experiential approach, interactivity is the user's subjective perception of the level of the medium's interactivity (Liu, 2003). The message-exchange approach regards interactivity as an on-going communication process in which (semantic) meanings between two or more communicators are exchanged (Rafaeli, 1988). We conceptualise interactivity according to the structural approach, since in terms of causality the media stimulus that has been manipulated precedes users' responses to that stimulus (Bucy & Tao, 2007). Yet the structural approach often has been criticized for focusing only on direct relations between the media stimulus and the dependent measures and omits the possibility of third variable effects (Bucy & Tao, 2007). Therefore, in the conceptual model of the present study four types of variables are included: interactivity (manipulated independent variable), possible mediators, possible moderators, and a dependent variable.

A moderated mediation model of interactivity effects

In our conceptual model, we will test whether cognitive involvement, perceived active control, and cognitive load mediate the relationship between interactivity and recall. In addition, we will look at whether need for cognition and health literacy moderate the proposed mediation-effects.

Dual process models, such as the Elaboration Likelihood Model (ELM), propose that information that is elaborated via the central route is likely to produce greater and more permanent changes in communication outcomes (Petty & Cacioppo, 1986). Cognitive involvement (i.e., the number of content related thoughts generated during exposure to the stimuli) is considered an indicator of systematic information processing (Cacioppo & Petty, 1981). Interactive environments are thought to improve cognitive involvement since they enable non-linear, cognitively flexible information use (Cognitive Flexibility Theory; Jacobson & Spiro, 1995). If individuals are afforded with the possibility to adapt their information use to their own preferences and cognitive needs, individuals can process information more deeply, with the result of better information elaboration (Merrill, 1980; Patterson, 2000). Therefore, we propose that interactivity improves recall through higher levels of cognitive involvement.

The relation of interactive media attributes (i.e., objective interactivity) and users' perceived interactivity (i.e., subjective interactivity) is not always linear, therefore, a distinction is needed between the two (Voorveld, Neijens, & Smit, 2011). Moreover, experimental research on interactivity has shown that perceptions of interactivity are more closely related to the dependent measures (e.g., attitudes) than objective interactivity (i.e., the independent variable manipulated; McMillan, Hwang, & Lee, 2003; Tremayne, 2005). For instance, perceived interactivity mediated the effects of objective interactivity on attitudes (G. Wu, 2005) and on recall (H. Chung & Zhao, 2004). The control dimension of interactivity has been most often associated with cognitive elements of information processing (e.g., elaboration; Shrum, Lowrey, & Liu, 2009). As suggested by Rafaeli (1988), increased interactivity could give communicants a sense of control, which in turn, is likely to encourage cognitive processing. This latter would help users to learn more because they are able to control the information flow (H. Chung & Zhao, 2004). Therefore, interactivity may improve recall through higher levels of perceived active control.

Interactivity may challenge individuals' information processing capacities by putting an extra burden on users. Tremayne and Dunwoody (2001) found evidence that when users visited a more (versus less) interactive website much cognitive effort was spent to navigation and orientation which had a detrimental effect on recall. In interactive environments, individuals have to complete different tasks

performed concurrently (e.g., reading, navigating). Every task generates a cognitive cost on the working memory in terms of cognitive load. Moreover, the tasks may interfere with each other since they compete for the same cognitive resources, but those resources are limited (Lang, 2000; Sweller, 1994). Consequently, there are fewer capacities left for information processing (i.e., encoding, storage, retrieval). Indeed, research has shown that individuals retain less information when performing more than one task at the same time because multitasking inhibits the transfer of information into the short and long-term memory (Edwards & Gronlund, 1998; Lee, Lin, & Robertson, 2012). Therefore, we assume that cognitive load increases with higher levels of interactivity, which may lead to decreased levels of recall.

Moderators: need for cognition and health literacy

In addition to the mediation-effects described above, we aim to explore whether individual difference variables moderate the proposed mechanisms. Information processing is influenced by individuals' ability and/or motivation to process information (Lang, 2000; Petty & Cacioppo, 1986). Need for cognition reflects the tendency to engage in and enjoy effortful cognitive endeavours (Cacioppo & Petty, 1982; Cacioppo, Petty, & Feng Kao, 1984). It is considered a stable trait that may be influenced by situational factors such as interactivity (Cacioppo, Petty, Feinstein, & Jarvis, 1996). Evidence suggests that interactivity improves information processing, especially among low need for cognition individuals (Sicilia et al., 2005). This may be related to the fact that low need for cognition individuals prefer interactive websites more than their high need for cognition counterparts (Amichai-Hamburger, Kaynar, & Fine, 2007). However, high need for cognition individuals are more cognitively immersed when engaging in interactive websites than low need for cognition individuals (Sicilia et al., 2005; Srivastava, Shukla, & Sharma, 2010).

Individuals may also differ in their ability and skills to understand and use health information. Health literacy "entails the motivation, knowledge, and competencies to access, understand, appraise and apply health information in order to make judgments and take decisions (...) concerning health care, disease prevention etc." (Sørensen et al., 2012, p. 82). In general, low health literate individuals engage less in health information seeking and have greater difficulties with reading and searching for health information on the Internet (Birru et al., 2004; Jensen, King, Davis, & Guntzviller, 2010). Moreover, interactivity may challenge users with limited literacy skills since they have difficulties with recognizing graphic links (i.e., pictures that function as hyperlinks), using navigational tools, and understanding graphics that respond to mouse

movements (Zarcadoolas, Blanco, Boyer, & Pleasant, 2002). In addition, sufficient levels of metacognitive skills are needed to make mindful navigational selections and build meaningful sequences of information, for instance in a hypermedia environment (Lawless & Brown, 1997).

In sum, we aim to answer the following research questions: 1. Through which mechanisms does interactivity affect recall of health information? 2. Do these mechanisms differ according to individuals' level of need for cognition and health literacy? We summarized our conceptual model in Figure 6.1.

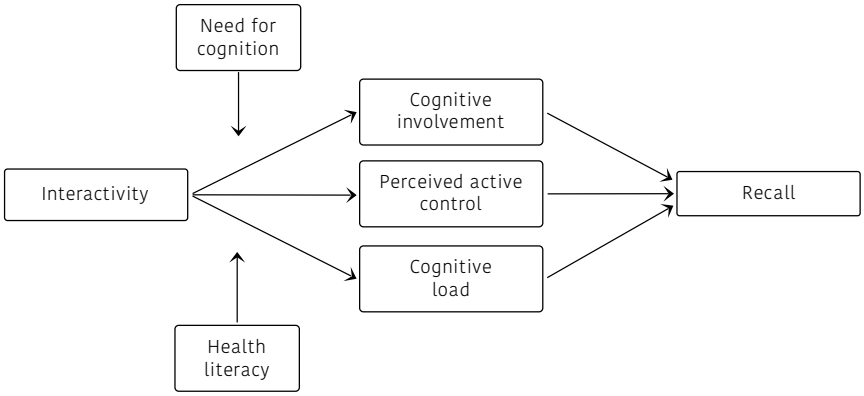

Figure 6.1 Conceptual model of the moderated mediation-effects of interactivity

METHOD

Design

A between-subjects experiment with three levels of interactivity (no interactivity, moderate interactivity, high interactivity) was conducted to investigate the effects of interactivity on cognitive involvement, perceived active control, cognitive load, and recall. Two weeks prior to the experiment background characteristics and moderator variables were measured. During the experiment, pre- and post-exposure measures were performed.

Participants

A priori power analysis (Gpower; Faul et al., 2007) indicated that at least 776 participants were needed to detect small effects (f^2 = .02; J. Cohen, 1988) with an alpha-level of .05, .90 statistical power, and 4 predictors. Participants were recruited from 26 000 active panel members of I&O Research, an ISO-certified

research bureau for access panels in market, opinion, and social research (ISO-26362; I&O Research, 2016). I&O Research recruits its panel members offline (e.g., from municipal registers) and self-registration is not allowed in order to prevent selection biases (e.g., overrepresentation of frequent Internet users; I&O Research, 2016). A random sample consisting of 4000 individuals was drawn from the panel, of which 1340 individuals (33.5 per cent) responded to the invitation to participate in the first part of the study. This response rate was comparable to the average response rate of this panel (35 per cent; I&O Research, 2016). The final sample consisted of 983 (73.4 per cent) individuals who participated in both parts of the study and completed the pre- and post-exposure questionnaires. Among these participants 50 vouchers of 10 euros of an Internet warehouse were raffled. Due to technical issues data of 15 respondents were lost in the pre-exposure measurement. Therefore, these participants were excluded from the analyses.

Procedure

Participants were invited by e-mail that contained a short description of the study, an explanation of the procedure, and contact details of the researcher. Upon agreeing to participate in the study and giving informed consent, individuals were asked to fill out a short questionnaire about health literacy, need for cognition, and educational level. Based on individuals' educational level, the sample was divided into three strata: low, medium, and high educational level. Two weeks after completing the first measurement, participants were invited to take part in the actual experiment. Prior to visiting the website, individuals filled out a pre-exposure measurement about their involvement of the research topic and dietary supplement use. Then, within each stratum, participants were randomly assigned to one of the three versions of the website about vitamin B6 and dietary supplements. In order to make the browsing task similar to a 'real-life' online health information search, participants had the freedom to decide what information and in which order they wanted to explore and no specific instructions or time limits were given. Participants were allowed to view the website only once. In order to prevent any pre-exposure to the stimulus material, the website was not publicly accessible. Once participants were finished with browsing on the website, they were redirected to the post-measurement questionnaire.

Ethical approval

According to the decision of the Research Ethics Commission of Maastricht University Medical Centre and Maastricht University (decision number: METC 16-4-268), the Medical Research Involving Human Subjects Act (WMO) does not apply to the present study. At the time of the study further ethical clearance was not required.

Stimulus material

In all three conditions, the information presented was identical and aimed to provide complete information about vitamin B6, its physiological effects, how it relates to food, and the risks and benefits of supplementation with vitamin B6. The goal was to offer information that is well balanced in terms of describing advantages and disadvantages of vitamin B6, and improves individuals' understanding of whether and to whom supplementation with vitamin B6 may be reasonable. Therefore, the recommendations of the Ottawa Decision Support Tutorial (ODST) were used (e.g., present scientific evidence; O'Connor, Stacey, & Boland, 2015).

In addition to the textual information, the website included four educative infographics that contained information about: the Recommended Dietary Allowance (RDA) of vitamin B6 by age category and gender, the vitamin B6 content of different food products, scientific evidence of possible health effects of vitamin B6, and safe and unsafe doses of vitamin B6 dietary supplements. Further details about the content and structure of the website are presented in Appendix D.

The manipulation of interactivity

Three versions of a website were developed which shared the same content, lay-out, and pictures, but differed in terms of levels of interactivity. In our study, interactivity refers to the technical attributes of the medium (Bucy & Tao, 2007). In line with previous research that falls into the structural approach of interactivity (Sundar, 2007; Sundar, Bellur, Oh, Xu, & Jia, 2014), we manipulated levels of interactivity in terms of the amount of interactive tools available on the web interface (e.g., menus) for accessing and interacting with the content of the website. Accordingly, in the control condition no interactive features were presented. Participants navigated by scrolling up or down on the webpage and the infographics did not respond to users' mouse movements. In the moderate interactivity condition, a dropdown menu consisting of nine sub-menus was the

only interactive tool presented on the website. The infographics shown in the moderate interactivity condition were static. In the high interactivity condition, two types of interactive features were presented: a dropdown menu and responsive infographics. Three rounds of pilot tests were conducted before the websites were finalised. In Figure 6.2, the differences in the navigation (i.e., scrolling vs. dropdown menu) between the conditions are presented. In Figure 6.3, the differences in the infographics (i.e., static vs. responsive) between the conditions are presented.

Figure 6.2 Navigation in the control condition (left) and in the moderate and high interactivity condition (right)

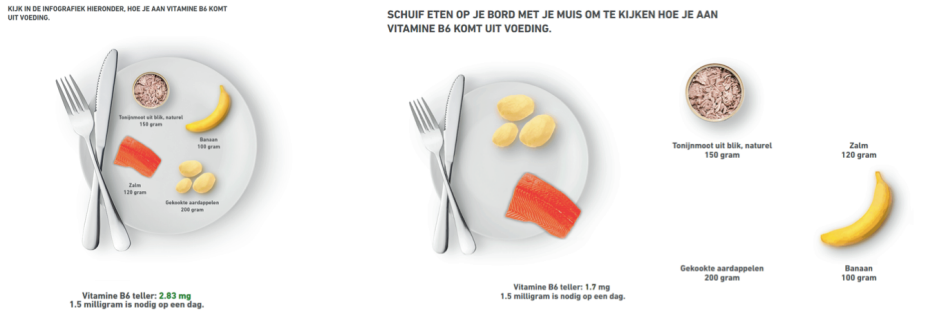

Figure 6.3 Example of an infographic in the control and in the moderate interactivity condition (left), and in the high interactivity condition (right)[2]

[2] Text above left picture: "Look at the infographic below how you can get vitamin B6 from food." Text above right picture: "Swipe food on your plate with your mouse to see how you can get vitamin B6 from food."

Measurements

Dependent variable: recall

During a pre-test, six questions were developed to measure recall: four questions measured text base level comprehension (i.e., literal recall of information stated on the website) and two questions measured situation level comprehension (i.e., to make inferences to situations based on the information; Kintsch, 1988; Smerecnik et al., 2010). Three of the six questions were in multiple-choice format (i.e. only one answer option was correct) and three other questions were in multiple response format (i.e., multiple answer options were correct). In both types of response options the "I don't know" option was also presented. Participants received 1 point for each correct answer, up to 9 points in total if all answers were correct.

Mediating variables

Participants' cognitive involvement with the website content was measured with a thought listing task (Cacioppo & Petty, 1981). Individuals were asked to list their thoughts that came to their mind about vitamin B6 during their website visit. Participants could list up to twelve thoughts in empty text boxes, each beginning with the statement: "Vitamin B6 is: ". Each field of text that was filled out counted as a thought. The cognitive involvement measure was placed second in the post-exposure questionnaire, after the one-item manipulation check of interactivity. Compared to thought listing measures during exposure, obtaining responses after the stimulus can be accomplished without the interruption or distraction from the stimulus (Cacioppo & Petty, 1981). In addition, in post-stimulus measures of cognitive involvement loss or retention is negligible (Cacioppo & Petty, 1981).

Perceived active control refers to users' voluntary and instrumental actions that directly influences their website experience (Liu, 2003; Liu & Shrum, 2002). Liu's (2003) four-item measurement of perceived active control was used.

Cognitive load was conceptualized as the perception of "the cognitive capacity that is actually allocated to accommodate the demands imposed by the task" (Paas, Tuovinen, Tabbers, & Van Gerven, 2003, p. 64). It was measured with 4 items derived from the Subjective Workload Assessment Technique (mental effort load sub-dimension; Eggemeier & Wilson, 1991; Reid, Potter, & Bressler, 1989) and from the Nasa Task Load Index (effort sub-dimension; Eggemeier & Wilson, 1991; Hart & Staveland, 1988).

