Health communication with adolescents and young adults to promote healthy eating

Helse formidling rettet mot ungdom og unge voksne for å fremme et sunt kosthold

Philosophiae Doctor (PhD) Thesis

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Preface

The work consists of a theoretical introduction and four scientific papers discussing efforts to enhance health communication with adolescents and young adults. The roles of nutrition labels in healthy food evaluation and healthy food choices were investigated in two papers. The third paper studied health information in diet and physical activity applications as an innovative way to promote health communication. The role of health communication in school environment was evaluated in the last paper.

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Summary

Enhancing health communication with adolescents and young adults for health promotion, including a healthier diet, is essential. Nutrition labeling, applications (apps), and school environment are three channels for health communication. Using nutrition labels for making healthy food choices, using health apps for healthy eating and physical activity, and health communication at schools were investigated by four studies.

Paper I investigated which nutrition labels adolescents checked and used to evaluate the healthiness of food products using an in-house computer program. This study included the participation of 176 adolescents, age 16 to 20, from six Norwegian high schools. They evaluated the healthiness of food products based on the information they accessed through food labels in an online tool. Adolescents were able to check nutrition information to evaluate the healthiness of food products. They were interested in simple nutrition information, but not familiar with some quantitative nutrition information, such as percentage daily value. Simplified nutrition information tailored to adolescents may be helpful in evaluating the healthiness of food products.

Paper II identified whether the Keyhole symbol affected Norwegian adolescents' perception of the healthiness of snacks and their intention to buy them. It also examined adolescents' ability to correctly use percentage daily values (%DVs). A total of 566 Norwegian adolescents completed two tasks to indicate their taste perception and health perception of snacks with the Keyhole symbol, with %DVs, or with no nutrition label. A third task, pairwise selections of products, tested whether they could use %DVs to identify healthier food products. The Keyhole symbol increased health perception without influencing the taste perception of snacks. Norwegian adolescents had limited abilities to use information from the %DVs.

Paper III identified how diet and physical activity apps affected their users, through semi-structured focus group discussions and a questionnaire. Three semi-structured focus group discussions about app usability were conducted with 15 app users and 8 non-users. Results from the discussions were used to develop a questionnaire, which was answered by 500 Norwegian young adults. App usage influenced action, conscientiousness, self-education about

nutrition and physical activity, and social life. Over half of the users perceived that apps were effective in assisting them to eat healthier and to exercise more. Using apps facilitated the maintenance of a healthy diet and more exercise.

Paper IV explored experts' opinions about school interventions in the promotion of healthy eating. A survey collected experts' attitudes and opinions about school interventions that used three strategies (law, education, and marketing). The experts thought that education about nutrition and healthy eating at school was necessary, but not sufficient. They thought that food availability and accessibility at school were also very important. For future school interventions, the experts suggested multicomponent interventions that combine two or more intervention strategies.

Sammendrag

Å styrke kommunikasjon om helse mot ungdom og unge voksne om et helsefremmende levesett, herunder et sunnere kosthold, er viktig. Ernærings etiketter, applikasjoner (apper), og skolemiljø er tre kanaler der man kan jobbe med helsekommunikasjon. Bruk av ernærings etiketter for et sunt mat valg, helse apper for å spise sunnere og trene mer, og helsekommunikasjon på skoler, ble undersøkt i fire studier.

I **Artikkel I** ble det undersøkt ved hjelp av et in-house dataprogram, hvilke ernærings etiketter ungdom undersøkte og brukte til å vurdere sunnheten av matvarer. I denne studien deltok 176 ungdom i en alder av 16 til 20 år, fra seks norske videregående skoler. De evaluerte sunnheten av matprodukter basert på informasjonen de fikk tilgang til via mat etiketter i et nettbasert verktøy. Ungdommene var i stand til å sjekke informasjon om ernæring for å vurdere sunnheten av matvarene. De var interessert i enkel ernærings informasjon, men var ikke kjent med noen kvantitativ ernærings informasjon, som anbefalt prosent daglig inntak av næringsstoffer. Forenklet ernærings informasjon som er skreddersydd for ungdom, kan være et nyttig verktøy for at denne gruppen kan vurdere sunnheten til matvarer.

I **Artikkel II** ble det undersøkt om Nøkkelhull-symbolet påvirker norske unge sin oppfatning av sunnheten til snacks samt deres intensjon om å kjøpe disse. Det ble også undersøkt hvilken evne de unge hadde til korrekt bruk av prosent daglig inntak (% DVS). Totalt 566 norske ungdommer fullførte to oppgaver som ga en indikasjon på deres smaks- og helseoppfatning av snacks med Nøkkelhull symbolet, med % DVS, eller uten ernærings etikett. En tredje oppgave, gjennomført med parvise utvalg av produkter, testet om de kunne bruke % DVS for å identifisere sunnere matvarer. Nøkkelhull-symbolet økte oppfatningen av sunnhet uten å påvirke smaks oppfatningen av snacks. Norsk ungdom hadde begrenset evne til å bruke informasjonen gitt i % DVS.

Artikkel III Identifiserte hvordan apper om kosthold og fysisk aktivitet påvirket brukeren. Dette ble gjort gjennom semi-strukturerte fokusgruppe diskusjoner og spørreskjema. Tre semi-strukturerte fokusgruppe diskusjoner om appene sin brukervennlighet ble gjennomført med 15 app brukere og 8 ikke-app brukere. Resultater fra diskusjonene ble brukt til å utvikle et

spørreskjema som ble besvart av 500 unge norske voksne. App bruk påvirket handling, bevissthet, selv opplæring om ernæring og fysisk aktivitet, og sosialt liv. Over halvparten av brukerne mente at apper var effektive i å hjelpe dem til å spise sunt og å trene mer. Bruk av apper tilrettelegger for opprettholdelse av et sunt kosthold og mer mosjon.

I **Artikkel IV** ble ekspertenes meninger om tiltak i skolen for å fremme inntak av sunn mat utforsket. En undersøkelse som brukte tre strategier (lovgivning, utdanning, og markedsføring), samlet ekspertenes holdninger og meninger om skole intervensjoner. Ekspertene mente at utdanning om ernæring og sunt kosthold på skolen var nødvendig, men ikke tilstrekkelig. De trodde at tilgjengelighet av mat på skolen også var svært viktig. For fremtidige skoleintervensjoner, foreslo ekspertene multikomponent intervensjoner som kombinerer to eller flere intervensjon strategier.

List of papers

I. Qing Wang, Marije Oostindjer, Gro V. Amdam, Bjørg Egelandsdal. Use of nutrition information on labels by adolescents when evaluating the healthiness of new food products. Submitted to British Food Journal.

II. Qing Wang, Marije Oostindjer, Gro V. Amdam, Bjørg Egelandsdal. Snacks With Nutrition Labels: Tastiness Perception, Healthiness Perception, and Willingness to Pay by Norwegian Adolescents. Journal of Nutrition Education and Behavior. 2016;48(2):104-111. DOI: 10.1016/j.jneb.2015.09.003.

III. Qing Wang, Bjørg Egelandsdal, Gro V. Amdam, Valerie Lengard Almli, Marije Oostindjer. Diet and Physical Activity Apps: Perceived Effectiveness by App Users. JMIR mHealth and eHealth. 2016;4(2):e33. DOI: 10.2196/mhealth.5114.

IV. Qing Wang, Marije Oostindjer, Gro V. Amdam, Bjørg Egelandsdal, Ellen van Kleef. Promoting healthy eating behavior at school: Experts' opinions about promising intervention strategies. Submitted to Journal of School Health.

Abbreviations

NNR	Nordic Nutrition Recommendations
EU	European Union
FOP	Front-of-Package
%DV	Percentage daily value
FDA	The US Food and Drug Administration
App	Application
PA app	Physical activity app
ANOVA	Analysis of variance

Contents

Papers (individual numbering)

1. Introduction

1.1. Healthy eating

The high prevalence of overweight and obesity has drawn much attention in recent decades. Worldwide, more than 2.8 million people die each year due to the consequences of overweight and obesity [1]. Overweight and obesity are associated with increased rates of hypertension, diabetes, and dyslipidemia, and increased risks of breast cancer, colon cancer and other medical conditions [1, 2]. This is not limited to adults. A growing global childhood obesity epidemic has been observed [3, 4]. According to the Norwegian Public Health Report 2014, one in six children was overweight or obese [5]. Overweight and obesity during childhood and adolescence can have both short-term and long-term consequences. Obese children and adolescents may suffer from hyperlipidemia, hypertension, and abnormal glucose tolerance [6], and are likely to become obese adults and suffer other health problems as a result [7].

Engaging people in healthy eating and regular physical activity can lower their risk of obesity [8-10]. This thesis mainly focuses on promotion of healthy eating. Healthy eating throughout life helps people prevent overweight and obesity [11]. Healthy eating in this thesis is defined as consuming the right quantities of food from all food groups. However, it is not easy for people to develop and maintain healthy eating habits. Many factors can influence healthy eating behavior, such as personal knowledge, personal attitude, social environment, and food environment [12].