Moderating variables

Need for cognition was measured with seven items derived from the 18-item Need for Cognition Scale (NCS) in Dutch (Pieters, Verplanken, & Modde, 1987). A limited number of items may be sufficient to measure need for cognition, since evidence suggests that the full NCS measures a single underlying construct (Cacioppo et al., 1984; Dornic, Ekehammar, & Laaksonen, 1991; Sadowski, 1993). Therefore, the items with the highest factor loadings were chosen from the study of Hevey and colleagues (2012).

Health literacy was measured using the Newest Vital Sign in Dutch (NVS-D; Fransen et al., 2014). The NVS-D is a 6-item test that assesses three types of skills: math skills, locate-the-information skills (by reading and comprehending), and abstract reasoning skills (i.e., making inferences from the information to specific situations; B. D. Weiss et al., 2005). For each correct answer, respondents received 1 point, up to 6 points in total. Details of the measurement scales (number of items, example items, answer categories, mean scores, and Cronbach's alphas) are presented in Table 6.1.

Table 6.1 Overview of number of items, examples of questions, answering categories, mean scores, and Cronbach's alphas of the measurement scales

Variable	Number of items	Example of questions/items, number of questions/items, answer options	Mean *(SD)*	Cronbach's alpha
Recall[a]	6	"Some groups of individuals are at risk of developing vitamin B6 deficiency. Which groups are these?" "Someone is using highly dosed vitamin B6 dietary supplements (100 milligram) for a longer period of time. What kind of influence may this have on the health condition of this person?" Multiple choice or multiple response questions	4.30 (2.71)	
Cognitive involvement[b]	12	"During your website-visit, certain thoughts may have come into your mind about vitamin B6. Please write down your thoughts about vitamin B6 in the text boxes below." Open ended questions	2.81 (1.84)	
Perceived active control	3	"While I was on the website, I could choose freely what I wanted to see." *Totally disagree* (1) to *totally agree* (7)	3.98 (1.29)	.80
Cognitive load	4	"I had to think hard in order to understand the information on the website" *Totally disagree* (1) to *totally agree* (7)	4.05 (1.42)	.92
Health literacy[c]	6	"If you are allowed to eat 60 gram of carbohydrates as a snack, how much ice cream could you have?" Open ended questions	5.14 (1.34)	
Need for cognition	7	"I really enjoy a task that involves coming up with new solutions to problems" *Totally disagree* (1) to *totally agree* (7)	4.94 (1.02)	.83

[a]Range: 0 (= *No correct answer*) to 9 (= *All answers are correct*). [b]Range: 0 (= *No thoughts*) to 12 (= *12 thoughts*). [c]Range: 0 (= *No correct answer*) to 6 (= *All answers are correct*).

Manipulation check measure

The effectiveness of the manipulation was measured by asking respondents: "To what extent do you agree with the following statement: This website is interactive." Answer options ranged from *Totally disagree* (1) to *Totally agree* (7) (Sundar, Kalyanaraman, & Brown, 2003).

User activity

During participants' website visit, the following user activity indicators were measured: duration of website visit in seconds (M = 11765.69, SD = 92169.31, Min = 5, Max = 1302883), the extent of scrolling down on the website (control condition: M = 0.98, SD = 0.32), total amount of clicks on the nine menus (moderate interactivity condition: M = 6.11, SD = 3.45; high interactivity condition: M = 6.13, SD = 2.64), and total amount of clicks on the four infographics (high interactivity condition: M = 11.05, SD = 9.09). Due to personal browser settings (e.g., disabled JavaScript; Clifton, 2012) user activity data of 524 participants out of the 983 participants were collected.

Control variables

Several variables were measured to control for their potential influence in the statistical analyses. The following demographic background characteristics were measured: gender, age, and highest obtained educational level. The latter was measured with seven response categories (1 = primary education or less, 2 = preparatory secondary vocational education (level 1) or equivalent, 3 = secondary vocational education, 4 = senior secondary vocational education (level 2-4) or equivalent, 5 = senior general secondary education, pre-university education, 6 = bachelor's level or equivalent, 7 = master's level or equivalent, doctorate). The strata of low (category: 1, 2, 3), middle (category: 4, 5), and high educational level (category: 6, 7) were based on these response options. In addition, meat consumption, diet, mode of life (e.g., anthroposophic nutrition), dietary supplement use, and involvement with the topic 'vitamin B6' were measured. Involvement was measured with 3 items from Zaichkowsky's (1994) personal involvement inventory scale (e.g., "The topic vitamin B6 is important for me", with answer options ranging from *Totally disagree* (1) to *Totally agree* (7)).

Statistical analyses

Descriptive statistics were run to investigate sample characteristics. To investigate the proposed mediations and to examine whether differences exist

between sub-groups, the PROCESS macro for SPSS (version 2.16.3) was used (Hayes, 2013). PROCESS applies bootstrapping to estimate 95% bias corrected confidence intervals for total and indirect effects. In PROCESS, 76 different conceptual diagrams are available. Model number 4 is programmed to test a simple mediation. In order to test mediations, Model 4 (10 000 samples) was used with three mediators operating in parallel: cognitive involvement, perceived active control, and cognitive load. In the analyses, the independent variable interactivity was defined as multicategorical. Consequently, it was automatically dummy coded by PROCESS (D_1: moderate interactivity condition, D_2: high interactivity condition, reference category: control condition). The percentage mediated effect was calculated for each significant indirect effect separately by dividing the corresponding unstandardized regression coefficient of the 'ab path' (i.e., indirect effect) by the unstandardized regression coefficient of the 'c path' (i.e, total effect) and multiplying it by hundred. In order to examine differences between sub-groups regarding the mediations (high versus low health literacy, high versus low need for cognition), Model 4 (10 000 samples) was run for each group separately. Sub-groups were created based on a mean-split. All analyses were conducted with adjustments for: gender, age, educational level, dietary supplement use, involvement with the topic 'vitamin B6', being on a diet, following a certain rule of life (e.g., anthroposophy), meat consumption, and duration of website visit. Analyses were conducted with SPSS version 23.

RESULTS

Sample characteristics

Slightly more female (53.9 %) than male (46.1 %) individuals participated in the study. Participants were on average 53.2 (*SD* = 15.31) years old and most of them held either a medium (40.9 %) or high educational level (37.3 %; Table 6.2). More than half of the sample (53.3 %) used dietary supplements in the last 12 months. Participants can be regarded as neutral towards the topic 'vitamin B6' since they were moderately involved (*M* = 3.42, *SD* = 1.54).

Table 6.2 Sample characteristics (n = 983)

Variable	*n*	*%*
Gender (male)	453	46.1
Mean age (*SD*)	53.20 (15.31)	
Educational level		
Low	214	21.8
Medium	402	40.9
High	367	37.3
Living according to a specific mode of life (yes)	92	9.4
Meat consumption (yes)	945	96.1
Being on a diet (yes)	201	20.4
Dietary supplement use in the last 12 months (yes)	524	53.3
Mean involvement with the topic 'vitamin B6'[a] (*SD*)	3.42 (1.54)	

[a]Involvement was measured on a 7-point Likert scale. The higher the score, the more involved participants were.

Manipulation check of interactivity

The analysis of variance revealed significant differences between the three versions of the website regarding interactivity, F (2, 980) = 24.99, $p < .001$, $\eta_p^2 = .05$. Post-hoc Bonferroni-tests indicated that all three versions differed significantly from each other. Participants rated the level of interactivity as low in the control condition (M = 3.31, SE = .10, n = 364), as moderate in the moderate interactivity condition (M = 3.89, SE = .10, n = 321), and as high in the high interactivity condition (M = 4.30, SE = .10, n = 298). Thus, the manipulation was successful.

Descriptive statistics of user actions within conditions

Users spent the most time browsing the website in the control condition (M = 366.19, SD = 2146.69), followed by the moderate (M = 112.54, SD = 1103.02) and high interactivity condition (M = 78.05, SD = 893.48). In the control condition, 78.7% of the participants scrolled all the way down the website and saw all website content. In the moderate interactivity condition, 14.8% of the users clicked on all dropdown menus and viewed the complete content, whereas in the high interactivity condition only 8.9% did so. Within the high interactivity condition, the proportion of participants who used all infographics was higher (29.2%) than of those who used all dropdown menus (8.9%). Descriptive statistics of user actions within conditions are presented in Table 6.3.

Table 6.3 Indicators of user activity per condition (n = 524)

	Condition		
Indicators	Control condition (n = 258)	Moderate interactivity condition (n = 142)	High interactivity condition (n = 124)
Mean duration of website visit in minutes (SD) [range]	366.19 (2146.69) [0.08 -21714.72]	112.54 (1103.02) [0.08 -13083.52]	78.05 (893.48) [0.10 -11599.07]
% Scrolling down whole browser window[a] (Modus) [Median]	78.7 (1) [1]		
% Complete use of the dropdown menu[b] (Modus) [Median]		14.8 (7) [6]	8.9 (7) [6]
% Complete use of infographics[c] (Modus) [Median]			29.2 (4) [2]

[a]Range: 0 (= *No scroll down*) to 1 (= *Complete scroll down at least once*). [b]Range: 0 (= *No clicks on menus*) to 9 (= *All menus were used at least once*). [c]Range: 0 (= *None of the infographics were used*) to 4 (= *All infographis were used at least once*).

The mediating effect of cognitive involvement, perceived active control, and cognitive load

Results showed, that the effects of levels of interactivity were mediated by cognitive involvement (Moderate interactivity: b = −.20, 95%CI [−.31, −.10], 9% mediated effect; High interactivity: b = −.21, 95%CI [−.33, −.10], 10% mediated effect) and by perceived active control (Moderate interactivity: b = .28, 95%CI [.18, .40], 13% mediated effect, High interactivity: b = .27, 95%CI [.16, .40], 13% mediated effect), but not by cognitive load (Moderate interactivity: b = .02, 95%CI [0, .07]; High interactivity: b = −.01, 95%CI [−.04, .02]). The mediations were partial as there was a remaining significant direct effect of interactivity on recall (Moderate interactivity: b = −2.25, 95%CI [−2.59, −1.90]; High interactivity: b = −2.16, 95%CI [−2.51, −1.81]). Levels of interactivity and the three mediators explained 34 per cent of the variance in recall (F_{model} (14, 953) = 35.76, p < .001). See Figure 6.4 for direct and total effects.

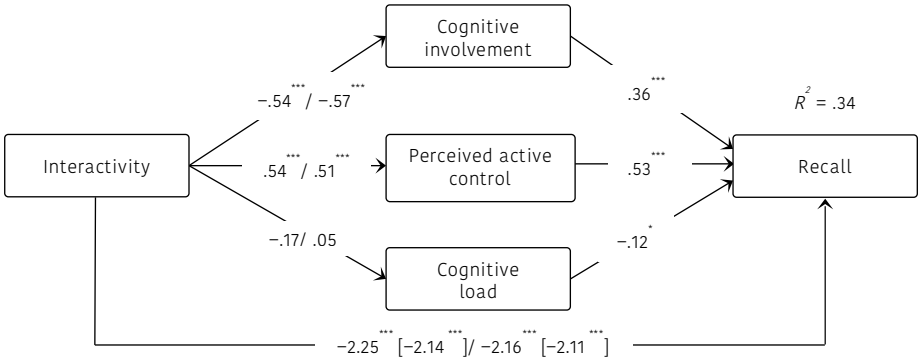

Figure 6.4 Unstandardized path-coefficients of the direct and total effects (in brackets) of moderate / high interactivity on recall, compared to the control condition (n = 968).
*p < .05, **p < .01, ***p < .001.

The conditional indirect effect of interactivity on recall according to two levels of need for cognition

The study sample was split into a high versus low need for cognition group using a mean-split (low need for cognition: score ≤ 4.94, n = 449, high need for cognition: score ≥ 4.95, n = 519). Results showed that in individuals with low need for cognition who were exposed to the moderate interactivity condition, the effects of levels of interactivity were mediated by cognitive involvement (b = −.18, 95%*CI* [−.36, −.05], 8% mediated effect) and by perceived active control (b = .14, 95%*CI* [.01, .30], 6% mediated effect), but not by cognitive load (b = .12, 95%*CI* [−.03, .08]). In low need for cognition individuals who were exposed to the high interactivity condition, none of the proposed mediations were significant.

In individuals with high need for cognition, in the moderate interactivity condition a significant mediation-effect of cognitive involvement (b = −.21, 95%*CI* [−.38, −.08], 11% mediated effect) and active control (b = .43, 95%*CI* [.27, .64], 22% mediated effect) was found. The mediation-effects of cognitive involvement (b = −.28, 95%*CI* [−.46, −.14], 16% mediated effect) and perceived active control (b = .43, 95%*CI* [.25, .65], 4% mediated effect) were also significant in the high interactivity condition. Regardless of the condition, no mediation effect of cognitive load was found in high need for cognition individuals. As presented in Figure 6.5, levels of functional interactivity had a significant direct effect on recall.

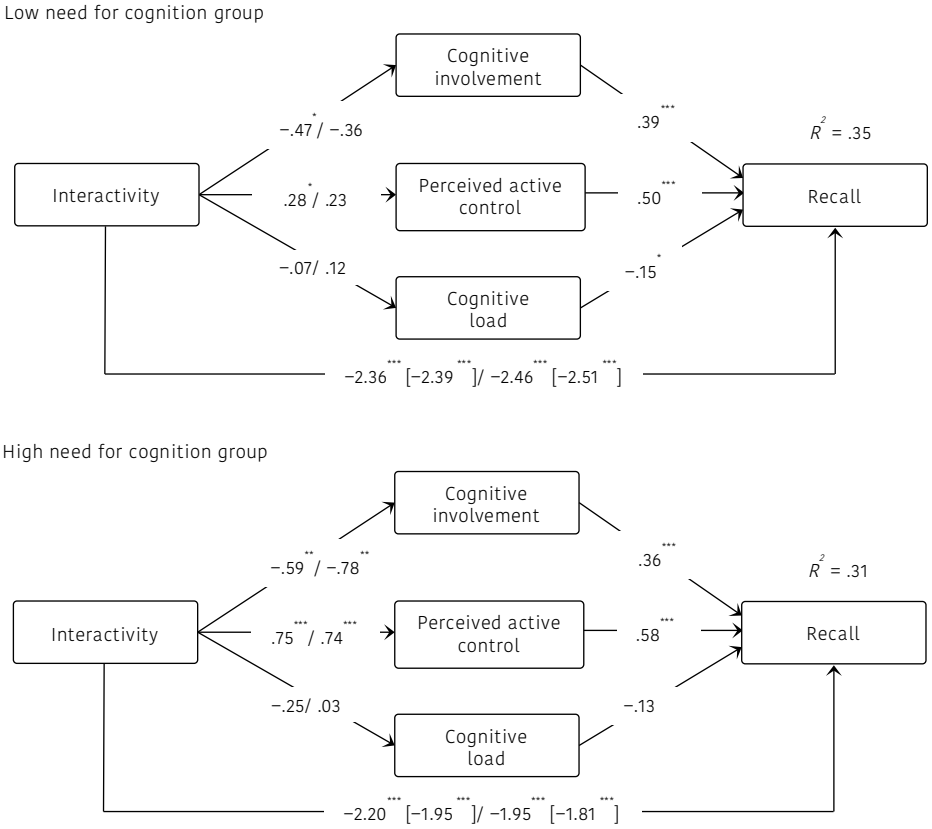

Figure 6.5 Unstandardized path-coefficients of the direct and total effects (in brackets) of moderate / high interactivity on recall, compared to the control condition in the low (n = 449) and high (n = 519) need for cognition group.
*p < .05, **p < .01, ***p < .001.

The conditional indirect effect of functional interactivity on recall according to two levels of health literacy

In order to test health literacy as a potential moderator of the mediation-effects, individuals were categorized as having a low health literacy level (i.e., score ≤ 5.14, n = 379) or high health literacy level (i.e., score ≥ 5.15, n = 589) using a mean-split. Results showed that in low health literate individuals, interactivity effects on recall were mediated significantly only by cognitive involvement (b = −.18, 95%CI [−.37, −.03], 7% mediated effect) in the moderate interactivity condition. When levels of interactivity were high, no mediation effects were found in low health literate individuals.

In high health literate individuals who were exposed to the moderate interactivity condition, interactivity effects were mediated by cognitive involvement (b = –.21, 95%CI [–.36, –.09], 10% mediated effect) and perceived active control (b = .42, 95%CI [.28, .60], 18% mediated effect). In the high interactivity condition, cognitive involvement (b = –.25, 95%CI [–.41, –.12], 11% mediated effect) and perceived active control (b = .40, 95%CI [.22, .61], 20% mediated effect) also partially mediated the effect. In Figure 6.6, direct and total effects are presented.

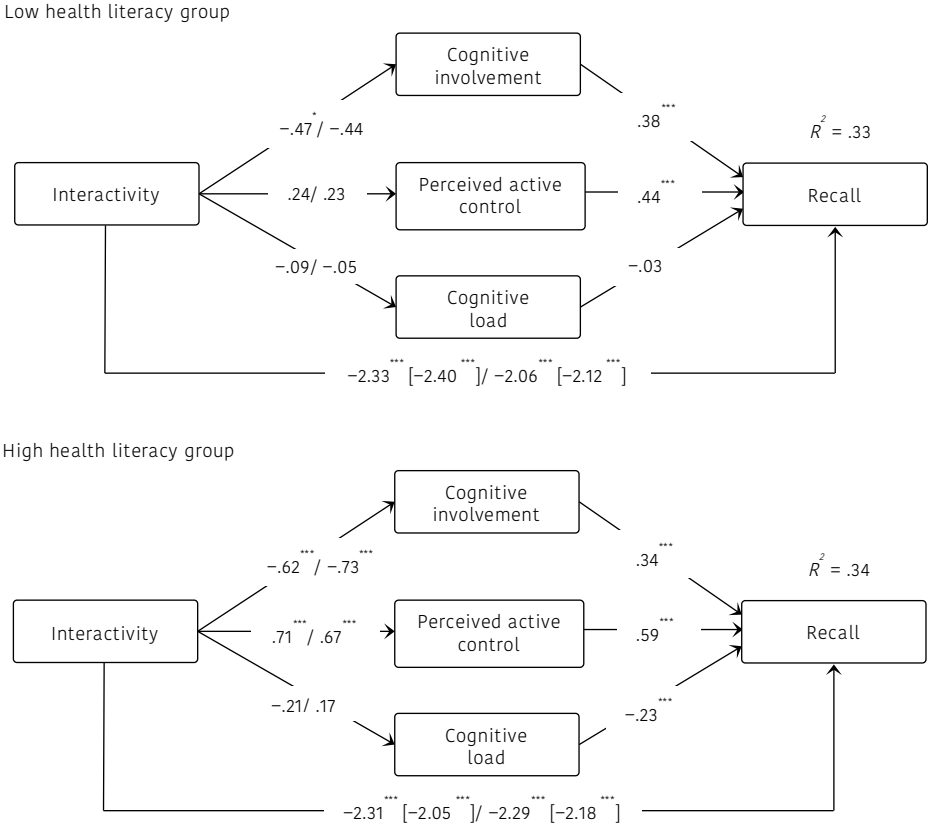

Figure 6.6 Unstandardized path-coefficients of the direct and total effects (in brackets) of moderate / high interactivity on recall, compared to the control condition in the low (n = 379) and high (n = 589) health literacy group.
*p < .05, **p < .01, ***p < .001.

DISCUSSION

Our study aimed to examine whether and how cognitive involvement, perceived active control, and cognitive load influenced the relationship between interactivity and recall. In addition, we looked at whether those pathways differed according to individuals' need for cognition and health literacy levels.

With regard to cognitive involvement, we found a small, negative indirect effect that indicates that moderate and high levels of interactivity reduced recall through reduced cognitive involvement (i.e., fewer thoughts generated). According to the ELM, individuals' cognitive responses such as the number of thoughts generated increase if information processing follows the central route (Petty et al., 2005). Our results may indicate that higher levels of interactivity hinder systematic information processing, resulting in less recall. This assumption is line with previous research in which participants generated significantly fewer thoughts when exposed to interactive versus non-interactive features (Oh, Bellur, & Sundar, 2015). A possible explanation for these findings is that when individuals are exposed to interactive media that require different types of user actions (e.g., reading, navigating), individuals may split their cognitive resources between the tasks. Since information processing capacities are already limited, this may lead to less conscious thinking about the message content (Lang, 2000; L. L. Wu & Lin, 2012). Jeong and Hwang (2016) found that media multitasking hindered systematic information processing which resulted in reduced levels of attention, comprehension, and recall.

Our results showed that moderate and high levels of interactivity improved recall indirectly through enhanced perceptions of active control. In terms of dual-process models, this may provide additional evidence that users tend to take the peripheral route of information processing when using interactive media. Sundar and Limperos (2013) argue that new media offer several types of technical affordances (e.g., navigability) that may serve as cues (i.e., snap judgments). For instance, the 'browsing heuristic' refers to users' online information seeking behaviour in which they skim the site content and check out the menus or hyperlinks superficially (Sundar, 2008). Indeed, our data on user activity showed that participants did not make use of all interactive functions of the moderately and highly interactive websites. However, the magnitude of the mediation-effect of perceived active control was comparable in both experimental conditions. As previously suggested, perceived active control may not be a function of the quantity but of the type of interactive features presented on a website (Voorveld et al., 2011).

Since we found no mediation-effect of cognitive load, we suppose that moderate and high levels of interactivity are not more cognitively demanding in

terms of information processing than static content (i.e., control condition). Website complexity is a function of page length, amount of information presented, and the number of pictures, hyperlinks or other elements embedded in the website (Huang, 2003). Our non-significant finding might be explained by the fact that we did not vary the website content across the conditions, we only varied the amount of interactive tools through which participants could interact with the website.

The direct, negative effect of interactivity on recall might be explained by user activity data that revealed that both time spent on website and the amount of content visited were the highest in the control condition. This may imply, that if users are provided with interactive features, their information search becomes more purposive. This entails that in their information search, users become more selective and herewith they might be exposed to less information, resulting in less recall.

Differences in mediation-effects with regard to need for cognition and health literacy

The partial negative mediation effect of cognitive involvement and the partial positive mediation effect of perceived active control were of greater magnitude in individuals with high (versus low) need for cognition, and in individuals with high (versus low) health literacy. While need for cognition and health literacy are generally associated with higher levels of elaboration on and recall of (health) information (Berkman, Sheridan, Donahue, Halpern, & Crotty, 2011; Cacioppo et al., 1996; McCarthy et al., 2012), such associations were not found in research on interactive media (Lustria, 2007; Sicilia et al., 2005) or negative associations were found (Broekhuizen & Hoffmann, 2012). Since literature suggests that interactive websites are preferred more by individuals with low need for cognition than their counterparts (Amichai-Hamburger et al., 2007), we assume that interactivity distracts high need for cognition individuals from systematic information processing.

Limitations

Our study had some limitations. First, we might have found less contrast between low and high health literacy groups since 87.2 per cent of the sample had adequate health literacy, according to the categorisation of the NVS (Fransen et al., 2014; B. D. Weiss et al., 2005). Second, we did not measure recall of interactive and non-interactive website content separately. Accordingly, conclusions can be

drawn only about individuals' overall recall of the website content. Third, this study was an online experiment that could be completed at participants' own device at their home. Therefore, it is possible that not all participants paid full attention to the website as some outliers were found in the variable 'duration of website visit'. However, analyses yielded comparable results when excluding those 66 outliers from the sample. Fifth, the topic of the study may seem very specific to some participants and may appeal only to a selective group of individuals, namely those interested in nutrition and dietary supplements.

Suggestions for future research

In previous research, interactivity has been operationalised in different ways and results are inconclusive, especially regarding interactivity's effects on recall. Therefore, future research should focus on testing different single interactive features against each other in terms of their effects on recall. In this manner, more insight may be gained regarding which specific interactive functions may hinder or improve recall. Future research may also benefit from incorporating user activity measures in the study design, such as frequency of clicks, drags, or mouse overs. There is limited knowledge about what individuals actually do with interactive tools, which functions they prefer, and whether objective interactivity and subjective (perceived) interactivity are congruous. The present study should be replicated on a different topic that may be relevant for a broader public. Herewith, it could be investigated whether interactivity effects are consistent across different health topics.

Practical implications: less is more

In the light of the results of the present study, important practical implications can be formulated about strategies to improve recall of online health information. Our overall conclusion is that incorporating interactive elements on a website substantially decreases recall. Internet users who are looking for health information pay more attention to information that is presented in a static manner than to information that incorporates interactive elements, such as menu bars or responsive infographics. Therefore, it is advisable not to divide the textual content in sub-menus but rather to present the information in a linear fashion with minimal navigational possibilities, such as scrolling. By doing so, web users will spend more time on the website paying close attention to the content and will recall more information.

Conclusions

Higher levels of interactivity decreased recall through reduced levels of cognitive involvement. At the same time, higher levels of interactivity increased recall through increased perceptions of active control. No significant mediation-effects of cognitive load were found. In addition, the identified indirect effects were of greater magnitude in individuals with high (versus low) need for cognition, and with high (versus low) health literacy. Besides the indirect effects, in all analyses levels of interactivity decreased recall also directly.

Acknowledgements

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CHAPTER 7

Revisiting interactivity effects on recall: A user engagement perspective

Based on: Pajor, E. M., Eggers, S. M., Oenema, A., de Vries, H. (under review). Revisiting interactivity effects on recall: A user engagement perspective.

CHAPTER 8

General discussion

The main aim of this dissertation was to explore how people can be optimally informed about dietary supplement use in order to be able to make informed decisions. In order to do so, the first aim was to gain insight into socio-cognitive predictors of dietary supplement use. The second aim was to determine what could be considered an informed decision about dietary supplement use. The third aim was to gain insight into whether interactivity is beneficial for individuals' recall of information about dietary supplement use.

In this chapter, a summary of the most important findings related to each of the sub-aims will be presented and discussed. In addition, possible explanations will be provided for the findings and implications for future research will be given. Furthermore, methodological considerations will be discussed, with recommendations for research and practice. This chapter will end with a general conclusion.

Salient beliefs and predictors of dietary supplement use

Main findings

The first aim of this dissertation was to gain insight into socio-cognitive predictors of dietary supplement use. We applied a theory-based, two-step approach. In the first step beliefs were discovered with a qualitative research method. In the second step predictors of the behaviour were explored in a longitudinal survey study.

In chapter 2, individuals' beliefs regarding dietary supplement use and non-use were explored with focus group discussions. Users' most important reasons (i.e., positive attitude beliefs) for dietary supplement use were related to health and could be grouped into three main categories: preventive reasons, health enhancement, and curative benefits. Yet most users were uncertain whether they actually experienced the health benefits they wanted to achieve. In contrast, non-users' most salient beliefs were related to disadvantages (cons): dietary supplement use is unnecessary, it intervenes in the normal functioning of the body, and both positive and negative effects have not been sufficiently investigated yet. Further contrasts were found between users and non-users in their trust regarding food products and food industry in general, and trust in health professionals. However, both groups held similar misconceptions (e.g., all types of dietary supplements are tested rigorously for safety before marketing), gave similar definitions about what a dietary supplement is, and had low levels of risk perceptions regarding possible side effects.

In chapter 3, the results of a longitudinal survey study investigating socio-cognitive determinants of dietary supplement use are reported. At baseline,

determinants derived from the qualitative study and from three different phases of the ICM (predisposing, pre-motivational, motivational) were measured, whereas behaviour was measured at one-month follow-up. Results revealed that intention, health regulatory focus (promotion), social modelling, positive attitudes (pros), risk perception (i.e., chances of getting ill), cues to action (product-related), and self-efficacy were positively associated with dietary supplement use, whereas (external) health locus of control and negative attitudes (cons) were negatively associated. In addition to psychosocial factors, age, gender, and having chronic conditions were also significantly associated with the behaviour. In the forthcoming sections the most important findings of chapter 2 and 3 will be discussed together.

Reflections on findings

In line with the findings of the focus group discussions, a concept that reflects the preventive and promotional aspects of the positive attitude beliefs was added to our theoretical model in the survey study: health regulatory focus (HRF; Higgins, 2002). HRF may yield important insights into whether individuals are motivated by health gains (i.e., promotion focus) or by health losses (i.e., prevention focus) when pursuing a (health) goal (Crowe & Higgins, 1997). Our results showed that only the promotion dimension of HRF was significantly associated with dietary supplement use. Our finding is line with previous research that demonstrated that individuals with promotion HRF tend to engage more in health maintenance behaviours (Gomez et al., 2013). This has important implications for health communication about dietary supplements. Research has shown that health messages that match individuals' HRF are more accepted than messages that do not match (e.g., eager-framed arguments and promotion focus; Borges & Gomez, 2015; Cesario, Grant, & Higgins, 2004). Therefore, the persuasiveness of health messages about dietary supplements could be improved by addressing either promotion or prevention concerns, depending on the HRF orientation of the recipient. Up till now, this approach has been underutilized to individualise health information (Ludolph & Schulz, 2015).

Results of chapter 2 and 3 showed that social norms and social support did not influence individuals' decisions about whether or not to use dietary supplements. However, social modelling emerged as an important determinant. Our findings may be related to an additional finding from the focus group discussions: participants often indicated that they held several doubts about dietary supplements. For instance, whether the products are truly effective or they have a placebo effect. Research suggests that in doubtful or uncertain situations people are more inclined to model the behaviour of significant others

(Cruwys, Bevelander, & Hermans, 2015). Observing what others do may serve as a 'point of reference' when it is unclear whether a certain action or behaviour is desirable (Cruwtys et al, 2015).