1.1.1. Theories regarding healthy eating behavior

The Theory of Planned Behavior offers a theoretical framework for the link between attitude and behavior [13, 14]. According to this theory, three constructs - attitude towards the behavior, perceived behavioral control, and subjective norms, determine behavioral intention. Attitude toward the behavior is an individual's positive or negative evaluation of self-performance of the behavior. Perceived behavioral control is the individual's perception of how easy or difficult they find it to perform a healthy eating behavior. The subjective norm is the

perception about healthy eating behavior, which is influenced by judgment from others, such as friends or family. The stronger the behavioral intention, the more likely that people will have healthy eating behavior [15].

Another prominent health behavior theory, the Social Cognitive Theory, points to an important determinant, the food environment. The theory explains how people acquire and maintain behaviors [16-18], and evaluates behavioral change depending on the environment [19-21]. The food environment is physically external to people; it determines what kind of food products people can access, and hence influences people's abilities to successfully complete their behavioral intent.

In sum, when a person has a favorable attitude to a healthy eating behavior, feels capable to perform this behavior, perceives that others want him or her to perform this behavior, and is exposed to a food environment that enables him or her to perform the behavior, he or she will adopt the healthy eating behavior [22, 23]. Figure 1 shows a model that has been adapted from the two above-mentioned theories in order to explain key factors in healthy eating behavior.

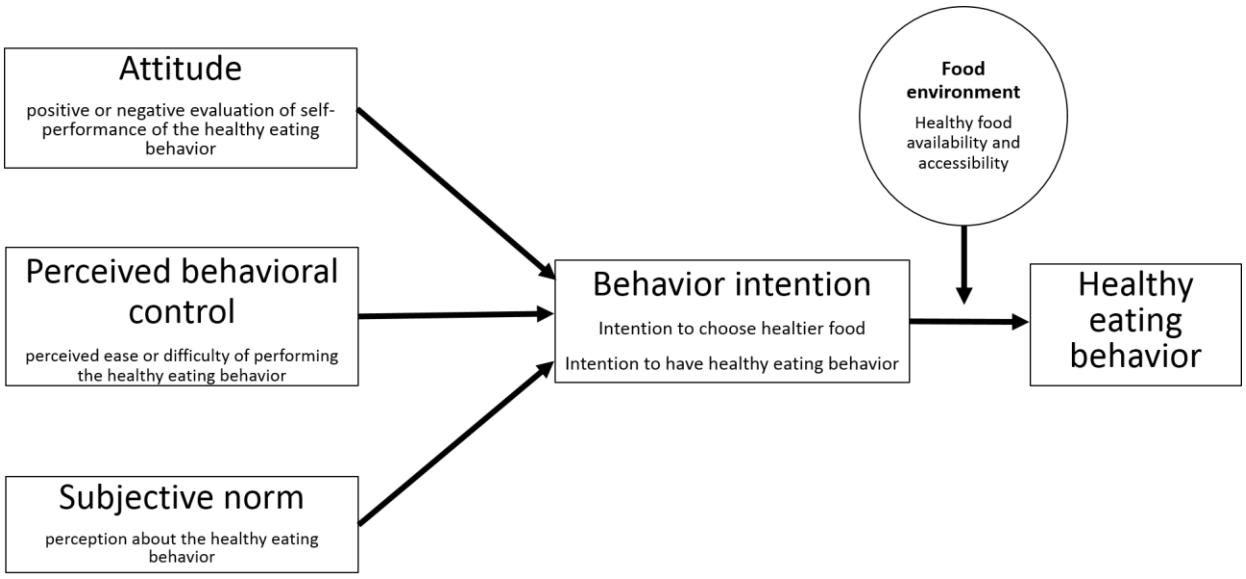

Figure 1. A model that shows the key factors in healthy eating behavior, based on the Theory of Planned Behavior and the Social Cognitive Theory.

1.1.2. Healthier food choices

Nowadays, people are exposed to an environment that contains a large number of high energy foods with little or no micronutrients; e.g. soft drinks and fast foods. In this food environment, it is not easy to eat healthy, and consumption of relatively unhealthy food has become common [24]. People need to focus on making healthier food choices [25], for example, they should swap unhealthy and high-energy food choices, such as fast foods, processed food, and soft drinks, for healthier choices, such as lean meats, whole grains, fruits, and vegetables. Nutrition recommendations are some of the tools that people can use to guide their food choices.

The Nordic Nutrition Recommendations (NNR) are based on the Nordic food culture [26]. They were established in 1980 by the five Nordic countries (Norway, Denmark, Sweden, Finland, and Iceland), which still work together to update it every eight years [26, 27]. NNR focuses on dietary patterns and determines recommended nutrient intakes. It gives dietary recommendations, and recommendations for adequate levels of physical activity. Examples of nutrition recommendations and dietary recommendations in the latest version of NNR 2012 are shown in Figure 2 [28, 29]. The NNR 2012 is used as the definition of healthy eating in this thesis.

However, as may be deducible from Figure 2, it may be hard to understand and to use the nutrition recommendations in practice. Nutrient percentages of energy intakes, or nutrient content in mg or grams is not easy to understand. In contrast to nutrition recommendations, food-based dietary guidelines are simple messages that may promote healthy eating. They include recommendations on what a person should be eating in terms of food groups or products, rather than on nutrients, when planning meals [30].

Generally, there are two types of food-based dietary guidelines – a list of food-based messages, and food messages presented in graphics. The list of food-based messages contains multiple bullet points about how to eat healthy. Countries usually have different lists, because of differences in food culture and food availability. Graphic messages illustrate the proportions of the diverse food products or groups that should be included in a healthy balanced diet. They come in a variety of formats: food pyramids, plate/circle, compass, house, and so on [30].

Nutrition recommendations

- Recommended intake for total fat intake is 25-40 E%.
- Recommended intake for dietary fiber is at least 25-35 g/d (>3 g/MJ) from foods naturally rich in dietary fiber foods such as whole grain, fruit and berries, vegetables, and pulses.
- Recommended intake for total carbohydrates is 45-60 E% .
- For protein, the recommendations are given both as population ranges expressed as E% (10-20 E%) and as a recommended intake in g/kg BW per day.
- The Recommended Intake (RI) for vitamin D is increased from 7.5 microgram to 10 microgram per day for children above 2 and adults and to 20 microgram per day for elderly > 75.
- For physical activity, recommendations are given for time spent at moderate-intensity (>150 min/week) or vigorous intensity (> 75 min/week) for adults and at least 60 min/day moderate- and vigorous intensity, equally distributed, for children.

Dietary recommendations

Ok	Change		Reduce
Vegetables Legumes	White flour	→ Wholemeal	Processed meat Red meat
Fruits Berries	Butter	→ Vegetable oils	Soft drinks Food with added sugar
Fish Seafood	High-fat milk products	→ Low-fat milk products	Salt
Nuts Seed			Alcohol

Figure 2. Examples of nutrition recommendations and dietary recommendations in the Nordic Nutrition Recommendations 2012.

The food pyramid is the most commonly used graphic format across countries. A pyramid-shaped diagram presents the optimal number of servings from each of the basic food groups to be eaten everyday (Figure 3). The food pyramid is divided into basic foods at the base, including milk, cheese, margarine, bread, cereals and potatoes; a large section of supplemental vegetables and fruit; and an apex of supplemental meat, fish and eggs. The different food pyramids are updated according to new insights in nutrition [31] or because of new demands in public health [32]. In addition, pyramids have also been developed for specific target groups, such as elderly people [33]. The food pyramid has been used in most European countries [30], in the US (from 1992 to 2011) [34, 35], and in other countries around the world. The plate is another common graphic representation of dietary guidelines. The plate is divided into food group sections, and the size of the section represents the proportion of the meal that should consist of that particular food group (Figure 3) [36, 37]. The plate has been used in some European countries, such as the UK and Finland, while the US started to use the plate instead of the pyramid in 2011.