Besides factors that were associated with dietary supplement use, in chapter 3 we discovered a factor that was associated with non-use: external health locus of control. Compared to users, non-users believed more that factors outside their control (i.e., health professionals; B. S. Wallston et al., 1976) were of influence on their health. This result corresponds with findings of the focus group discussions. Compared to users, non-users' trust was considerably higher in two factors that are outside an individuals' control and may influence health: expertise of health professionals and quality of food products. Our findings are partly in line with previous research in which a negative association was found between individuals' beliefs that health professionals influence their health and the use of complementary and alternative medicine (Tokuda et al., 2007). Thus, a preliminary conclusion might be that individuals who show more trust and acceptance towards factors outside their control are less inclined to seek for opportunities to control their own health with dietary supplements.

Both users and non-users had similar levels of risk perceptions (i.e., chance and severity of side effects and interaction effects) and knowledge. In addition, they held similar misconceptions about dietary supplements. For instance, both groups believed that most types of dietary supplements involve low levels of risk otherwise they would not be sold without restrictions. Despite the fact that both users and non-users gave a correct definition about what a dietary supplement is (i.e., concentrated sources of micronutrients that supplement the normal diet) they could not indicate for instance how the active ingredients are produced. The results imply that it is important to increase consumers' awareness of potential risks of dietary supplements.

Strengths and limitations

The strengths and limitations of our research methodology should be noted. First, to date no studies about dietary supplement use have employed a two-step, theory-based approach to explore the behaviour. In order to make the two studies consistent, we used in both studies the Integrated Change Model (ICM) as theoretical background. However, the ICM is an extensive model with 14 factors (predisposing, pre-motivational, motivational factors) that made it to a certain extent difficult to incorporate topic-specific variables that were explored during the focus group discussions into the longitudinal survey study. As a consequence, not all factors identified in the focus group discussions (e.g., distrust in food quality) were tested statistically in the longitudinal survey study. Second, future

research should further explore which phase of the ICM the topic-specific variables (e.g., health regulatory focus) belong to. Third, in the Netherlands dietary supplement use is higher in winter than during the rest of the year (van Rossum et al., 2016). Therefore, we asked individuals in which periods of the year they use dietary supplements and we asked them to indicate the frequency of use in that specific period. However, this type of measurement does not take into account possible fluctuations in actual use of dietary supplements (e.g., users may stop using dietary supplements for several weeks). Therefore, future research could replicate our study with several follow-up measurements of actual use (e.g., during summer and winter) in order to detect associations between socio-cognitive predictors and possible changes in the behaviour.

Informed decision-making about dietary supplement use

Main findings

The second aim of this dissertation was to gain insight into how informed decision-making (IDM) about dietary supplement use can be conceptualized and to what extent individuals make informed decisions about dietary supplement use. In order to answer the second aim two studies were carried out. A Delphi study was conducted to reach consensus among experts about what should be considered an informed decision on dietary supplement use and what hindering and facilitating factors are. In addition, we explored to what extent consumers can be differentiated regarding their (informed) decisions on dietary supplement use in order to identify possible target groups for health education about dietary supplement use.

As presented in chapter 4, the following indicators of informed decision-making were considered important by experts: knowledge (about risks, benefits, and alternatives), awareness of one's needs, ability to compare risks and benefits, the feeling of being fully informed, the feeling of being able to make the decision, and the decision should be made voluntarily (i.e., without the pressure of others). In addition, experts reached consensus on factors that facilitate IDM regarding the content of information: both positive and negative effects of dietary supplements should be presented including the scientific evidence for the claimed (health) effects and specific information about the nature of effects. Furthermore, the manner in which the information is presented (i.e., accessibility, order, tailoring) and the source of information (i.e., trustworthiness) were also important factors that facilitate IDM.

Based on scientific literature on IDM and the results of the Delphi study an instrument to measure the components of IDM was developed. This instrument

incorporated assessments of information seeking (active, passive), information elaboration, knowledge, autonomy, decisional uncertainty, and attitude-behaviour discrepancy (i.e., the extent to which someone's attitudes towards an action and actual behaviour are in line). According to our assumption a decisions can be considered as informed when there is a high score on information seeking, information elaboration, knowledge, and autonomy but there is a low score on decisional uncertainty, and attitude-behaviour discrepancy. Results of chapter 5 showed that three distinct groups of decision makers could be distinguished: 'Uncertain, high information users', 'Uninformed decision makers', and 'Certain, low information users'. 'Uncertain, high information users' were the most active information searchers. However, they had moderate levels of knowledge and they felt the most uncertain. In contrast, 'Uninformed decision makers' searched barely for information, but they were moderately certain, albeit with the lowest levels of knowledge, autonomy, and information elaboration. 'Certain, low information users' held the most knowledge, autonomy, and certainty, despite their moderate information use. In the forthcoming paragraphs the most important findings of chapter 4 and 5 will be discussed together.

Reflections on findings

In chapter 4, we identified and operationalised six different components of IDM. Compared to the Multidimensional Measure of Informed Choice (MMIC, Marteau, Dormandy & Michie, 2001), we did not only assess whether a decision was informed or not (i.e., evaluating knowledge and value-consistency) as part of IDM but also how the decision was made (e.g., whether the individual searched for relevant information). The latter factors gave insight into the process of the decision-making. Literature often distinguishes between the process of making a decision and the actual choice for a certain (treatment) option which is the result of the decision-making process (Bekker, 2003; Rimer et al., 2004; Summers, 1994; van den Berg et al., 2006). A similar differentiation could be possible in our conceptualization, since some components are process related (e.g., information search), whereas others are outcome related (e.g., decisional certainty). Therefore, the distinction between variables related to the decision-making process and outcome variables could be tested in future research, for instance with a confirmatory factor analysis. In addition, more insight is needed how our current operationalisation of IDM correctly indicates whether a decision is informed or not. This could be done by comparing the predictive validity of our measurement instrument with an existing measurement instrument, such as the Multidimensional Measure of Informed Choice.

According to experts' opinion, informed decisions involve sufficient levels of knowledge and understanding of information, coupled with decisional certainty, and voluntariness. Yet in chapter 4 in none of the clusters were all conditions of an informed decision met (i.e., high scores on knowledge, elaboration, certainty, and autonomy). The lack of (fully) informed decisions may have two main explanations. First, experts reached consensus on a list of components that are relevant for rational, fully deliberated decisions. Yet in real-life situations, human decisions are rarely fully rational since individuals tend to apply shortcuts (i.e., heuristics) during decision making to make the decision quick and easy (i.e., low-cost) in terms of cognitive effort. Second, experts' opinion is to a certain extent prescriptive and outlines how informed decision-making should look like in an 'ideal situation' which involves for instance that all information about positive and negative effects (and their probabilities) of dietary supplements is available in an understandable way to consumers. Unfortunately, to date scientific research on active ingredients of dietary supplements is still evolving and findings often contradict each other, are difficult to understand for a layperson, or may not be accessible to a broad public (e.g., publications in scientific journals). Such communicational factors may hinder IDM on dietary supplement use, as experts indicated in the Delphi study. Therefore, future research should investigate how individuals search for and use information about dietary supplements to make (informed) decisions. In addition, it should be explored whether and what kind of difficulties individuals encounter when searching for information.

Knowledge can be considered a central component of IDM on dietary supplement use. Experts agreed that individuals should have sufficient levels of knowledge on both the positive and negative effects, and on alternatives of dietary supplement use. Moreover, individuals should have the feeling of being fully informed. Results of chapter 5 showed that knowledge was moderate to low in two out of the three clusters. Therefore, it can be concluded that knowledge should be an important target point for health education about dietary supplement use. One may assume that obtaining and elaborating on information may result in higher levels of knowledge. However, knowledge (and decisional certainty) was inversely associated with information-related factors (e.g., active information seeking, information elaboration) in two clusters. For instance, members of the cluster 'Uncertain, high information users' had only moderate levels of knowledge despite their highest scores on information elaboration. A possible explanation for this result may be that some communicational factors may hinder knowledge acquisition. Such a hindering factor could be that the information does not correspond to the person's actual level of knowledge, as mentioned by experts of the Delphi study. A different explanation could be that

uncertain individuals are more inclined to search for information (Belkin, Oddy, & Brooks, 1982; Kuhlthau, 1991; Z. J. Yang, Aloe, & Feeley, 2014), whereas the opposite holds true for certain individuals.

In line with previous research on IDM within the clinical context (O'Connor, Jacobsen, & Stacey, 2002; O'Connor et al., 2007), results of chapter 5 showed that indicators of decisional conflict, such as decisional uncertainty, are important target points for health communication about dietary supplements. Results of the cluster analysis showed that the cluster with the highest proportion of dietary supplement users scored the lowest on decisional certainty with the highest level of attitude-behaviour discrepancy. An inverse pattern of these factors was found in a different cluster, which may imply that those who are the most uncertain have the highest gap between their attitudes and their behaviour (and vice versa). Therefore, more research is needed to investigate how these factors are related to each other. It is important to note, that experts did not reach consensus on the importance of attitude-behaviour discrepancy as a component of IDM on dietary supplement use. This is to some extent a surprising finding, since literature on IDM regards consistency between values and decisions an important component (Rimer et al., 2004).

Strengths and limitations

The strengths and limitations of the studies presented in chapter 4 and 5 should be mentioned together with recommendations for future research. First, IDM on dietary supplement use was explored with a two-step approach: a Delphi study was carried out to collect ideas about relevant components of IDM, followed by a survey study to explore how individuals actually make decisions. Yet not all individual characteristics of IDM mentioned by experts were included in the measurement instrument because for instance some characteristics were clustered into one overarching sub-component (e.g., 'knowledge of supplements' positive and negative effects' and 'knowledge about alternatives' were clustered into 'knowledge'). Second, with the cluster analysis, we gained insight into what type of decision makers can be distinguished, however we still know little about the circumstances in which the decisions are made. For instance, what type of information sources do individuals consult or what are the main reasons of users' uncertainty. Third, the measurement instrument used in chapter 5 needs to be validated. These questions and research aims should be addressed in future research.

The role of interactivity in online health communication about dietary supplements

Main findings

Chapter 6 and 7 investigated how individuals process and make use of interactive online information on a micronutrient with both health benefits and risks: vitamin B6. In chapter 6, results showed that individuals' recall of information decreased when levels of interactivity increased. In addition, two mechanisms working the opposite direction were discovered. Interactivity decreased recall through lowering individuals' cognitive involvement with the information content. At the same time, interactivity increased recall by enhancing perceived active control (i.e., the perception of actively controlling the website). These findings were more prevalent in individuals with high health literacy (vs. low health literacy) and with high need for cognition (vs. low need for cognition). The results of chapter 7 showed that interactivity significantly decreased recall, especially among users who moderately or barely interacted with the websites in the two experimental conditions. However, across all levels of user activity (i.e., low, moderate, high) most information was recalled when users were exposed to a non-interactive website (compared to the moderate or high interactivity condition).

Taken together, the studies presented in chapter 6 and 7 suggest that interactivity may not be beneficial for individuals' recall of health information. This is most likely due to the fact that increased interactivity did not stimulate most users to explore the whole website content. In addition, more interactivity led to less systematic information processing (i.e., decreased levels of cognitive involvement). This may be related to the fact that individuals' attention may have shifted from focused reading of the information to making use of interactive features albeit that not all of those features were used. Herewith we found initial evidence that online health information that is presented in a static linear manner (i.e., non-interactive) may be the most beneficial for recall. In the forthcoming sections the most important research findings and their implications will be discussed.

Reflections on findings

Our research has demonstrated that during information processing of (interactive) online health information, different mechanisms simultaneously influenced recall. In line with previous research (F. Yang & Shen, 2017), our results showed that an indicator of central information processing, cognitive involvement, decreased when levels of interactivity increased. Furthermore, interactivity significantly increased perceptions of controlling the website even if individuals made little

use of interactive features. This might mean that interactive features may serve as peripheral cues (i.e., heuristics; Sundar et al., 2015; Sundar & Limperos, 2013) that may distract individuals' attention from the content of the message. According to the Limited Capacity Model of Mediated Information Processing "individuals have only a limited (and perhaps fixed) pool of mental resources to process information" (Lang, 2000, p. 47). Consequently, if individuals are exposed to a multitask environment in which they have to use interactive tools and read the information at the same time, the latter process may become superficial. Therefore, an important implication for future research is to address questions such as: what type of information processing (central or peripheral) does interactivity evoke? Sundar et al. (2015) have listed 29 possible cues that may be evoked by digital media and may influence how individuals process information and how they may judge the information (e.g., acceptance of information). However, more empirical research is needed to gain more insight into whether and how interactivity may function as a peripheral cue and whether interactivity could be utilized to stimulate central information processing.

Giving individuals the freedom to explore the website content the way they wanted (e.g., order, pace) resulted to some extent in a backfire effect both in terms of recall and active engagement with the content. When exposed to (more) interactive features, individuals discovered less content as Google Analytics data revealed. In addition, individuals' recall significantly decreased with increasing levels of interactivity. This contradicts the assumption that interactivity helps website visitors to become more engaged with the content since they may be active users instead of passive receivers of the information. However, our findings are in line with previous research in which interactivity was operationalised in terms of presence or absence of freedom of information choice. In the study of Crutzen et al. (2012) participants spent less time on the website, viewed fewer pages, and had lower levels of knowledge in the freedom of information choice condition. The finding that our participants' superficial website visit might have led to missing important information may suggest that health education materials that guide readers through the information in a predetermined order are more suitable for improving recall of health information. Therefore, future research should further examine users' online behaviour and how it is related to recall.

Interactivity effects should be interpreted in the light of how actively individuals engage with the website as presented in chapter 7. As described above, recall decreased with increasing levels of interactivity and this effect was significantly stronger for users who were moderately or hardly active compared to highly active users. Herewith the importance of measuring and incorporating

users' online behaviour in experimental study designs on interactivity was demonstrated: interactivity effects may be contingent upon the extent to which interactive features are actually used. However, recent experimental research rarely has measured users' online behaviour (i.e., objective measures) and has rather employed self-report measures (e.g., perceptions of flow experience). Taken the results of chapter 6 and 7 together, it may be concluded that self-report measures (e.g., perceived active control) and objective measures (e.g., online behaviour) yielded divergent insights into the mechanisms through which interactivity works. This may indicate that they capture different aspects of users' engagement with a website, therefore they should be taken into consideration together when interpreting research results. User activity data showed that individuals made moderate use of the interactive features offered, however even this low level of interaction was associated with for example higher levels of perceptions of controlling the website. However, the two experimental conditions (moderate and high interactivity) influenced to a similar extent perceptual and objective measures of user engagement. Future research should incorporate different types of measurements of user engagement as they complement each other.

Strengths and limitations

Some important methodological and theoretical considerations should be noted. First, individuals in our sample indicated to be neutrally involved with the topic of our experiment ('Health benefits and risks of vitamin B6'). Since interactive features require user actions, involvement may play a crucial role in whether individuals are motivated to make use of such features. Second, a direct comparison of user activity between the conditions was not possible either with the unstandardized or with the standardised variable. Consequently, we could not draw conclusions about which condition evoked the highest or lowest level of user activity. Unstandardized (i.e., condition-specific) measures are not suitable for comparisons because in each condition different types of user actions were possible. After standardization (to z-scores) direct comparisons were not possible (e.g., with one-way ANOVAs) because the means were set to zero. However, an advantage of standardized measures is that they can be used as condition independent indicators of user activity in statistical analyses, for instance in moderation analyses. Third, due to the various ways interactivity was operationalised in previous research, it is difficult to compare our results to previous findings and draw general conclusions about whether interactivity is beneficial or disadvantageous for recall.

Recommendations for future research

The following recommendations for future research can be given based on the findings presented in chapter 2 to 7.

- Some factors that were not included in our theoretical background but were additionally explored in chapter 2 (e.g., distrust in health professionals), need to be tested as predictors of dietary supplement use in a quantitative study. In addition, it should be examined which phase of the ICM the topic-specific factors belong to.
- In chapter 2 and 3, we did not differentiate between users of different types of dietary supplements (e.g., multivitamin users, herbal remedy users etc.). However, different socio-cognitive factors might be associated with different types of dietary supplements (e.g., vitamin C and prevention health regulatory focus). Therefore, future research should examine whether differences exist between groups of dietary supplement users with regard to socio-cognitive factors.
- In chapter 3, we used a measurement instrument of dietary supplement use that took into consideration that the behaviour is strongly related to the seasons of the year. Therefore, future research should measure actual dietary supplement use with several follow-up measurements. In this manner, changes in the behaviour could be discovered and how these changes might be related to socio-cognitive factors.
- The current operationalisation of IDM on dietary supplement use as presented in chapter 5 needs validation. For instance, it should be compared to existing measurement instruments, such as the Multidimensional Measure of Informed Choice (Michie et al., 2002), or the decisional conflict scale (O'Connor, 1995). Construct validity could be examined by investigating associations between the different measurement instruments.
- As presented in chapter 5, none of the decision-making groups that we identified scored high on all six components of IDM. Herewith the question arose whether it should be further differentiated between sub-dimensions or sub-processes of IDM, such as the process of decision-making and its outcomes. Therefore, future studies need to explore whether such differentiations could be made.
- Our finding that individuals who search the most for information have moderate levels of knowledge, and highest levels of uncertainty needs clarification. Therefore, in a follow-up study it should be explored how individuals search for and use information about dietary supplements and what kind of difficulties they encounter.

- Experimental research on interactivity should take into consideration what users actually do with interactive features because it may be an important effect modifier. Therefore, tracking users' online behaviour should be incorporated in research designs and should be tested as moderators in effect analyses (i.e., when the relation between (levels of) interactivity and communication outcomes are tested).
- Our results showed that interactivity is not beneficial for recall of online health information. Herewith the question remains unanswered whether and how interactivity could be utilized to improve recall of health information. A possible way to further investigate interactivity effects is to test how single interactive features influence recall. In this manner, it could be determined which type of interactive feature could be utilized in health communication. This approach may be more useful than the quantitative approach of interactivity in which different levels of interactivity are tested.

Recommendations for practice

Based on the research findings presented in chapter 2 to 7, some important recommendations for practice can be formulated.

- Most dietary supplement users indicated to take dietary supplements for health-related reasons. Therefore, in future communication about dietary supplements it is important to use those reasons as a starting point in communication messages and explain the efficacy and possible side effects in the context of the expected health benefits.
- Individuals held several misconceptions about dietary supplements that should be addressed. One frequently mentioned misconception was, for instance, that most types of dietary supplements involve negligible health risks because they can be bought without a prescription of a health professional. Since dietary supplement use may involve health risks besides benefits, consumers' awareness about their own responsibility for making informed decisions should be improved.
- Dietary supplement users had low levels of trust in general practitioners and dieticians. Given the fact that dietary supplement use is associated with having chronic conditions, one may assume that users regularly have consultations with health professionals. Users' education on dietary supplements could be realized through experts who could give evidence-based information. Yet distrust might be a barrier for users to accept and discuss information about dietary supplements. It would be important to

overcome such barriers because patients with chronic conditions may use prescription drugs and dietary supplements concurrently which may increase the risk of possible interaction-effects.

- Dietary supplement users were uncertain about their decision, had moderate levels of knowledge, and there was an inconsistency between their attitudes and their behaviour. These are important target points for health communication about dietary supplements. This target group is interested in information on dietary supplements because they already search actively for and elaborate well on the information.
- In terms of background characteristics, one of the most important target groups for health education about dietary supplement use is: middle-aged (or older) women, who may have chronic conditions but a considerably healthy lifestyle at the same. These characteristics may help to find communication channels that are frequently used by this group.
- Our research findings suggest that online communication on dietary supplements should be presented in a static, non-interactive way in order to keep individuals' attention on the content of the message. Individuals recalled the most information when they were exposed to a non-interactive website, even if they showed moderate or low levels of online activities. In addition, the general population is moderately involved with dietary supplements as a topic. As a consequence, they might not be motivated to make use of interactive features to retrieve (more) information on dietary supplements.

General conclusions

The following socio-cognitive factors were positively associated with dietary supplement use: promotion health regulatory focus, social modelling, risk perceptions (i.e., chances of getting ill), cues related to the product, positive attitude beliefs (pros), self-efficacy, and intentions. In addition, negative attitude beliefs (cons) and external health locus of control were negatively associated with dietary supplement use. Furthermore, non-users had higher levels of trust in health professionals and food quality compared to users.

Six components of IDM about dietary supplement use were identified: knowledge about both the advantages and disadvantages of the product and the ability to compare those pros and cons, awareness of one's own need of using dietary supplements, and knowledge about alternative options. In addition, the decision maker should have the feeling of being fully informed, should regard

himself/herself as being able to make a decision, and the decision should be made voluntarily. According to our results, none of the groups of decision makers that were identified scored high on all sub-components. Moreover, results showed that decisional uncertainty, attitude-behaviour discrepancy, and knowledge are important target points for health education among dietary supplement users.

From the three versions of online communication we tested, individuals obtained the most knowledge from a non-interactive website compared to interactive websites. Therefore, in order to improve individuals' knowledge about dietary supplements, online communication may benefit from non-interactive information. Future research should further investigate our current operationalisation of informed decision-making, for instance by comparing our measurement instruments to other existing measurement instruments. In addition, research should explore what type of online communication about dietary supplement use might be effective.

VALORISATION ADDENDUM

In this valorisation addendum, the societal relevance and impact of this thesis will be discussed, with focus on the following aspects: 1) relevance of the study results; 2) target groups for which the results may be of interest; 3) products that result from the PhD-project; 4) the innovativeness of the findings; 5) the planning of implementation of obtained knowledge.

RELEVANCE

Dietary supplement use rates have never been as high as nowadays. In the Netherlands, 42 per cent of the general population uses dietary supplements (van Rossum et al., 2016) and rates of use are even higher in other Western countries such as the US or Norway (i.e., 50 per cent; Gahche et al., 2011; Skeie et al., 2009). Dietary supplements are thought to be beneficial to health because their efficacy to cure or to prevent deficiency related diseases has been scientifically proven. Yet evidence is growing that besides benefits, dietary supplements may pose risks to one's health since they frequently contain pharmacologically active agents capable of producing biological responses (Boyer, 2005). Such risks include interactions with prescription and over-the-counter drugs (Izzo, Hoon - Kim, Radhakrishnan, & Williamson, 2016; Vrolijk et al., 2015), contamination with undeclared active pharmaceutical ingredients (P. A. Cohen, 2009; Petróczi, Taylor, & Naughton, 2011), two-sided effects etc. (e.g., vitamin D supplements may lower the risk of osteoporosis but may increase the risk of cardiovascular events; Bolland, Grey, Avenell, Gamble, & Reid, 2011). In most cases, supplements related adverse events involve sympathomimetic toxicity which may cause cardiac symptoms (e.g., palpitation, tachycardia, chest pain), shortness of breath, tremulousness etc. (Geller et al., 2015; Haller et al., 2008). Therefore, it is important that consumers are well informed about both the health risks and benefits of dietary supplements in order to make informed decisions.

In the light of these developments, the results of the present dissertation are highly relevant as our findings provide important input for developing health communication messages and how to deliver such messages. The insights into the most salient beliefs and determinants of dietary supplement use provide target points for health communication messages. In addition, our finding that higher levels of interactivity decreased individuals' recall has important implications for online health communication.

TARGET GROUPS

Policy makers, regulators at the national and international level

The studies presented in this dissertation were funded by The Netherlands Food and Consumer Product Safety Authority (NVWA). This organisation is responsible for guarding and maintaining animal health, plant health, food safety, and product safety in the Netherlands. In order to support their practical activities, the NVWA funds scientific research in the areas mentioned. Accordingly, the findings of the present thesis are of interest of the NVWA: they help to understand consumers' perspectives on dietary supplement use and herewith risk-benefit communication about dietary supplements can be adjusted to consumers' information needs. For instance, our results showed that a large group of dietary supplement users are uncertain about their decision and have low levels of knowledge. Therefore, the NVWA should take these findings into account when informing consumers about dietary supplements.

Following a series of food crises, since 2002 the European Food Safety Authority (EFSA) has been an independent source of scientific advice and communication on risks associated with food products both for legislative and executive institutions of the European Union and for consumers (EFSA, 2017). In their effort "to bridge the gap between science and the consumer" our results may help the EFSA to get important insights into consumers' risk perceptions, attitudes, and decision-making patterns about dietary supplement use. Herewith, scientific results on risks associated with dietary supplements can be better translated to the non-scientist public.

Advisory organisations

Based on (the most recent) scientific evidence, the Health Council of the Netherlands (in Dutch: *Gezondheidsraad*) advises the Ministry of Public Health, Welfare & Sport on issues related to public health including dietary supplement use. For instance, the Health Council has already warned policy makers that the current state of claim regulation is confusing: "there is only juristic but no practical or scientific difference between claims about 'maintaining and promoting health' (i.e., health claims) and claims about 'preventing an illness' (i.e., medical claims)" (Health Council of the Netherlands, 2003, p. 3). Results of this dissertation might be of value for the Health Council because they may help to communicate more effectively about dietary guidelines. Among others, these guidelines include information about the rationale of dietary supplement use for risk groups.

Our findings might be relevant to the National Institute for Public Health and the Environment (RIVM) as well. The RIVM is responsible for the Dutch National Food Consumption Survey (DNFCS) in which data are collected and analysed on food consumption, including dietary supplement use. The RIVM is committed to promoting public health. On the long term, dietary supplement use may affect the health of the Dutch population, since it is increasing especially in the aging population. Therefore, insights are needed about individuals' motivation for dietary supplement use.

Non-governmental, non-profit organisations

The Netherlands Nutrition Centre (in Dutch: *Stichting Voedingscentrum Nederland*) is an independent organisation that aims to provide consumers (and professionals) with reliable information about healthy, safe, and more sustainable food (The Netherlands Nutrition Centre, 2017). The Dutch Consumers' Union (in Dutch: *Consumentenbond*) is a non-profit, independent alliance that strives for an "honest, fair, and safe market of consumer goods", including food products such as dietary supplements (The Dutch Consumers' Union, 2012). Both organisations can use our results as input for improving the information presented on their website.

Healthcare providers, dieticians

Dietary supplement use is more common in the older age groups and is positively associated with having chronic illnesses. Consequently, dietary supplement users may have regular appointments with health professionals who could inform them about health benefits and risks of dietary supplements. Unfortunately, research has shown that patient-physician communication about dietary supplements is rare: only one-third of patients report their use to their conventional health care provider (Frenkel et al., 2013; Mehta, Gardiner, Phillips, & McCarthy, 2008; Schofield, Juraskova, & Butow, 2003). The findings of chapter 2 showed the need for health education because several misconceptions should be targeted. In addition, chapter 4 revealed that users are uncertain about their decision and have low levels of knowledge. Healthcare providers could fulfil an important role in educating patients about dietary supplements.

Users, non-users of dietary supplements, and risk groups of micronutrient deficiencies

Users of dietary supplements could benefit from the findings of this thesis. Despite the fact that dietary supplement use is associated with individuals' need to improve their health, consumers should not overlook the possible health risks of dietary supplements. This especially holds true if individuals take prescription drugs or undergo conventional health treatments. In addition, dietary supplement users should become more aware about the need to make informed decisions about dietary supplement use. According to our results in chapter 4, some groups of consumers decide to take dietary supplements but they remain uncertain about their decision. In addition, a small group of dietary supplement users seemed to avoid information about them.

Risk groups of micronutrient deficiencies might also benefit from our findings. In their case, there is sufficient scientific evidence for supplementing the normal diet. However, research showed that in risk groups dietary supplement use is not adequate. Therefore, our findings regarding the most salient beliefs and determinants of dietary supplement use may give insight into what determinants should be targeted in order to increase dietary supplement use.

In the Netherlands, 42 per cent of the general population uses dietary supplements on a regular basis (van Rossum et al., 2016). Even if the majority of the Dutch population does not use dietary supplements, the findings of this thesis might be of interest to them. Dietary supplements are readily available in grocery shops, 'health stores' etc. According to findings in chapter 2, this creates the misconception that dietary supplements involve only negligible risks. Otherwise — as individuals argued — they would not be sold without the prescription of a health professional. This illustrates that the general population should become more aware about the fact that not all types of dietary supplements undergo rigorous safety and efficacy tests. However, clear communication about both the benefits and risks (and uncertainties) of dietary supplements is often lacking, which hinders informed decision-making.

Producers of dietary supplements or related stakeholders

In the European Union, in the current legislation on dietary supplements (i.e., Food Supplements Directive) and on claims (i.e., Nutrition and Health Claims Regulation) producers are expected to take responsibility for the (correct) labelling on the package (e.g., listing all ingredients, not making exaggerated or misleading claims). Consequently, it is also the producers' responsibility to enable consumers to make informed decisions. Therefore, producers of dietary

supplements may have interest in our results with regard to how consumers make decisions in favour or against dietary supplement use and what are their information needs.

The Vitamin Information Bureau (in Dutch: *Vitamine Informatie Bureau*) has been sponsored by Bayer Consumer Health, but they do not advise in favour or against specific brands and they are not involved in commercial activities. As stated at their website (www.vitamine-info.nl), they aim to provide consumers (and professionals) with evidence-based information, such as the dietary guidelines of the Health Council. Our findings may help them to improve their (online) health communication about dietary supplements.

ACTIVITIES AND PRODUCTS

Since input was lacking for developing effective health communication about the benefits and risks of dietary supplements, the main product of this dissertation is the insights gained into people's beliefs about dietary supplements, how they make decisions about their use (or non-use), and whether interactive health information is beneficial for health education purposes. In addition, two surveys were developed during this project. Based on formative research, items were generated for a survey measuring psychosocial and cognitive determinants of dietary supplement use. Another survey was developed — also based on formative research — to assess relevant components of informed decision-making about dietary supplement use. After validation, this tool can be used in the area of self-care decisions such as the use of complementary and alternative medicine (e.g., special diets) or the use of over-the-counter drugs (e.g., painkillers). Although the website developed for the purposes of the experimental study might be considered a prototype, it is a result of several pilot-tests and it was based on the guidelines of the Ottawa Decision Support Tutorial (O'Connor et al., 2015). Therefore, it might be used for further experimental research: by adjusting the CSS coding, other elements of the website could be manipulated.