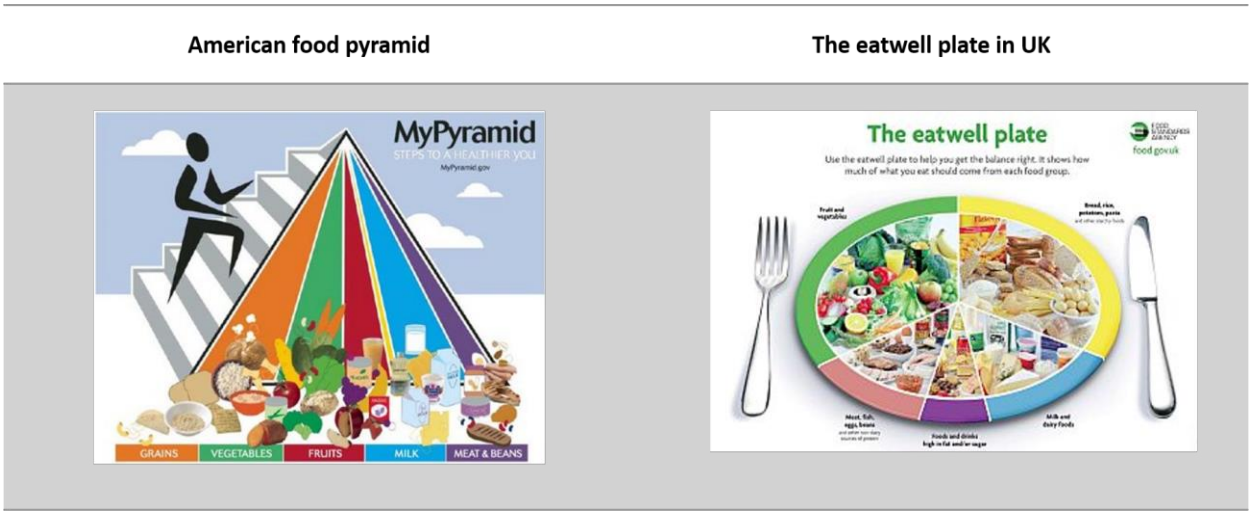

Figure 3. Examples of food-based dietary guidelines in graphic formats.

In sum, with the goal of healthy eating, people need to choose their daily food to meet nutrition recommendations and dietary guidelines. Choosing healthier foods is essential and good communication about healthier food choices is therefore necessary.

1.2. Health communication

Health communication is the study and use of communication strategies to inform and influence individual decisions that enhance health [38]. It disseminates promotional health information through, for instance, health education or public health campaigns [39]. It conveys health information between patient and doctor, the public and public health institute, student and teacher, and so on. The purpose of health communication is to influence personal health choices, and can be relevant to every aspect of health and well-being. It benefits overweight and obesity prevention [40]. The scope of health communication includes disease prevention, health promotion, healthcare policy, enhancement of the quality of life, and health of individuals in the community [41, 42].

The International Communication Association officially recognized health communication in 1975, and it was categorized as a discipline of Public Health Education and Health Promotion in 1997 [43]. Research in health communication aims to identify and provide effective and efficient communication strategies to improve the overall health of the society [43, 44]. Such research includes the development of effective health messages, the dissemination of health information through broadcasts, print, and media, and the role of interpersonal relationships in health communication.

Health communication is an intervention that focuses on the transmission of information exchange [45]. Considering the transmission of health communication, it is reasonable to think carefully about the channels through which health information is disseminated, who the target audiences are, and how the target audiences respond to the intervention messages [46]. However, designing health communication that can efficiently transmit health information is not an easy task.

The process of designing effective health communication can be explained by the McGuire's communication/persuasion matrix [46-48]. This model consists of 5 input communication factors and 13 output persuasion steps (Figure 4) [49]. It is a simplistic sum of inputs and outcomes of the communication, which reflects the process of how people are persuaded.

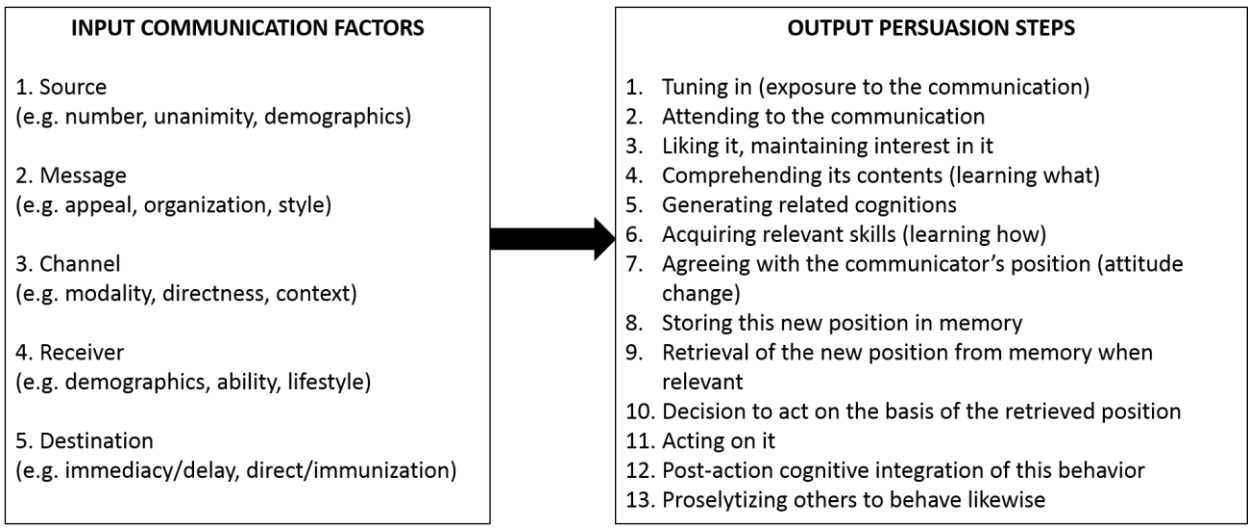

Figure 4. Input communication factors and output persuasion steps in designing of health communication, adopted from McGuire's communication/persuasion matrix.

Table 1. Six phases and key steps to design a science- and audience-based health communication intervention.

Phases	Key steps
1	Review background information to define the problem Set communication objectives
2	Analyze and segment target audiences
3	Develop and pretest message concepts Select communication channels Select create and pretest messages and products
4	Develop promotion plan
5	Implement communication strategies and conduct process evaluation
6	Conduct outcome and impact evaluation

There are multiple paths from the input to the outcomes. It offers a primary insight into the factors necessary to design effective health communication.

Effective health communication functions when the target audiences have achieved, acted on or responded to the health information. To have effective communication, six phases and key steps are suggested by the US Centers for Disease Control and Prevention (Table 1) [50, 51].

Even though the guidelines are useful, it is still very difficult in practice to design and to conduct effective health communication. No existing health communication can guarantee healthy eating behavior. How to effectively create an impact on the target audiences still needs further discussion.

1.3. Health communication for healthy eating

Health communication related to diet aims to educate the public about the importance of a healthy diet and motivate them to eat healthier, create supportive environments for healthy eating, and eventually change social norms of diet and health [52]. In order to sufficiently communicate healthy eating and healthier food choices to target audiences, health communication messages and channels are two important issues that need to be considered and evaluated. Choosing an appropriate message and a suitable channel to convey to the target audiences is the core of effective health communication.

Three health communication channels are discussed in this thesis:

- *Nutrition labeling* is a channel used to communicate nutrition information that consumers can use to make healthier food choices [53]. In order to make correct and understandable information available to consumers, the European Union (EU) has provided a complex legal framework about nutrition labeling to provide consistent and usable labels that can help consumers make healthier food choices [54, 55]. It recommends daily nutrient allowance, energy conversion factors and definitions [56]. Norway adheres to the EU regulation on food labeling [57].

Nutrition labels include Nutrition Facts Label, label claims, and Front-of-Package (FOP) labels. The Nutrition Facts Label is a panel on the food package that provides detailed information about a food product's nutrient content, such as the amount of fat, sodium, and carbohydrates. It is commonly found on the back of the package. Percentage daily value (%DV) is optional information in the Nutrition Facts Label, which corresponds to the percentage of the daily requirements or allowance for a particular nutrient based on a 2000-calorie diet. The information in the Nutrition Facts Label helps people, for example, restrict fat and salt intake, or get enough minerals and vitamins.

Most of the pre-packaged foods in the EU now have the Nutrition Facts Label. Information about energy value and six nutrients (total fat, saturated fat, carbohydrate, sugar, protein and salt) on pre-packaged foods will become mandatory in the EU in December 2016 [58]. The EU's provision of the Nutrition Facts Label is very similar to the one in the US [59]. The US label has seen some recent changes: The US Food and Drug Administration (FDA) first proposed changes to the Nutrition Facts Label in 2014. In July 2015, the FDA issued a supplemental proposed rule for %DV and changing the footnote in this label [60]. The original and the proposed formats are shown in Figure 5 [60-64].

Label claims include health claims and nutrition claims. The health claim can be any statement about a relationship between the food product and health [62]. The nutrition claim is any claim that states, suggests or implies that a food has particular beneficial nutritional properties [63]. Consumers' reactions to health claims vary. Their reactions are influenced by the provision of the information (such as framing of the claims) and personal attributes (such as experienced disease states or country of residence) [65-67]. Label claims should follow national or international food labeling regulations when they appear on food packages. According to the EU regulation, label claims are voluntary. In the Norwegian food market, label claims are very limited.