The results of this thesis were presented at international conferences, such as the conference of the European Health Psychology Society (EHPS). In addition, results were published in peer-reviewed, international journals.

INNOVATION

Research on why people use dietary supplements is still scarce. Therefore, there was a need for systematic and comprehensive research on this topic. The studies presented in chapter 2 and 3 are innovative because to our knowledge, no

previous research used a two-step approach (i.e., qualitative and quantitative research) to gather in-depth knowledge on beliefs and determinants of use and non-use of dietary supplements. In addition, both studies used the same theoretical background which resulted in a more systematic investigation of the behaviour.

Another innovative aspect of the thesis is, that we conceptualised and assessed informed decision-making in a context in which it has never been investigated before. In chapter 5, we demonstrated that informed decision-making is a relevant concept for dietary supplement use. In addition, the results of chapter 4 and 5 indicated that informed decision-making should not be restricted to two measures (i.e., knowledge and value-behaviour consistency), but it should entail more relevant components such as autonomy.

Our study presented in chapter 6 and 7 contributed to existing experimental research on interactive online health information in several ways. First, to our knowledge only a few previous studies incorporated different types of variables (i.e., independent variable, moderators, mediators, and dependent measure) in their conceptual model to investigate interactivity effects. In this manner, we explored different mechanisms through which interactivity might influence recall. Herewith, we made an attempt to find an explanation for inconsistent results in previous research. Second, even less studies measured what users actually do with interactive features of websites despite the fact that interactivity entails — among others — that users are free to choose what interactive functions they want to use. Third, data on online behaviour were successfully linked to other types of individual-level measures, such as recall of information. Herewith, we demonstrated how tracking tools, such as Google Analytics can be employed in scientific research.

PLANNING OF IMPLEMENTATION OF KNOWLEDGE

This project was aimed at generating input for evidence-based health communication about the risks and benefits of dietary supplements. Although important steps were made towards a better understanding of this health behaviour and health communication about dietary supplement use, currently, there are no concrete plans to continue the project. Therefore, we give suggestions for future research.

First, in our studies we focused on the general population however, epidemiologic data showed that dietary supplement use varies according to age, gender, and health condition (van Rossum et al., 2016). Therefore, future studies should explore the information need and decision-making processes of sub-

groups in which dietary supplement use is high. In addition, risk groups of developing micronutrient deficiencies could be another important target group for future research. In contrast to the general population, in which dietary supplement use involves uncertainties and lack of scientific consensus, there is sufficient scientific evidence that risk groups may truly benefit from dietary supplement use. Second, in order to communicate effectively about health benefits and risks of dietary supplements, the risk-benefit ratio of each type of dietary supplement should be known. In addition, other types of risks, such as supplement-drug interactions also should be known. Unfortunately, to date scientific research on the potential adverse effects of dietary supplements is scarce. Therefore, more laboratory research is needed in order to identify risk groups of supplement-drug interactions and to adequately inform these target groups.

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APPENDICES

APPENDIX A

Interview schedule of focus group discussions with dietary supplement users (predefined themes)

Main themes	Main questions
Definition of dietary supplements	Please describe what dietary supplements are and what they are meant for.
Positive attitude (pros)	What are the most important benefits of taking dietary supplements for you? What are your most important reasons for taking dietary supplements?
Self-efficacy	In which situations is it difficult for you to keep taking dietary supplements? In which situations would it be difficult for you to quit taking dietary supplements?
Response efficacy	How do you notice the advantageous health effects of dietary supplements?
Social influences	What do people think in your social environment about dietary supplements? Think of the opinion of your partner, family, friends and colleagues.
Negative attitude (cons)	What are the disadvantages of dietary supplement use for you? Can you think of reasons against dietary supplement use?
Risk perception (severity)	In your opinion, how severe are the adverse effects of dietary supplements?
Risk perception (chance)	What is the chance of experiencing adverse effects of dietary supplements?

APPENDIX B

Interview schedule of focus group discussions with non-users (predefined themes)

Main themes	Main questions
Definition of dietary supplements	Please describe what dietary supplements are and what they are meant for.
Positive attitude (pros)	Can you think of reasons why you would take dietary supplements? Can you think of reasons why people take dietary supplements?
Self-efficacy	In which situations would it be difficult for you to stay away from dietary supplements? Can you think of situations in which people may encounter difficulties with quitting taking dietary supplements?
Social influences	What do people think in your social environment about dietary supplements? Think of the opinion of your partner, family, friends and colleagues.
Negative attitude (cons)	What are your most important reasons against taking dietary supplements for you? What are the disadvantages of dietary supplement use?
Risk perception (severity)	In your opinion, how severe are the adverse effects of dietary supplements?
Risk perception (chance)	What is the chance of experiencing adverse effects of dietary supplements?

APPENDIX C

Measures of IDM components

IDM component	Operational definition	Questions, items, and answer options
Information seeking (active)	Active information seeking is the purposive seeking of information as a consequence of a need to satisfy some goal (Wilson, 2000).	"In which manner do you gather information about dietary supplements?" 1. "I search actively for information about dietary supplements." 2. "I consult different sources of information when I need information on dietary supplements." 3. "I compare different information I have found on dietary supplements." 4. "I keep up with the newest information on dietary supplements." *Totally disagree* (1) to *totally agree* (5)
Information seeking (passive)	Passive information seeking/receiving refers to information acquisition without intentional information seeking (Wilson, 1997).	"In which manner do you gather information about dietary supplements?" 1. "I get information passively on dietary supplements (like e-mail newsletters)." 2. "I usually come across information on dietary supplements coincidentally (like on television or on the Internet)." *Totally disagree* (1) to *totally agree* (5)
Information elaboration	Information elaboration was defined as the careful consideration, exchange, discussion and integration of the distributed information (van Knippenberg, De Dreu, & Homan, 2004).	"When I read information about dietary supplements..." ~~1. "... I read the information, and when I'm finished I go on with other activities (like surfing on the internet).~~" (dropped) 2. "... I take notes of the information for myself." 3. "... I keep thinking about the content of the information." 4. "... it raises questions in my mind about the content of the text." 5. "... I tell the information my friends and acquaintances."

Measures of IDM components (continued)

IDM component	Operational definition	Questions, items, and answer options
Information elaboration (continued)		6. "... I ask others about their opinion of what I have read." 7. "... I discuss the information with others, using arguments." 8. "... I strive for to find a complete conclusion with others." *Totally disagree* (1) to *totally agree* (5)
Knowledge	Knowledge is having correct factual knowledge and principles knowledge about dietary supplements and micronutrients.	"Are the following statements about dietary supplements and micronutrients true or false?" 1. "On the packages of dietary supplements is the Recommended Dietary Allowance (RDA) of each ingredient stated." 2. "Your body is able to produce vitamin D." 3. "Dietary supplements are tested by official agencies on health effects and possible side effects." 4. "An orange contains about 25 per cent of the Recommended Dietary Allowance (RDA)." 5. "Eggs, fish, and dairy products contain vitamin K." 6. "Vitamins pills boost your immune system (so you are less susceptible to illnesses)." ~~7. "Women above 50 years old and men above 70 years old need extra vitamin B12.~~" (dropped) 8. "A healthy individual gets sufficient amount of vitamins and minerals through eating healthily and varied." 9. "Vegans run the risks of vitamin B12 deficiency." 10. "Vitamin E strengthens the cells of your skin and hair." *True* (1), *false* (2), *I don't know* (3)

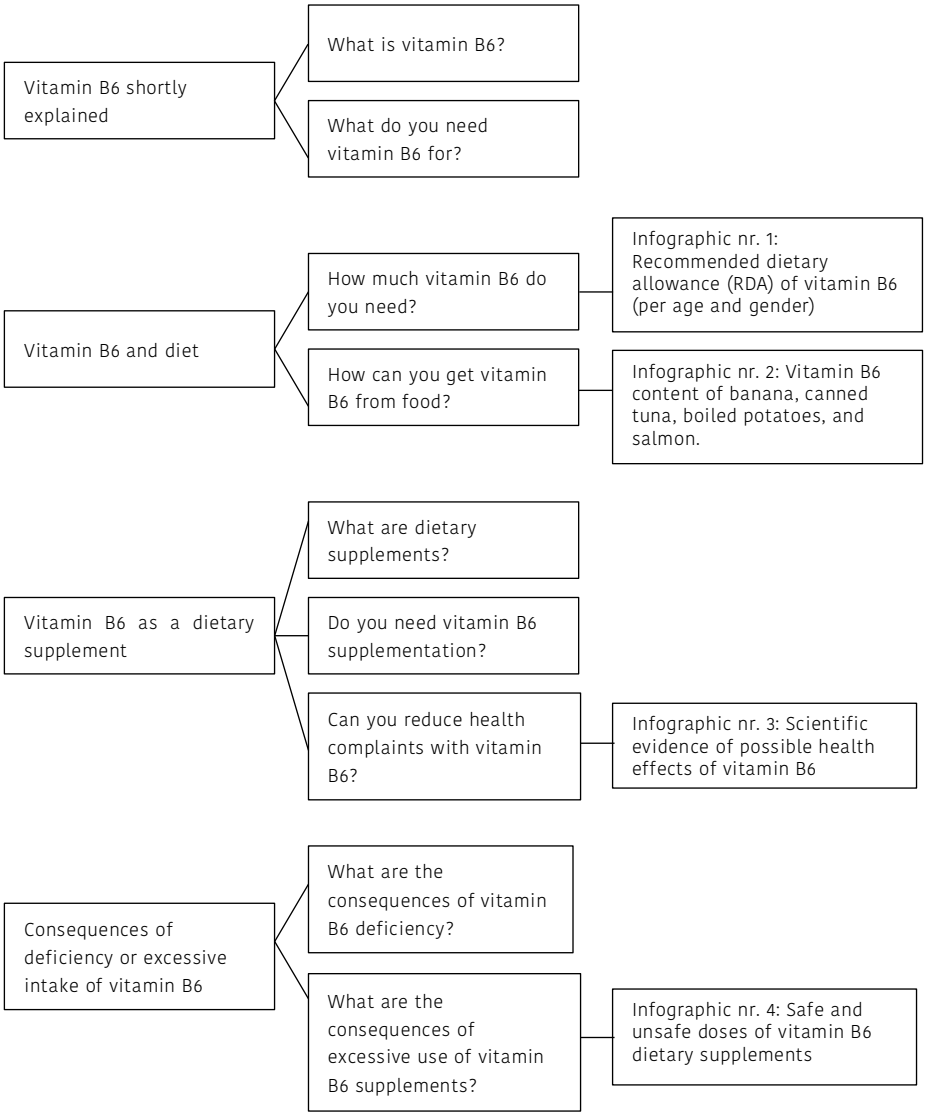
Autonomy	Autonomy "is the degree that he or she wills the action without being under the control of another's influence" (Beauchamp & Childress, 2001, p. 93)	"To what extent did the following factors play a role in your decision about whether or not to use dietary supplements?" 1. "My own considerations." 2. "My emotions." ~~3. "Advice of partner, friends, and/or colleagues.~~" (dropped) ~~4. "Advertisement in a newspaper, television or other media.~~ " (dropped) ~~5. "Advice of my GP or dietician.~~" (dropped) *Not at all* (0) to *to a very great extent* (4)
Decisional certainty	Decisional uncertainty is the level of emotional uncertainty an individual perceives about the course of action he/she took (Koedoot et al., 2001; O'Connor, 1995).	"Regarding my decision whether or not to use dietary supplements... 1. "... I am indecisive." (R) 2. "... I am satisfied." 3. "... I have regrets." (R) 4. "... I have inconsistent emotions (positive and negative at the same time)." (R) 5. "... I am thinking about again and again." (R) *Totally disagree* (1) to *totally agree* (5)
Positive attitude (pros)	Positive outcome expectations of the (health) behaviour.	"If I use/used dietary supplements every day... " 1. "... it would make me feel better." 2. "... I would have more inclination to arrange things." 3. "... I would feel more energetic." 4. "... I would be able to think more clearly." 5. "... I would feel better physically and mentally." 6. "... my immune-system would improve." 7. "... my appearance (hair, nails) would improve." 8. "... my body would function better." 9. "...my physical complaints would decrease." 10. "... my deficiencies on micronutrient would decrease." Unipolar, 5-point Likert-type scale.

Measures of IDM components (continued)

IDM component	Operational definition	Questions, items, and answer options
Negative attitude (cons)	Negative outcome expectations of the (health) behaviour.	"If I use/used dietary supplements every day… " 1. "… it would feel like I am doing something wrong." 2. "… I would be concerned." 3. "… I would be unsure about the safety of the product." 4. "… I would be worried." 5. "… I would have regrets." 6. "… it would be expensive." 7. "… it would be unnatural." 8. "… it would be unnecessary." 9. "… the active ingredients of the supplement would leave my body via de urine." 10. "… I would just imagine that they help." Unipolar, 5-point Likert-type scale.
Attitude-behaviour discrepancy	Attitude-behaviour discrepancy refers to the degree to which individuals' attitudes towards taking an action are inconsistent with the actual behaviour.	Computed variable

APPENDIX D

Content and structure of the website about vitamin B6



SUMMARY

In the Netherlands, 42 per cent of the general population uses at least one type of dietary supplements regularly. Yet according to the Dietary Guidelines of the Health Council of the Netherlands, dietary supplements may have evidence based health benefits only for individuals who are at risk of developing micronutrient deficiencies. Despite the fact that in wealthy and industrialized countries individuals have low chances to develop deficiency related diseases (e.g., rickets), dietary supplement use has never been as high as now in the Netherlands and internationally. Therefore, there is a need to explore why dietary supplement use is widespread. In addition, since dietary supplements may involve both benefits and risks to individuals' health, it is important to investigate how individuals make decisions on dietary supplement use and whether those decisions are well considered in terms of weighing up benefits against risks. Furthermore, there is a need to examine how individuals can be educated about dietary supplements via online communication.

The dissertation is divided into three parts. The aim of the first part, which consisted of two studies, was to examine which socio-cognitive determinants are associated with dietary supplement use and non-use. The second part of the dissertation consisted of two studies that were aimed at exploring the concept of informed decision-making in the context of dietary supplement use. The last two studies that belong to the last part of the dissertation were aimed at providing insight into how interactive features could be employed in online communication about dietary supplements.

Chapter 2 described the results of a qualitative study that was aimed at exploring and comparing users' and non-users' beliefs towards dietary supplements. Thirteen focus group discussions were held of which 7 with users (n = 28) and 6 with non-users (n = 28). Based on the Integrated Change Model (ICM) a semi-structured topic guide was set up. The discussions were audiotaped and subjected to systematic interpretative content analysis. Results showed that dietary supplement users' attitude beliefs (pros) were mainly related to mental and physical health enhancement, illness prevention, and curative health benefits. In contrast, non-users' beliefs were related to attitudes (cons): dietary supplement use is unnecessary because the human body does not need any support in the form of dietary supplements. The most striking contrasts between the two groups were found in their trust in health professionals and trust in quality of food. Users were mainly dissatisfied with their general practitioners and were concerned about food quality, whereas non-users showed high levels of trust. Yet both groups held similar misconceptions, gave similar definitions about what a dietary supplement is, and had low levels of risk perceptions regarding possible side effects.