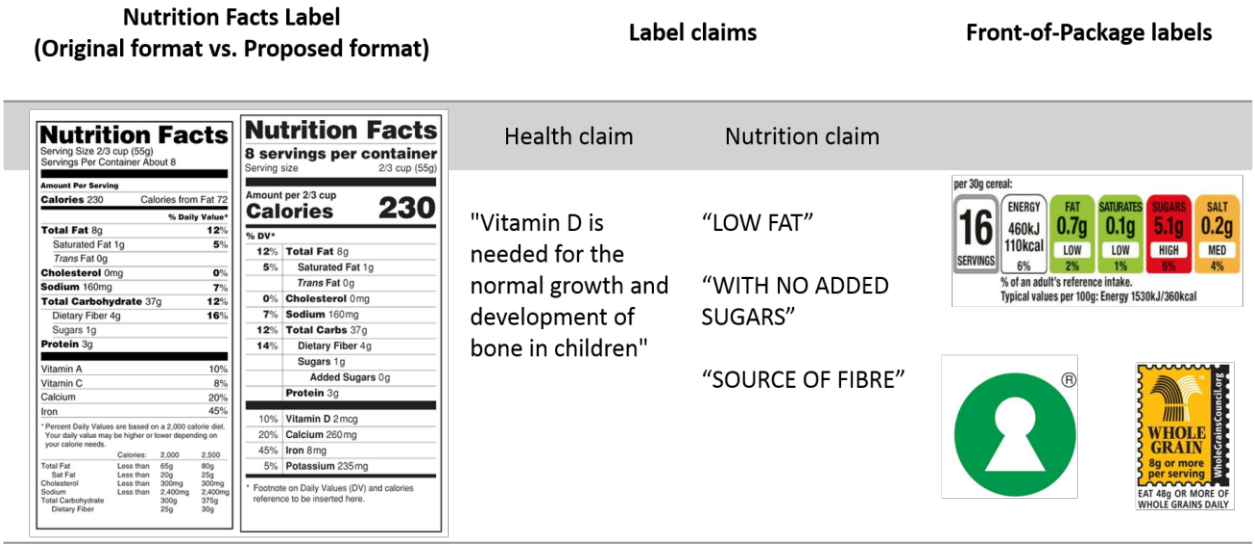

Figure 5. Examples of nutrition labels – Nutrition Facts Label, Label claims, and Front-of-Package labels.

FOP labels were first introduced in the late 1980s by non-profit organizations and government agencies, and since then have been further developed by the industry. FOP labels are voluntary labels in the EU. In Norway, FOP labels can often be seen on packaged food. There are three common types of FOP labels – nutrient-specific FOP labels (such as traffic-light labels, the first example of FOP labels in Figure 5), summary indicator FOP labels (such as the Keyhole symbol, the green symbol in Figure 5), and food group information FOP labels (such as “whole grain” labels, the yellow label in Figure 5) [64]. FOP labels, in general, can help consumers identify healthier foods [68-70]. Adult consumers prefer FOP labels over the Nutrition Facts Label, since the former is simplified nutrition information that does not require advanced nutrition knowledge or high cognitive capacity from consumers [71, 72].

A unique FOP label in the Nordic countries is the Keyhole symbol. It was introduced in Sweden in 1989 [73]. Foods labeled with this symbol contain less fat, sugar and salt, and more dietary fiber, than comparable foods without the symbol. For more than 20 years, the Keyhole symbol has been widely used in Sweden [74]. Since 2009, the authorities in Norway, Sweden, and Denmark have joined forces in using this symbol as a joint nutrition label to

make it easier for Nordic consumers to choose healthier foods [73, 75]. Using the Keyhole symbol is recommended in the NNR 2012 to support healthy eating. Over 90% of Nordic adult consumers recognize the Keyhole symbol [76]. However, consumers may not fully understand the concept and the meaning of the Keyhole symbol. In addition, for a specific target group, for instance, adolescents, it is unknown how they perceive the Keyhole symbol, how they perceive food products with the Keyhole symbol, and how well they can use the Keyhole symbol to choose healthier foods. Whether the Keyhole symbol can be a good tool to communicate health information towards a specific targeted audience is therefore worth investigating.

- *Applications (apps)* on smartphones, tablets, and computers have become popular with the rapid development of information technologies in the last decade. With the launch of the iPhone in 2007 and the quick development of other smartphones, consumers have easy access to a tremendous amount of health information [77]. Health apps are internet-based communication, and have attracted more and more attention recently [78].

  Health apps are a new channel of health communication, and provide rich ground for health promotion and for new research [77]. Disseminating information through smartphones has shown some positive effects in promoting healthy behavior. For instance, periodic prompts by sending text messages can effectively assist in adopting healthy behaviors and facilitate changes in individuals with unhealthy practices [77, 79]. Health apps deliver various health information, such as medical information, diet information, and physical activity information. It has the potential to affect users' eating behavior and physical activity behavior.

  Health apps may offer functions such as tracking and calculations. This thesis focuses only on two kinds of health apps (Figure 6) [80, 81], because they are tools to communicate healthy eating and physical activity information to users. Diet apps track energy intake and physical activity (PA) apps track energy expenditure. In detail, app users can use diet apps to track calories and nutrients, monitor food intake, and calculate body mass index. Using diet apps can facilitate healthy eating. PA apps can track exercise routes, calculate energy

expenditure, give training tips, and allow users to share physical activity results on their social network. PA apps can be used to increase physical activity. By using these health apps, users get feedback immediately, they evaluate their own performance, and then they can modify their actions according to the evaluation. Therefore, users take ownership in this health communication process.

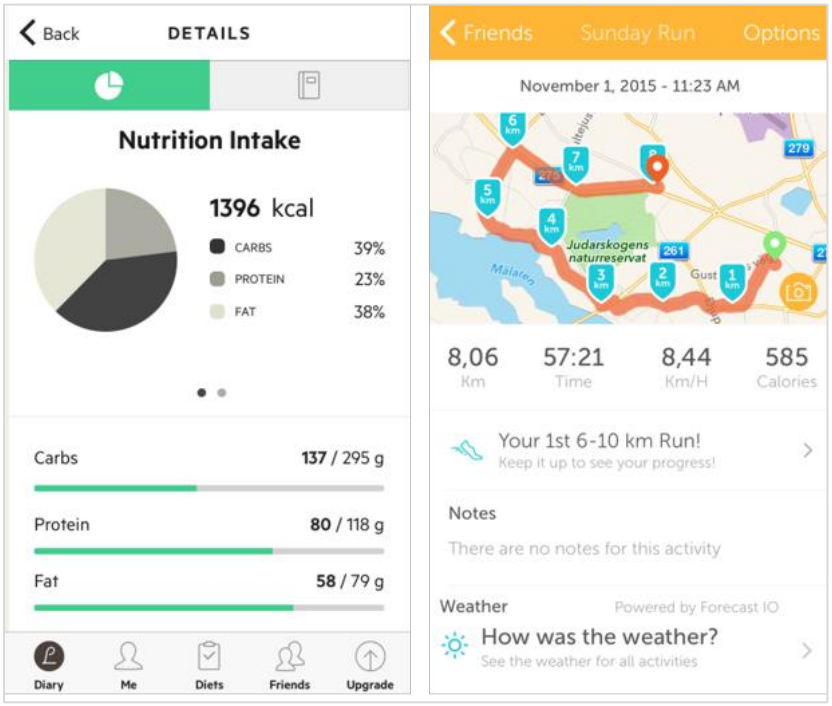

Figure 6. Screenshots of a commercial diet app (the left hand side, Lifesum, ShapeUp Club AB, Sweden) and a commercial physical activity app (the right hand side, Runkeeper, FitnessKeeper Inc., Boston, MA).

However, the effectiveness of using health apps in promoting healthy behavior is still unknown. Apps are developed by people who are not experts in health communication and health promotion. Therefore, app studies mostly evaluate the apps' contents [82, 83]. Information about how people use those apps in their daily routines and what their opinions and attitudes are towards the apps is limited. A proper evaluation is needed to examine whether the use of health apps can affect health communication outcomes. A

discussion of people's opinions about health apps, and more experiments that aim to evaluate apps' impact on behavior are necessary.

- *School environment* is an important food environment for health communication with school students. Students consume a large portion of their daily energy at school through lunches, snacks, and sometimes breakfast, which makes conducting health promotion programs at school very convenient. Usually, governments, educators, and/or researchers lead health communication programs at school. For example, schools can establish policies and implement interventions to promote healthy eating through changing the foods and beverages offered at school [84]. There are many other school interventions that target healthy eating, such as nutrition education, cooking, gardening, school fruit programs, and so on [85-90]. School is a good environment in which to disseminate information about healthy eating [91].

  School interventions can be categorized into educational interventions, single interventions, and multicomponent interventions [92]. Educational interventions are very common interventions at school, and may help to improve the students' knowledge of nutrition and guide the students' attitudes towards healthy food and healthy eating. Single interventions involve the modification of a single factor in the environment to promote healthy eating, such as fruit intake, vegetable intake, or preference of healthy food. Multicomponent interventions involve the modification of multiple factors in the environment. They can promote healthy food consumption as well as physical activity. Such interventions can focus on energy balance in order to prevent overweight and obesity.