In CHAPTER 3 we continued exploring what type of socio-cognitive factors were associated with dietary supplement use. Determinants were derived from the focus group discussions and from the ICM. In a longitudinal survey study, socio-cognitive and psychosocial factors were measured among users and non-users of dietary supplements at baseline (n = 1448) and behaviour was measured at one-month follow-up (n = 1161). Results of the negative binomial regression analysis showed positive associations between dietary supplement use and intentions, promotion health regulatory focus, social modelling, attitudes (pros), risk perception (chance of getting ill), and self-efficacy. Negative associations were found between dietary supplement use and attitudes (cons), and external health locus of control.

CHAPTER 4 aimed to gain insight into what relevant components of informed decision-making (IDM) about dietary supplement use are and what communication factors may enhance or hinder IDM. In a three round international Delphi-study (n_{round1} = 38, n_{round2} = 89, n_{round3} = 51) experts of (risk) communication or related fields were asked to (1) provide input about what they consider important characteristics of IDM (2) and to rate the importance of each individual IDM component, and hindering or facilitating factors of IDM in the subsequent rounds. Experts agreed on the following six important characteristics of IDM: (1) having knowledge of the supplements' positive and negative effects, (2) the ability to compare these effects, (3) knowing alternatives besides supplement use, (4) feeling informed and (5) to feel able to make the decision, and (6) to make the decision voluntarily. In addition, consensus was reached on the following enhancing factors of IDM: provision of information about positive and negative effects and the nature of the effects including scientific evidence, ensuring information is easily accessible, well-ordered, tailored and provided by a trustworthy, credible and independent source.

CHAPTER 5 addressed the question how individuals make decisions about whether or not to use dietary supplements. More specifically, we explored whether different groups of decision makers can be distinguished based on their scores on the IDM components. A cluster analysis was conducted on cross-sectional data of 1161 respondents. Results indicated three distinct clusters of decision makers: (1) 'Uncertain, high information users', (2) 'Uninformed decision makers', and (3) 'Certain, low information users'. In each of the clusters identified, IDM was insufficient due to low scores on one or more component(s). Decision-makers in cluster one were uncertain with low levels of knowledge and high levels of attitude-behaviour discrepancy. Individuals in cluster two were ignorant for information about dietary supplements, whereas information use was very low in cluster three. In order to improve IDM the components which members of the

clusters scored low on should be targeted with health education (e.g., low levels of knowledge in cluster one).

Chapter 6 focused on whether it is beneficial for individuals' recall to employ interactive website features in online communication about the health benefits and risks of vitamin B6. The study investigated different mechanisms through which interactivity may affect recall of health information. Hereby we looked at whether cognitive involvement, perceived active control, and cognitive load mediated the effects of interactivity on recall. In addition, it was examined whether there were differences in the mechanisms between individuals with different levels (low versus high) of need for cognition and health literacy. Participants of an online between-subjects experiment (n = 983) were randomly assigned to one of the three conditions that differed only in the amount of interactive features (i.e., control condition: no feature, moderate interactivity: one feature, high interactivity: two features) embedded in the website. Moderate and high levels of interactivity decreased recall through lowered levels of cognitive involvement. At the same time, recall was increased by interactivity through increased perceptions of active control. These effects were more prevalent in the high need for cognition and high health literate groups, as compared to their counterparts. Besides the partial mediations, direct negative effects of interactivity on recall were found in all analyses.

Chapter 7 further explored the effects of interactivity on individuals' recall of health information on vitamin B6 from a user engagement perspective. Data (n = 524) on participants' online behaviour (e.g., amount of clicks) were collected with Google Analytics during browsing on a website about vitamin B6. Participants were randomly assigned to one of the three conditions (no interactivity, moderate interactivity, high interactivity) of an online between-subjects experiment. Results showed that the effects of interactivity on recall depended on users' level of actual engagement (i.e., exploring the website content) with a website. In other words, the extent to which users actively explored the website (i.e., low, moderate, high) with the different (interactive) tools offered (e.g., dropdown-menu) resulted in significant differences in recall scores in the moderate and high interactivity conditions compared to the control condition. Users who were moderately or barely active, recalled significantly less information in the two experimental conditions compared to the non-interactive condition. Among highly active users no differences were found in recall scores in the three conditions. Across all levels of user activity (i.e., low, moderate, high) most information was recalled in the control condition. Herewith evidence was found that presenting information in a static manner is the most beneficial when the aim is to improve individuals' recall.

Finally, CHAPTER 8 provided a general discussion of the results of all the studies, including strengths and limitations, and recommendations for practice and future research. Intentions, health promotion focus, and social modelling were the most important socio-cognitive predictors of dietary supplement use. We explored and identified six different components of informed decision-making about dietary supplement use. Groups of decision makers showed different profiles with regard to the IDM components. Within each group, important target points of health education were identified (e.g., to decrease decisional uncertainty). With regard to online health communication about health benefits and risks of dietary supplements, we did not find evidence that interactivity would be a promising tool in terms of improving recall of health information.

SAMENVATTING

In Nederland gebruikt 42 procent van de algemene bevolking ten minste één soort voedingssupplement op reguliere basis. Echter, volgens de Richtlijnen Goede Voeding van de Gezondheidsraad is het alleen bij individuen die bij een risicogroep horen wetenschappelijk aangetoond dat ze bij supplementgebruik baat zouden hebben. In goed ontwikkelde welvaartslanden hebben individuen weinig kans op ziektes die worden veroorzaakt door een tekort aan micronutriënten (zoals bijvoorbeeld rachitis). Desondanks is het gebruik van voedingssupplementen nog nooit zo hoog geweest in Nederland en internationaal als nu. Om die reden is het noodzakelijk om te verkennen waarom supplementgebruik algemeen verspreid is. Bovendien, aangezien voedingssupplementen zowel voordelen als ook risico's met zich mee kunnen brengen voor de gezondheid, is het belangrijk om te onderzoeken hoe individuen beslissingen nemen over supplementgebruik en of deze beslissingen goed overwogen zijn in termen van het afwegen van de voor- en nadelen. Verder is het noodzakelijk om te onderzoeken hoe individuen kunnen worden geïnformeerd over voedingssupplementen via online communicatie.

Dit proefschrift is onderverdeeld in drie delen. Het doel van het eerste deel dat uit twee studies bestaat, was om te onderzoeken welke sociaal-cognitieve voorspellers geassocieerd zijn met supplementgebruik. Het tweede deel van dit proefschrift bestaat ook uit twee studies die als doel hadden om het concept geïnformeerde keuze (in het Engels: *informed decision-making*, IDM) te verkennen in de context van supplementgebruik. De laatste twee studies die bij het laatste onderdeel van dit proefschrift horen, hadden als doel om inzichten te verkrijgen hoe interactieve functies gebruikt zouden kunnen worden in online communicatie over voedingssupplementen.

Hoofdstuk 2 beschrijft de resultaten van een kwalitatieve studie waarvan de doelstelling was om de mening van gebruikers en niet-gebruikers van voedingssupplementen te exploreren en te vergelijken. Er zijn dertien focusgroep discussies gehouden waarvan 7 met gebruikers (n = 28) en 6 met niet-gebruikers (n = 28). Gebaseerd op het *Integrated Change Model* (ICM) werd er een semigestructureerde lijst van onderwerpen samengesteld. Er werden audio-opnames gemaakt van de discussies die later geanalyseerd waren door middel van systematische-interpretatieve inhoudsanalyse. De resultaten hebben aangetoond dat de positieve attitudes (pros) van gebruikers vooral gerelateerd waren aan het bevorderen van de mentale en fysieke gezondheid, het voorkomen van ziektes, en het genezen van ziektes. In tegenstelling tot gebruikers was de mening van niet-gebruikers vooral gerelateerd aan negatieve attitudes (cons): het gebruik van supplementen is overbodig omdat het menselijk lichaam geen ondersteuning nodig heeft in de vorm van voedingssupplementen. Het meest

opvallende verschil tussen de twee groepen werd gevonden in hun vertrouwen in gezondheidsdeskundigen en in de kwaliteit van voedsel. Gebruikers van voedingssupplementen waren grotendeels ontevreden met hun huisarts en ze waren bezorgd over de kwaliteit van voeding. Niet-gebruikers hadden juist een hogere mate van vertrouwen. Echter, beide groepen hadden vergelijkbare misconcepties, gaven vergelijkbare definities van wat een voedingssupplement is, en hadden een lage risicoperceptie over de mogelijke bijwerkingen.

In HOOFDSTUK 3 hebben we verder verkend welk soort sociaal-cognitieve factoren met supplementgebruik geassocieerd zijn. De voorspellers (determinanten) waren afgeleid uit de focus groep discussies en uit de ICM. In een longitudinaal vragenlijst onderzoek waren sociaal-cognitieve en psychosociale factoren op baseline (n = 1448) en op een follow-up meetmoment van een maand (n = 1161) gemeten bij gebruikers en niet-gebruikers van voedingssupplementen. De resultaten van de negatieve binomiale regressie analyse hebben een positief verband aangetoond tussen supplementgebruik en intentie, regulatieve focus over de gezondheid (promotie), sociale modelling, positieve attitudes (pros), risicoperceptie (kans op ziektes), en eigen-effectiviteit. Er werd een negatieve associatie gevonden tussen supplementgebruik en negatieve attitudes (cons), en externe beheersingsoriëntatie.

HOOFDSTUK 4 had de doelstelling om inzichten te krijgen over wat relevante componenten van geïnformeerde keuze zijn in het geval van supplementgebruik en welke communicatiefactoren IDM zouden bevorderen of belemmeren. In een Delphi studie bestaande uit drie rondes (n_{ronde1} = 38, n_{ronde2} = 89, n_{ronde3} = 51) werden experts van (risico) communicatie of van een verwant onderzoeksgebied gevraagd om (1) input te geven over wat zij als belangrijke eigenschappen van IDM beschouwen om (2) vervolgens elk genoemd IDM component te beoordelen in hoeverre het belangrijk is, en in hoeverre bepaalde factoren IDM zouden bevorderen of verhinderen. Experts waren het eens geworden dat de volgende zes factoren belangrijke eigenschappen zijn van IDM: (1) kennis hebben over de positieve én negatieve effecten van voedingssupplementen, (2) bekwaam zijn om deze effecten met elkaar te kunnen vergelijken, (3) kennis hebben over de alternatieven van supplementgebruik, (4) het gevoel hebben van geïnformeerd te zijn, (5) het gevoel hebben van het kunnen maken van een beslissing die (6) vrijwillig gemaakt moet worden. Daarnaast was er consensus bereikt over de volgende bevorderende factoren van IDM: informatie moet verstrekt worden over de positieve én negatieve effecten en de aard van de effecten inclusief wetenschappelijk bewijs, de informatie moet makkelijk toegankelijk, goed geordend en afgestemd zijn, en een betrouwbare, geloofwaardige en onafhankelijke bron moet de informatie verstrekken.

Hoofdstuk 5 richtte zich op de vraag hoe individuen beslissingen maken over het wel of niet gebruiken van voedingssupplementen. We hebben met name geëxploreerd of verschillende groepen van keuzemakers onderscheiden kunnen worden op basis van hun scores op de componenten van IDM. Op cross-sectionele data van 1161 respondenten werd een clusteranalyse toegepast. De resultaten duidden op drie afzonderlijke clusters van keuzemakers: (1) 'Onzekere keuzemakers met hoog gebruik van informatie', (2) 'Ongeïnformeerde keuze makers', en (3) 'Zekere keuzemakers met laag gebruik van informatie'. In elk cluster dat werd geïdentificeerd was IDM ontoereikend vanwege lage scores op één of meerdere componenten van IDM. Keuzemakers in het eerste cluster waren onzeker met lage kennis en hoge mate van discrepantie tussen attitude en gedrag. Individuen in het tweede cluster hebben informatie over voedingssupplementen geïgnoreerd, en informatiegebruik was laag in het derde cluster. Om IDM te verbeteren moeten de componenten waarop laag werd gescoord getarget worden met gezondheidscommunicatie (bijvoorbeeld lage kennis in de eerste cluster).

Hoofdstuk 6 heeft erop gefocust of het bevorderlijk is voor het onthouden van informatie om interactieve functies te gebruiken in online communicatie over de voordelen en risico's van vitamine B6. De studie heeft onderzocht door welke mechanismen interactiviteit een invloed zou hebben op het onthouden van gezondheidsinformatie. Hierbij hebben we ernaar gekeken of cognitieve betrokkenheid, gepercipieerde actieve controle, en cognitieve belasting de effecten van interactiviteit op informatieherinnering hebben gemedieerd. Er werd ook onderzocht of er verschillen waren in de mediaties tussen individuen met verschillende niveaus (laag versus hoog) van neiging tot nadenken en gezondheidsvaardigheden. Participanten van een online between-subjects experiment (n = 983) waren op basis van toeval aan één van de drie condities toegewezen die alleen in het aantal interactieve functies van elkaar verschilden (dat wil zeggen: controle conditie: geen interactieve functies, matig interactieve conditie: een interactieve functie, zeer interactieve conditie: twee interactieve functies). Matig en hoge interactiviteit hebben informatieherinnering via verlaagde cognitieve betrokkenheid gereduceerd. Tegelijkertijd werd informatieherinnering verhoogd door matige en hoge interactiviteit via toegenomen percepties van actieve controle. De gevonden effecten waren meer van toepassing op de groepen met een hoog niveau van neiging tot nadenken en gezondheidsvaardigheden, dan op de groepen die op deze kenmerken laag hebben gescoord. Naast de partiële mediaties werd een direct negatief effect van interactiviteit op informatieherinnering gevonden in alle analyses.

HOOFDSTUK 7 heeft vanuit een gebruikersbetrokkenheid-perspectief het effect van interactiviteit op informatieherinnering verder verkend. Tijdens een bezoek aan een website over vitamine B6 werden data (n = 524) over het online gedrag van participanten verzameld (bijvoorbeeld het aantal keren dat er geklikt werd) met behulp van Google Analytics. Participanten werden op basis van toeval toegewezen aan één van de drie condities (geen interactiviteit, matige interactiviteit, hoge interactiviteit) van een online between-subjects experiment. De resultaten lieten zien dat de effecten van interactiviteit op informatieherinnering afhankelijk zijn van de mate waarin gebruikers daadwerkelijk betrokken zijn geraakt met de website (dat wil zeggen: in hoeverre ze de website hebben verkend). Met andere woorden: de mate waarin gebruikers de website actief hebben verkend (laag, gemiddeld, hoog) met de verschillende (interactieve) mogelijkheden die werden aangeboden (bijvoorbeeld uitklapbaar keuzemenu) resulteerde in significante verschillen in de scores op informatieherinnering in de condities met matige en hoge interactiviteit, vergeleken met de controle conditie. Gebruikers die laag of gemiddeld actief waren, hebben zich significant minder informatie kunnen herinneren in de twee experimentele condities (matige en hoge interactiviteit) dan in conditie zonder interactiviteit (controle conditie). Bij gebruikers die zeer actief waren, zijn er geen significante verschillen gevonden tussen hun scores op informatieherinnering in de drie condities. Tussen alle niveaus van gebruikersactiviteit (laag, gemiddeld, hoog) was informatieherinnering het hoogst in de controle conditie. Hiermee werd bewijs gevonden dat het presenteren van informatie op een statische manier het meest bevorderend is als het doel is om informatieherinnering te verhogen.