  Previous studies have shown that multicomponent interventions are generally more successful than single interventions [93, 94]. However, in some cases, single component interventions can prove successful. One example is the free fruit and vegetable program in Norwegian middle schools (age 13-16 years). This program offered one piece of fruit or carrot to students daily. The intervention was reported to increase fruit consumption and decrease the frequency of consumption of unhealthy snacks [95-98]. Another study included an education program in addition to a free school fruit program, but did not

improve fruit and vegetable intake as assessed in a 2-year follow-up [99]. In this case, a multicomponent intervention was not more successful than a single component intervention. There were several possible reasons for this; for instance, the health information that was delivered in the education program was not designed according to the guidelines. Students' knowledge may increase due to health communication programs at school, but how students react to the health information and whether they are able and would like to use the knowledge to guide their actions are still in question. Personal ability in using health information for healthy eating is another important part of health promotion - students need efficient health literacy to conduct healthy behavior.

1.4. Health literacy

Health literacy is a relatively new concept in health promotion. It was used more than 30 years ago as a measure of achievement in reading and writing health-related materials [100]. This narrow definition has been extended to a deeper meaning of people's literacy in the late 1990s. Based on the definition given by the World Health Organization, health literacy represents the cognitive and social skills that determine the motivation and ability of individuals to gain access to, understand, and use information to promote and maintain good health [101].

1.4.1. Relation between health literacy and self-efficacy

Health literacy shares some similarities with self-efficacy. Self-efficacy is a sense of control over one's behavior, which is a core concept in the Social Cognitive theory [102]. Self-efficacy reflects people's confidence in their abilities to control their behaviors. It determines people's motivations and actions. Self-efficacy decides whether people consider changing their behaviors, whether they mobilize their motivations and perseverance of the behaviors. It also links to people's abilities to recover from disappointments. People with high self-efficacy have a higher likelihood of believing that they can master challenges. On the other hand, people with low self-efficacy are more likely to be less confident and they do not believe that they can perform behaviors well. Self-efficacy is the basic process of personal change [103], and it is used

as one predictor to evaluate the effectiveness of health communication programs [104]. Some studies showed that health literacy had a moderate positive effect on self-efficacy [105, 106], while some studies used self-efficacy as a measure of health literacy [107].

1.4.2. Relation between health literacy and health communication

Health literacy is a composite term to describe outcomes from health education and health communication activities [108]. Health education and health communication are health promotion actions, and health literacy is one of the outcomes of health promotion. People need to function effectively in a healthcare environment, and health literacy refers to a set of skills that people have [109]. It is people's ability to obtain, read, understand and use healthcare information in order to make appropriate health decisions and to follow instructions for actions [110, 111]. It contains various kinds of literacy depending on the areas of health promotion, such as nutrition literacy, diabetes literacy, and eHealth literacy. For example, nutrition literacy shows consumers' ability to obtain, understand, and use nutrition information from nutrition labels. Improved health literacy includes improved health-related knowledge, changed motivation, attitudes, and intentions toward health behavior, improved health-related personal skills, and improved self-efficacy in relation to defined tasks.

A model of health literacy was summarized by Don Nutbeam when he discussed the role of health literacy in contemporary health education and communication strategies in the 21st century [108]. This model makes use of three levels to explain associations between health literacy, health education, and communication. The first level is functional health literacy. It reflects outcomes from traditional health communication of information about health risks and information about how to use a health system. It is direct communication, not interactive communication. The second level is interactive health literacy. It reflects outcomes from health education (such as using nutrition labels to choose healthier foods) and health communication (such as using diet apps to eat healthier) that aim to develop personal skills in a supportive health environment. The third level is critical health literacy. It reflects cognitive skills and skills development outcomes from health education and communication that involves information

communication and skill development. The skill development investigates political feasibility and organizational possibilities of various forms of actions to address social, economic, and environmental determinates of health. This level is the only level that can address population benefits as well as personal benefits.

1.4.3. Limited health literacy and health outcome

Instruments for the measurement of health literacy are under development [112], and questionnaires are a common method. The European health literacy project, 2009-2012, developed a European Health Literacy Survey [113] that has been frequently used in health literacy studies. Usually, health literacy is categorized in two levels – low and high health literacy; or four levels – inadequate, problematic, sufficient, and excellent general health literacy.

The prevalence of limited (inadequate or problematic) health literacy is high worldwide. The first European comparative survey on health literacy in eight European countries in 2015 showed that at least 1 in 10 respondents showed insufficient health literacy and almost half had limited health literacy [114]. The elderly, minorities, refugees, and poor people had higher prevalence of low health literacy [115, 116].

Limited health literacy puts people at a greater risk of having poor access to healthcare and health communication, and leads to poorer health outcomes, such as more hospitalizations, poorer ability to demonstrate taking medications, poorer ability to interpret labels, poorer ability to interpret health messages, and poorer overall health status [111, 117, and 118].

1.4.4. eHealth literacy

eHealth literacy reflects people's ability to seek, find, understand, and appraise health information from electronic resources and apply that knowledge to make a health-related decision [119, 120]. eHealth literacy combines six literacies: traditional literacy, health literacy,

information literacy, scientific literacy, media literacy, and computer literacy [121]. As web-based and mobile-based apps have become important components of people's lives, health communication through these channels has become a part of health promotion. Thereby, eHealth literacy is a new adaption from health literacy. App users have a certain level of eHealth literacy. Some studies found the apps were easy and convenient to use [122, 123]. Like health literacy, a higher level of eHealth literacy supports health decision-making and therefore improves health outcomes [124]. An individuals' age, education, health status, and experience with internet usage influenced eHealth literacy [125-127]. Older and less educated people have lower eHealth literacy than their counterparts. Limited eHealth literacy can preclude some populations from accessing health information and using these resources online or in apps [128].

Clearly, health literacy is an indispensable factor in the discussion of health communication. It explains how well the target group can react to health communication. This thesis uses health literacy to discuss and explain why health communication through certain channels works or fails.

2. Methodology

Qualitative, quantitative or mixed methods should be selected based on the aims of a study. The selected method should be able to answer the research questions. Advantages and disadvantages of a method need to be considered in advance, and some of these are discussed below.

2.1. Qualitative method - Focus group discussion

A focus group is a qualitative method where a group of people are asked about their opinions, attitudes, and perceptions towards an item or an idea [129, 130]. Usually, a focus group contains six to eight people. The discussion allows researchers to study people in a more natural conversation pattern than typically occurs in a one-to-one interview. This natural conversation pattern allows interactions between people. The group members answer questions in their own words and they can explain their answers. They are free to interact and discuss these questions and they can explore the topic from as many angles as they want. The focus group discussion can reveal a wealth of detailed information and can provide a unique depth of understanding of the topic [130, 131].

Photo 1. A focus group discussion. A moderator was instructing a focus group of 8 participants.

Usually, an interview guide contains questions that are semi-structured, and typically not more than ten questions. These questions are carefully predetermined, but the discussion that follows in response to the questions is free-flowing. The semi-structured questions allow new ideas to be brought up from the discussion [132]. After recruiting and preparing for the participants, the focus group discussion can be conducted by one moderator and one observer. The moderator leads the discussions and keeps the group focused on the topic, but does not direct the discussion [133]. The observer sits beside the group and takes notes [134]. Photo 1 shows an example of a focus group discussion, which was conducted by Nofima AS in Norway, in September 2014. Discussion can be recorded with agreement from all participants. The discussion is transcribed and translated if necessary for data analysis. Focus group data is sorted through by indexing and categorizing, in order to find key ideas, opinions, and experiences [130, 134]. In order to obtain valid results, two or three focus groups need to be conducted. When there is no new input to the same set of questions, it reaches a point of saturation. Advantages and disadvantages of the focus group discussion are summarized in Table 2 [132-138].

2.2. Quantitative methods

2.2.1. Experiment

An experiment is a test or investigation where one plans to provide evidence for or against a hypothesis [139]. The three types of experiments commonly used in consumer research are natural experiments, controlled experiments, and field experiments.

Natural experiments are observational studies, which are not controlled to the same extent as randomized experiments [140]. This type of experiment attempts to collect data in such a way that contribution from all variables can be determined. It is applied when a controlled experiment is difficult to implement or is unethical, or when a natural occurrence is of interest (such as seasonal food choices or consumers' shopping behavior in a supermarket).

Controlled experiments compare experimental samples against control samples [141]. Controls are designed to minimize the effect of variables other than the particular factor under investigation. By comparing the controlled measurements and the factorial measurements, the results are reliable in pointing out the effect of a particular factor. An ideal experiment should have all variables controlled. Then the results of the experiment are due to the effect of the particular factor. Controlled experiments provide insight into cause-and-effect by manipulating a particular factor and demonstrating what outcome occurs.

Designing controlled experiments should consider three key elements: randomization, comparison, and statistical replication [142, 143]. A randomized controlled trial is an experiment in which participants are assigned randomly under different conditions, in order to objectively test which alternative is superior [144]. The comparisons between controls and treatments are preferable and valuable. The replication helps the experiments identify the sources of variation, and better estimate the effects of treatments. It strengthens the reliability and validity of the experiments. Experiments are usually blinded, and detailed information about the purpose of the experiment is kept away from the participants until they finish the experiment. Moreover, considering blocking, orthogonality, and factorial experiments is also beneficial for experimental design.