Tot slot, in HOOFDSTUK 8 werd een algemene discussie gegeven over de resultaten van alle studies, inclusief de sterke punten, de beperkingen, en de aanbevelingen voor de praktijk en toekomstig onderzoek. Intentie, regulatieve focus van gezondheid (promotie), en sociale modelling waren de meest belangrijke sociaal-cognitieve voorspellers van supplementgebruik. We hebben zes verschillende componenten van geïnformeerde keuze over supplementgebruik geëxploreerd en geïdentificeerd. De groepen van keuzemakers toonden verschillende profielen met betrekking tot de componenten van IDM. In elke groep zijn de belangrijkste target punten voor gezondheidseducatie geïdentificeerd (bijvoorbeeld het verlagen van onzekerheid over de beslissing). Met betrekking tot online gezondheidscommunicatie over de voordelen en risico's van voedingssupplementen hebben we geen bewijs gevonden dat interactiviteit een veelbelovende tool zou zijn om informatieherinnering te verhogen.

ÖSSZEGZÉS

Hollandiában az általános népesség 42 százaléka szed rendszeresen legalább egy fajta táplálékkiegészítőt, viszont a Holland Egészségügyi Tanács Étkezési Irányelvei szerint a táplálékkiegészítőknek csak azon személyek esetében van igazolt hatásuk, akiknél fennáll a mikrotápanyagok súlyos hiánya okozta betegségek kialakulásának veszélye. Annak ellenére, hogy a fejlett jóléti államokban kevés az esélye annak, hogy az egyéneknél mikrotápanyag-hiányhoz köthető betegségek jelentkeznének (pl.: angolkór), mind Hollandiában mind nemzetközi viszonylatban a táplálékkiegészítők használata még soha nem volt olyan magas mint napjainkban. Éppen ezért van szükség arra, hogy megvizsgáljuk miért ilyen széleskörű a táplálékkiegészítők használata. Mivel a táplálékkiegészítők az egyén egészségére előnyös de akár hátrányos hatással is lehetnek, fontos, hogy megvizsgáljuk, hogy az egyének hogyan hoznak döntést a használatukról és hogy ezek a döntések jól megfontoltak-e az előnyök és a hátrányok mérlegelése szempontjából. Továbbá azt is szükséges megvizsgálni, hogy hogyan lehetséges az egyéneket online kommunikáció segítségével a táplálékkiegészítőkről felvilágosítani.

A doktori értekezés három részre van tagolva. A két tanulmányból álló első rész célja az, hogy megvizsgálja, hogy mely szocio-kognitív determinánsok állnak kapcsolatban a táplálékkiegészítők használatával (vagy elutasításával). Az ugyancsak két tanulmányból álló második rész célja az, hogy a tájékozott döntéshozást (angol szakkifejezéssel: *informed decision-making*) mint fogalmat vizsgálja a táplálékkiegészítők esetében. Az utolsó két tanulmány, amely a disszertáció utolsó részéhez tartozik, azt a célt tűzte ki, hogy betekintést nyerjünk miként lehetne interaktív elemeket alkalmazni a táplálékkiegészítőkről szóló online kommunikációban.

A 2. FEJEZET egy kvalitatív tanulmány eredményeit ismerteti, amelynek célja az volt, hogy megismerje és összehasonlítsa azoknak a véleményét, akik szednek és akik nem szednek táplálékkiegészítőket. A tizenhárom fókuszcsoport-beszélgetésből hetet azokkal tartottunk, akik táplálékkiegészítőket szedtek (n = 28) és hatot azokkal, akik nem szedtek (n = 28). Egy félig strukturált témasor lett összeállítva az *Integrated Change Model* (ICM) alapján. A beszélgetésekről hangfelvétel készült, amelyet rendszerező és értelmező tartalomelemzésnek vetettünk alá. Az eredmények arra mutattak rá, hogy a táplálékkiegészítők használóinak (pozitív) attitűdje a mentális és fizikai egészség előmozdításához, a betegségek megelőzéséhez, és a gyógyuláshoz köthetők. Ezzel ellentétben, akik nem használtak táplálékkiegészítőket, azoknak az állásfoglalása főleg a (negatív) attitűdhöz volt köthető: a táplálékkiegészítők használata felesleges, mivel az emberi testnek nincs szüksége semmilyen segítségre táplálékkiegészítők formájában. A két csoport között a legfigyelemreméltóbb különbséget a

háziorvosba és az élelmiszerek minőségébe vettet bizalom terén találtuk. A táplálékkiegészítők használói többnyire elégedetlenek voltak az egészségügyi dolgozókkal és aggodalmukat fejezték ki az élelmiszerek minőségével kapcsolatban, míg azok, akik nem használtak táplálékkiegészítőket, több bizalmat tanúsítottak. Viszont hozzá kell tennünk, hogy mindkét csoport hasonló téves ismeretekkel rendelkezett, hasonlóan definiálta, hogy mi az a táplálékkiegészítő, és enyhének értékelte a lehetséges mellékhatásokat.

A 3. FEJEZETBEN tovább vizsgáltuk, hogy mely szocio-kognitív faktorok állnak kapcsolatban a táplálékkiegészítők használatával. A fókuszcsoport beszélgetések és az ICM alapján választottuk ki, hogy mely determinánsokat vonjuk be a vizsgálatba. Egy longitudinális kérdőívben az alapmérés során szocio-kognitív és pszichoszociális determinánsokat mértünk ($n_{baseline}$ = 1448), majd a viselkedést egy hónap elteltével újra mértük a táplálékkiegészítők használói és nem használói körében ($n_{follow\text{-}up}$ = 1161). A negatív binomiális regresszió analízis eredményei pozitív összefüggést mutattak ki a táplálékkiegészítők fogyasztása és a cselekvési szándék, az egészségi regulációs fókusz (promóciófókusz), a szociális mintázás, a (pozitív) attitűd, a kockázatészlelés (a megbetegedés valószínűsége), és az én-hatékonyság között. Negatív összefüggést találtunk a táplálékkiegészítők használata és a (negatív) attitűd, valamint az külső egészségi kontrollhely között.

A 4. FEJEZET célja az volt, hogy betekintést nyerjen, hogy az informált döntéshozás milyen releváns komponenseket foglal magában a táplálékkiegészítők használatának esetében, valamint hogy mely kommunikációs tényezők segíthetik elő vagy éppen hátráltathatják az informált döntéshozást. Egy nemzetközi, három adatgyűjtési körből álló Delphi kutatásban ($n_{1.kör}$ = 38, $n_{2.kör}$ = 89, $n_{3.kör}$ = 51) a kockázat-kommunikáció és más kapcsolódó tudományok szakértőit arról kérdeztük, hogy (1) az informált döntéshozás mely jellemzőit tekintik fontosnak, majd ezt követően arra kértük őket, hogy (2) minden egyes említett jellemzőt osztályozzanak fontosságuk szerint, valamint, hogy a hátráltató és segítő tényezőkről állapítsák meg, hogy milyen mértékben hátráltatnak vagy segítenek. A szakértők az alábbi hat komponenst találták fontosnak: (1) ismerni kell a táplálékkiegészítők előnyeit és hátrányait, (2) ezeket az ellentétes hatásokat össze kell tudni vetni, (3) ismerni kell, hogy az étrend-kiegészítők használatának mely alternatívái léteznek, (4) fontos a jól informáltság érzete és (5) annak az érzete, hogy az illető képes meghozni egy döntést, valamint (6) a döntést önként kell meghozni. Mindezek mellett a szakértők konszenzust értek el abban is, hogy az alábbi tényezők elősegíthetik az informált döntéshozást: információt kell nyújtani a táplálékkiegészítők pozitív és negatív hatásairól, a hatások jellegéről és hogy mennyire vannak tudományosan alátámasztva. Fontos biztosítani, hogy az információ könnyen elérhető, jól rendszerezett, és egyénre

szabott legyen, valamint azt, hogy egy megbízható, hiteles és független forrás nyújtsa az információt.

Az 5. FEJEZET arra kereste a választ, hogy az egyének hogyan hoznak döntést az étrend-kiegészítők használatáról. Egész pontosan azt vizsgáltuk, hogy elkülöníthetők-e a döntéshozók különböző csoportjai az informált döntéshozás különböző komponensein elért értékeik szerint. Egy keresztmetszeti kérdőíves vizsgálat adatait (n = 1161) elemeztük klaszteranalízissel. Az eredmények arra mutattak rá, hogy a döntéshozók három különböző klaszterét lehet elkülöníteni: (1) „Bizonytalan, sok információt használók", (2) „Informálatlan döntéshozók", és (3) „Biztos, kevés információt használók". Az informált döntéshozás feltételei egyik azonosított klaszterben sem teljesültek, mivel a döntéshozók alacsony értéket értek el egy vagy több komponensen. Az első klaszter döntéshozói bizonytalanok voltak, kevés tudással rendelkeztek, és nagy volt az ellentmondás az attitűdjük és a tényleges viselkedésük között. A második klaszter tagjai figyelmen kívül hagyták az étrend-kiegészítőkről szóló információkat, míg a harmadik klaszter tagjai csupán csekély mértékben informálódtak. Annak érdekében, hogy az informált döntéshozást elősegítsük, az egészséggel kapcsolatos felvilágosításnak azokat a komponenseket kell célba vennie, amelyek alacsony értékeket mutattak (pl.: alacsony tudás az első klaszterben).

A 6. FEJEZET arra fókuszált, hogy az emlékezés szempontjából előnyös-e ha interaktív elemeket alkalmazunk a B6 vitamin előnyeiről és kockázatairól szóló online kommunikációban (weboldal). Azokat a mechanizmusokat vizsgáltuk, amelyeken keresztül az interaktivitás befolyásolhatja az információra történő emlékezést. Egész pontosan azt vizsgáltuk, hogy a kognitív elmélyülés, (a tartalom felett) tapasztalt aktív kontroll, és a kognitív terhelés mediáló (avagy közvetítő) befolyással bír-e az interaktivitás emlékezetre kifejtett hatására. Emellett azt is vizsgáltuk, hogy ezekben a folyamatokban megfigyelhető-e eltérés az egyének különböző szintű megismerési szükséglete és egészségi készsége szerint. Egy online *between-subjects* (kontrollcsoport terv) kísérlet résztvevőit véletlenszerűen osztottuk be három lehetséges kondíció egyikébe, amelyek csak az interaktivitás mértékében tértek el egymástól (kontroll kondíció: nincs interaktív elem, közepes interaktivitás: egy interaktív elem, magas interaktivitás: két interaktív elem). A közepes és magas interaktivitás csökkentette az emlékezést, amelyben közvetítő szerepet játszott a csökkent mértékű kognitív elmélyülés. Ezzel egyidejűleg az interaktivitás növelte is az emlékezést, a növelt mértékű aktív kontrollon keresztül. Ezek a hatások azoknál jelentkeztek inkább, akiknek a megismerési szükséglete és egészségi készsége magasabb szintű volt, összehasonlítva azokkal akik alacsonyabb értékeket értek el ezekre a jellemzőkre. Az interaktivitás nem

csak közvetett (mediáló), hanem közvetlen, negatív hatással is bírt az emlékezetre minden elvégzett analízisben.

A 7. FEJEZET a felhasználói elköteleződés szempontjából vizsgálta tovább azt, hogy az interaktivitás hogyan befolyásolja, hogy a felhasználók mennyire emlékeznek a B6 vitaminról és annak az egészségre kifejtett hatásáról szóló információra. A Google Analytics segítségével 524 résztvevő online viselkedéséről (pl.: kattintásokról) gyűjtöttünk adatokat amíg egy B6 vitaminról szóló weboldalon böngésztek. A résztvevőket véletlenszerűen osztottuk be egy online *between-subjects* kísérlet három lehetséges kondíciójából az egyikbe: interaktivitás nélküli kondíció (kontroll csoport), közepes interaktivitás, magas interaktivitás. Az eredmények arra mutattak rá, hogy az interaktivitás hatása az emlékezetre a felhasználók ténylegesen megfigyelt elköteleződésétől függött. Ez az elköteleződés a weboldalon tanúsított viselkedésükben nyilvánult meg. Másként fogalmazva: a kontroll kondíciót összehasonlítási alapul véve megállapíthatjuk, hogy a közepesen és magasan interaktív kondícióban az, hogy a felhasználók milyen mértékben ismerkedtek meg a weboldallal (alacsony, átlagos, magas felhasználói aktivitás) a különféle (interaktív) eszközök használatán keresztül (pl.: legördülő menü), az emlékezet tekintetében szignifikáns különbségekhez vezetett. Azok a felhasználók, akik csak alacsony szinten, vagy átlagosan voltak aktívak, szignifikánsan kevesebb információra emlékeztek a két kísérleti kondícióban (közepes és magas interaktivitás), mint a kontroll kondíció résztvevői. Nem találtunk szignifikáns különbséget az emlékezet tekintetében azon felhasználók között, akik mind a három kondícióban nagy aktivitást mutattak. A különböző aktivitású résztvevők (alacsony, közepes, magas) a kontroll kondícióban emlékeztek a legtöbb információra. Ezáltal bizonyítékot találtunk arra, hogy az információ statikus prezentációja a legalkalmasabb az emlékezet elősegítésére.

Végezetül a 8. FEJEZETBEN minden kutatás eredménye áttekintésre került, beleértve a kutatások előnyös és gyenge pontjait, valamint gyakorlati és tudományos javaslatokat is nyújtottunk. Az étrend-kiegészítők használatának legfontosabb szociális-kognitív determinánsai a cselekvési szándék, az egészségi regulációs fókusz (promóciófókusz), és a szociális mintázás voltak. Az informált döntéshozás hat különböző komponensét határoztuk meg. A döntéshozók csoportjai különböző profillal rendelkeztek az informált döntéshozás komponenseit illetően. Minden azonosított csoporton belül meghatároztuk, hogy az egészséggel kapcsolatos felvilágosításnak mit kell célpontba vennie (pl.: a bizonytalanság csökkentése döntéshozáskor). Ami a táplálékkiegészítők előnyeiről és hátrányairól szóló online kommunikációt illeti: nem találtunk bizonyítékot arra, hogy az interaktivitás ígéretes eszköz lenne arra, hogy elősegítsük az egyének egészséggel kapcsolatos információra történő emlékezetét.