Field experiments examine interventions in the real word, outside of the laboratory [145]. They have been commonly used in social science. Healthcare interventions, education, and information aggregation at schools are all examples of field experiments [146, 147]. Similar to controlled experiments, field experiments also randomize participants into treatment and control groups and then compare the outcomes of these two groups.

In addition, experiments can be conducted online. An online tool was specifically designed for one study in this thesis by using computer mouse tracking [148]. It recorded the nutrition information that the participant checked when they examined food products. Conducting an experiment online is easy at schools. It is also convenient for a larger sample population, such as an entire class.

Advantages and disadvantages of the experiments are summarized in Table 2 [149, 150].

Table 2. Advantages and disadvantages of three methodologies.

	Cost per participant	**Sample size**	**Ethic**	**Setting**	**Response rate**	**Data collection**	**Data analysis**	**Other advantages**	**Other disadvantages**
Focus group discussion	High	Small	Need consent	Need a room	Can be low	Generate ideas and breadth of discussion. Allows clarification. Encourage participation from people reluctant to be interviewed on their own.	Data may be messy. Time consuming.	Suitable for specific group of people. Suitable for exploration of new area.	Bias if the discussion is swayed.
Experiment	Variable	Can be large	May need consent	Can be online	Variable	Lab setting or natural setting.	Easy to determine cause-and-effect relationship.	Suitable to tailor to unique research situation.	Creates artificial situations. Personal biases. Replication of the experiments can be difficult.
Questionnaire	Low	Large	Usually need consent	Can be online	Can be low	Standardized answers. Respondents need to be able to read.	Simple to compile data. Sensitivity to subgroup differences. Need sufficient sample size for statistical analysis.		Standardized answers may frustrate respondents. Misinterpretation of questions.

2.2.2. Questionnaire

A questionnaire is a research instrument consisting of a series of questions and other prompts for gathering information from respondents [151]. It is often designed for statistical analysis. Advantages and disadvantages of the questionnaire are summarized in Table 2 [152-155].

Researchers need to design the questions to form a proper questionnaire. A well-designed questionnaire can help reduce the measurement errors that are caused by respondents' motivation, computer literacy, or privacy concerns [154]. However, there is no theoretical base to guide the development of a questionnaire [152]. Generally speaking, the questionnaire design should be supported by a logical, systematic and structured approach, and it should follow a list of do's and don'ts according to the experience of previous researchers.

There are two kinds of questionnaire designs – the exploratory questionnaire and the formal standardized questionnaire. The exploratory questionnaire collects qualitative data. It offers a brief guide to research topics and asks open-ended questions. It allows a full exploration of people's views and attitudes towards the research topics. The formal standardized questionnaire, in turn, collects quantitative data. Janice Rattray [155] reviewed previous studies and summarized a series of decision-making strategies of such questionnaire designs. First, the researcher needs to define what the questionnaire measures and what types of scales can be used. Second, the researcher needs to pilot the questionnaire through item analysis and testing reliability and validity [156]. Many studies have reported questionnaire testing by comparing the results of questionnaires to that of standardized methodology. For example, comparing correlation coefficients between a food frequency questionnaire and one-week diet records could test reproducibility and validity of this questionnaire [157]. In practice, using validated questionnaires is helpful. Third, factor analysis, such as principle components analysis, can be used to explore the inter-relationship of variables in the questionnaire. By using factor analysis, unnecessary questions can be removed from the questionnaire [158]. The questions should not be guiding, both in the question design and in the order of the questions. When exploring a new area with no existing questionnaire, using outcomes from focus group discussions is

helpful in questionnaire development. Such outcomes offer key topics and can be turned into hypothetical-type of questions.

Piloting the questionnaire is necessary. Through pre-testing, researchers can know whether the questions wording will achieve the desired results, whether the questions have been placed in the best order, whether target audiences can understand the questions, as well as whether some questions should be removed or added to the questionnaire. This pre-test only needs a small number of respondents, but the small sample should be representative of the target audiences. After the pre-test, a questionnaire can be presented online or on paper to the target audiences.

2.3. Statistical analysis

Statistics is the study of the collection, organization, examination, summarization, manipulation, interpretation and presentation of quantitative data [159]. Statistical analysis discovers underlying causes, patterns, relationships and trends. There are two main statistical methodologies: descriptive statistics and inferential statistics. The descriptive statistics describes the study population by using indexes, such as mean and standard deviation. It gives an idea of the similarities or differences between the data. Inferential statistics investigates the data further to draw general conclusions. A technique of statistical inference called hypothesis testing [160] is used for testing a statistical hypothesis. It is a procedure for deciding if a null hypothesis should be accepted or rejected in favor of an alternate hypothesis. When testing the hypothesis, statistical assumption needs to be considered, for instance, assumption about statistical independence or distribution of the observations [161]. Then an appropriate test can be decided upon by considering the distribution of the observations. The significance level is a probability threshold below which the null hypothesis will be rejected, which is commonly 5%. A selection process for a right statistical test [162-164] is shown in Figure 7.

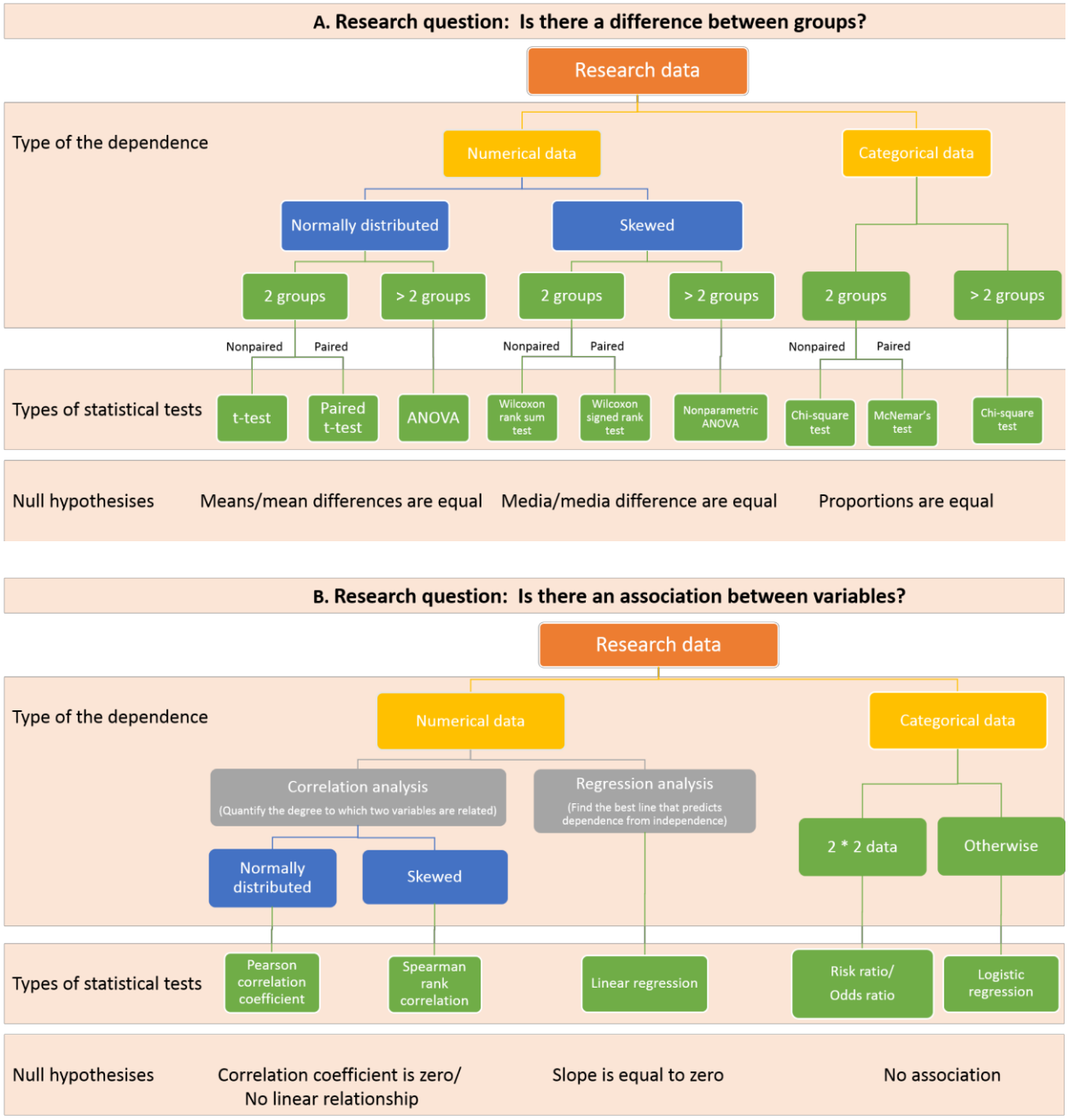

Figure 7. A selection process for a right statistical test. A. The research question is “Is there a difference between groups?”. B. the research questions is “Is there an association between variables?”.

2.3.1. Parametric and nonparametric statistics

Parametric statistics are the statistics that come from a type of probability distribution and make inferences about the parameters of the distribution [165]. **Nonparametric statistics** are not based on parameterized families of probability distribution. Their distribution is skewed. The most commonly known statistical methods are the parametric methods, which make more assumptions than the nonparametric methods [166]. Meanwhile, they have more statistical power, because parametric methods can produce estimates that are more accurate than nonparametric methods, if the assumptions are correct. In practice, the nonparametric methods will be used only if the parametric method assumptions are not correct, which is often the case for questionnaire data.

2.3.2. t-test, analysis of variance (ANOVA), and Linear regression for numerical data

t-test is a statistical hypothesis test in which the distribution of the observations follows a t-distribution. It examines two group means to determine if they are significantly different from each other. If the study samples come from two populations, each population should follow a normal distribution.

ANOVA is a group of statistical models used to analyze the differences among group means. It generalizes the t-test to more than two groups. One-way ANOVA compares means of three or more samples. Two-way ANOVA is an extension of the one-way ANOVA, which aims to assess the main effect of independent variables as well as the interactions between these variables. ANOVA is a special case of linear regression [167].

Linear regression is a model to assess the relationship between a scalar dependent variable y and one or more independent variables X. Data are modeled using linear predictor functions. Unknown model parameters can be estimated from the data.

2.3.3. Chi-square test, logistic regression, and ordered logistic regression for categorical data

Chi-square test is a statistical hypothesis test in which the distribution of the observations follows a chi-square distribution. It determines whether there is a significant difference between the expected frequencies and the observed frequencies in one or more categories.

Logistic regression is a regression model when the dependent variable is categorical. Logistic regression predicts the probability of particular outcomes. Multinomial logistic regression is a method that generalizes the logistic regression to multiclass problems when there are more than two possible discrete outcomes [168]. It is used to predict the probabilities of the different possible outcomes of a categorically distributed dependent variable, given a set of independent variables that may be real-valued, binary-valued, or categorical-valued.

Ordered logistic regression is a regression model for ordinal dependent variables, for instance, if a dependent variable is a choice from a Likert scale (e.g. “Strongly disagree”, “Disagree”, “Neither agree nor disagree”, “Agree”, or “Strongly agree”). Ordered logistic regression can be considered as an extension of a logistic regression with dichotomous dependent variables; the ordered logistic regression allows more than two ordered dependent variables.

2.3.4. Post hoc test

Post hoc tests are designed for a situation in which a significant result has been obtained (from ANOVA) and this factor consists of three or more means. It is an additional exploration of the differences among the means, so that it provides information about which means are significantly different from each other.

Tukey’s test is one commonly used post hoc test, which conducts pairwise comparisons. Essentially it is a t-test, but it corrects family-wise error rate, which is the probability of making one or more false discoveries when performing multiple hypotheses tests.

2.3.5. Model selection

Model selection is the process of picking among different candidate models, which all purport to describe the same data set. **Akaike information criterion** is a common tool for model selection, which measures the relative quality of statistical models for a given set of data [169]. It offers a relative estimate of information lost when a given model is used to represent the generation of the data, and it deals with the trade-off between the goodness of fit of the model and the complexity of the model [170, 171]. It selects the model that most adequately describes the dependent variable.

3. Objectives

3.1. Target group

This thesis focuses on young individuals, who are still learning to make their own food choices. Learning about food and eating already occurs during the transition from the exclusive milk diet of infancy to the omnivorous diet consumed in early childhood [172, 173]. Parents impose child-feeding practices and provide children with few opportunities for self-control in food choices [173]. Therefore, parents play a critical role in helping children at these ages eat healthy [174]. Opportunities to choose some of their own food start when individuals have some pocket money to buy snacks for themselves. They also gain more opportunities for food choices when they go to high school, where some of them choose lunch and snacks for themselves. Gradually, they choose food apparently independently.

Adolescents, age 16-20, have opportunities for self-control in food choices. It is a very important stage for adolescents, when they need to learn how to choose healthier foods for healthy eating behavior. Acquired skills will benefit them afterwards in their adulthood. Hence, discussing health communication with adolescents to promote healthy eating behavior is essential. Adolescents' preference and perception of nutrition labels have not been fully studied in Norway.

Young adults have a high interest in using modern technology, such as smartphones or tablets. A Norwegian nationwide questionnaire showed that 28% of young adults, age 18-30, had experience in using diet apps, PA apps or weight loss apps in the period April 2014 to April 2015 (Faktum AS Report, unpublished data, April 2015). Health communication through apps is hence worthwhile to discuss.

3.2. General objective

The overall objective of this thesis is to explore efficient ways to enhance health communication among Norwegian adolescents and young adults. The efficiencies of the efforts should be evaluated based on target groups' features. The impact of nutrition labels was evaluated in Papers I and II. The impact of using diet and PA apps among young adults was evaluated in Paper III. Health communication at school to promote healthy eating was discussed in Paper IV.

3.3. Specific objectives

1) Investigate which labels adolescents checked and used when they evaluated the healthiness of food products (Paper I)
2) Investigate whether Norwegian adolescents could obtain nutrition information from the %DVs to identify healthier foods (Paper II)
3) Identify whether nutrition labels (the Keyhole symbol and the %DVs) affected healthiness perception, taste perception, intention to buy, willingness to pay, and how adolescents liked such labels and products (Paper II)
4) Identify the impact of using diet and PA apps on users' day to day life (Paper III)
5) Identify whether using apps was associated with perceived changes in diet and physical activity (Paper III)
6) Get experts' opinions on school interventions and discuss intervention strategies (Paper IV)

4. Main results

This thesis targets adolescents and young adults, and aims to find opportunities to promote healthier food choices, healthy eating and a healthy lifestyle. Herein, the studies discussed three health communication strategies – health communication through nutrition labels (Paper I and Paper II), health communication through apps on smartphones, tablets and computers (Paper III), and health communication methods in a school environment (Paper IV).

Paper I aimed to investigate which information adolescents would like to check and use to evaluate the healthiness of food products. This study collected data from 176 adolescents, aged from 16 to 20 years, from six Norwegian high schools, and the participants were asked to examine new and commercially unavailable food products presented electronically in an online tool. Adolescents evaluated the healthiness of the food products based on the information they accessed through the food labels. This study showed that adolescents checked nutrition facts, ingredients list, health claims, nutrition claims, and FOP nutrition labels when they had sufficient time to evaluate the healthiness of food products. Almost all of the adolescents in this study knew about the Keyhole symbol. Generally, adolescents were interested in simple nutrition information, and were not familiar with some quantitative nutrition information, such as %DVs.

Paper I delivered an interesting point of view that Norwegian adolescents had a positive attitude toward the Keyhole symbol, but they had difficulties using %DVs. Therefore, Paper II was conducted to further examine adolescents' perceptions of the Keyhole symbol and the %DVs.

Paper II aimed to identify whether the information provided by the Keyhole symbol and %DVs affected Norwegian adolescents' perceptions of snacks and their intention to buy them. This study collected data from 566 adolescents, aged from 15 to 20 years, from five Norwegian high schools, and they were asked to examine snacks with the Keyhole symbol, with %DVs or without any nutrition label. Adolescents evaluated how tasty and how healthy they thought these snacks were, and how much they would like to pay for the snacks. In addition, they had pairwise selection tasks, which examined their ability to use the %DVs to identify healthier

foods. This study identified that Norwegian adolescents perceived that the Keyhole symbol indicated a healthier food product, and they did not associate the label with lower tastiness of the snack. Meanwhile, this study supported Paper I regarding adolescents' low ability to correctly use the information from %DVs to identify healthier foods.

Paper I and Paper II suggested that the Keyhole symbol, as a simple FOP label, might be a health communication strategy that promotes healthier food choices among Norwegian adolescents.

Paper III explored a rapidly developing channel of health communication - apps on smartphones, tablets, and computers. This study aimed at identifying how diet and PA apps affected their users. It also investigated if using apps was associated with changes in diet and physical activity behaviors. Three focus group discussions were conducted to find out motivations, experiences, opinions, and adherence of app usage. A questionnaire was designed based on results from the focus group discussions. This study recruited 500 Norwegian young adults, age 18 to 35, to answer the questionnaire. Half of them were diet/PA app users, and half of them were non-users. App users perceived that diet and PA apps were effective in promoting healthy eating and exercising. Diet apps were perceived as being more effective when they were frequently used and over a long period, compared to infrequent or short-term use. Users of both diet and PA apps, perceived apps as more effective than users of only one type of app. When comparing the changes in diet and physical activity behaviors among the app users and non-users, the users were better at maintaining diet and physical activity behaviors than non-users. The outcomes of this study indicated a potential of diet apps and PA apps for improving behavior and, consequently, health.

Paper IV had an in-depth discussion of school interventions for promoting healthy eating. It collected opinions from various relevant perspectives (31 experts, who were policy makers, school workers, nutrition/school project experts, and researchers) through an online survey. This survey gave examples of school interventions that used law, education, or marketing strategies and asked the experts' attitudes and opinions about the examples, and asked them to clarify and comment on their answers. Experts thought that school interventions that were designed through a single strategy were not promising towards promoting healthy eating

behavior. Education about nutrition and healthy eating at school was necessary but not enough; food availability and accessibility at school were also very important. To have a multicomponent intervention could be effective from cost and other perspectives.

Paper IV discussed health communication at school and summarized advice from the experts for future school interventions. The experts thought that combining law and education or combining education and marketing were two approaches that were worth trying for future school interventions.

5. Discussion of papers

Four papers provided insights into how to promote healthy eating through health communication with adolescents and young adults in Norway, using three health communication channels (nutrition labeling, apps, and school environment). The research interests, methodology, main results, and limitations of these papers are discussed before highlighting their scientific contributions.

5.1. Research interests

When designing the studies, it was decided to focus on some specific research interests. The key interests are discussed, including target group, target food category, physical activity apps, and school intervention.

5.1.1. Target group

This thesis focused on young consumers including adolescents and young adults. Paper III was the only one that focused on young adults, because they use health apps more often than other groups of people, and they are able to and willing to share experience about app usage. On the other hand, adolescents, as a group of people who will become independent consumers after they start living independently, have not been fully understood with regards to their perception of nutrition labels. Hence, the studies in Paper I and Paper II targeted this group to generate new input to this research area. Paper IV also targeted adolescents but in a slightly different way: it discussed school interventions to promote healthy eating among adolescents.

Although adolescents obtain nutrition knowledge at school, they probably have limited experience in choosing and purchasing healthy foods, because their food consumption mainly relies on family and school sources. The adolescents may participate in grocery shopping and cooking, but their involvement is often limited. Therefore, they do not have as much food

choice experience as adults do, with the exception of buying snacks in stand of full meals at school or in their free time.

Due to their lack of experience, it is possible that adolescents have a limited ability to understand and interpret complicate nutrition information in purchase situations, and thus simplified health information for adolescents could be a good approach to communicate health with the adolescents. Based on this assumption, Paper I and Paper II were designed to examine adolescents' preferences and perceptions of both simple nutrition labels and quantitative nutrition labels that are more complex.

5.1.2. Target food category

Paper III and Paper IV targeted healthy eating, so they focused on foods in general. Meanwhile, Paper I and Paper II were experimental studies about nutrition labels, so they focused on specific target food categories.

In Paper I, the food products in the online tool were new, hypothetical, and unspecified food products. These hypothetical products prevented participants from being influenced by their opinions regarding whether a product was healthy or unhealthy, and the participants needed to check food information to judge how healthy the product was.

In Paper II, snacks were chosen as a target food category, because adolescents commonly have experience in making snack choices. Having light meals and snacks in between meals is part of the food culture in many countries, including the Nordic countries, and snacks commonly contribute to 25% to 35% of daily energy intake [175]. Snacks are often sold at places where adolescents spend a lot of time, for instance, schools. Considering this fact, adolescents are more familiar with the nutrition labels on snacks than on the other kinds of food. Therefore, snacks were chosen to test adolescents' perception of nutrition labels.

5.1.3. The role of physical activity

According to WHO, both healthy diet and regular physical activity provide significant benefits to health [176], and people who engage in one are often also interested in the other. While three of the papers in this thesis focused only on healthy eating, Paper III focused on both.

In Paper I and Paper II, physical activity levels were identified from the questionnaires, and were related to the interest in healthy food. In Paper III, diet apps and PA apps were mentioned most frequently by the participants during the focus group discussions. It was easy to understand why participants were interested in both apps, since diet apps could take care of energy intake while physical activity apps could take care of energy expenditure. Considering the fact that the app usage is a new research area that has not been evaluated much, and the fact that app users often use both diet and PA apps and, Paper III took both apps into consideration. Paper IV focused only on school interventions to promote healthy eating, so physical activity was not included in this study.

5.1.4. Health communication in school interventions

According to the experimental studies (Paper I and Paper II), using simple health information showed potential to promote healthier food choice among adolescents. However, an important question remained: to what extent would health information be sufficient to promote healthy eating? A school was then chosen as a place for real-life health communication. Although no evidence shows that a school is the only or the best place for health communication, it has its own advantages. Schools are a convenient place to conduct nutrition policy and marketing strategies, as adolescents spend 8 hours and consume at least one meal at school daily. Adolescents are given nutrition education at school and are able to practice the knowledge while choosing food (lunch or snacks) at school. Therefore, many interventions have been conducted at school to promote health [177, 178].

Box: One school-based health intervention in a Norwegian high school

One Free Fruit program for 600 students (age 16 to 20) was implemented from January to June 2014 at Frogn high school in Akershus Country in Norway. Free fruits (banana, apple, and orange) were served every Tuesday and Thursday, one portion fruit per student. Based on a short survey about this free fruit program (response rate was 71%), 85% students said they had the free fruits once or twice weekly. A fruit and vegetable command (FV command, Figure, A), which is a common message in Norway to promote fruit and vegetable consumption, was displayed with the free fruits for two weeks in May (Figure, C). FV command was used as an education strategy to enhance health communication. The hypothesis was that free fruits and/or FV command could decrease unhealthy snack sales or increase healthy snack sales at school. ANOVA models were used to test the hypothesis.

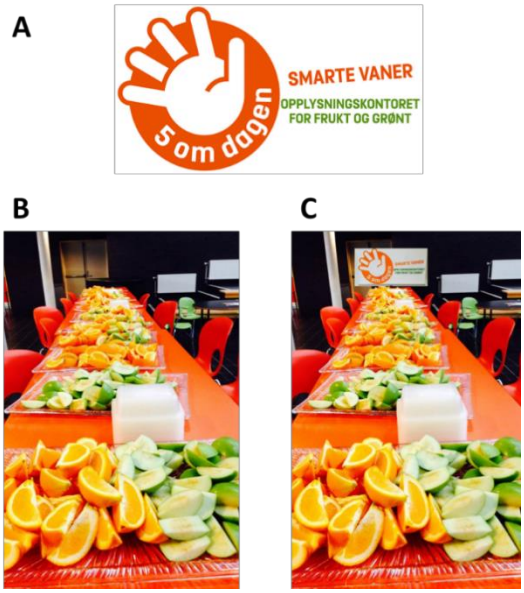

Figure. The Fruit and vegetable command and the two settings in the study. A: the FV command '5 om dagen, smarte vaner, opplysningskontoret for frukt og grønt' (in Norwegian), '5 a day, smart habits, information office for fruit and vegetables' (in English). B: setting 1 - fruits were served without the FV command in the first week and the fourth week. C: setting 2 - fruits were served with the FV command beside the fruits in the second week and the third week of the study.

On average, the school café sold only 3 healthy snacks (fruit and rye bread with cream) and 114 unhealthy snacks (muffin, bun/ waffle/cake, ice cream) per day. The Free Fruit program had no effect on the sales of unhealthy/healthy snacks (P=0.22). The FV command had no effect on the sales of healthy snacks. However, the sales of unhealthy snacks increased when there was a FV command at the school café (P=0.03). This was particularly true on the days that no free fruit was served (P=0.03, interaction). This FV command thus had the opposite result than what was desired.

In order to test the idea of using simple health information to promote healthier food choices, a school intervention was designed and conduced at one Norwegian high school (Box). Nevertheless, the simple health information had no effect on promoting healthy snack sales. This pilot study example shows that designing effective interventions at school can be very difficult, because of many other key elements that can influence the students' food intake. Therefore, Paper IV was designed to investigate the key elements that should be included in the future school interventions to improve health communication with adolescents.

5.2. Methodology

Methods in the four papers were carefully chosen to answer the research questions. The process of designing and integrating methods are discussed below, and three interesting points in the choice of methods are discussed – the online survey, the mixed methods, and the pilot tests.

5.2.1. Online questionnaire, online survey, and survey questions

Online questionnaire is a common method to collect people's personal attributes, such as gender, age, socioeconomic status, food habit, and so on. Papers I, II, and III used the online questionnaires to collect participants' personal attributes. These information offered descriptive statistics of the study group, and were linked to people's perceptions of nutrition labels or perceptions of app usage.

Online survey is a common method to collect people's opinions. It involves a wide variety of data collection methods including questionnaires. It was chosen as the method in Paper IV to collect opinions from experts in three different countries (Norway, the Netherland, and the US). Using the online survey has two obvious advantages: 1. it is easy to conduct, 2. the participants can join whenever and wherever they want. An alternative approach is to have a face-to-face interview, which is commonly used to collect participants' opinions. Compared to the face-to-

face interview, the online survey is more cost-effective, more time-effective, and it usually can reach more participants [179].

On the other hand, compared to the face-to-face interview, the online survey has one disadvantage that it does not have an interviewer. A trained interviewer in the face-to-face interview can ask clarifying questions, whereas the online survey does not allow researchers to ask follow up questions. In order to partly avoid this disadvantage, open-ended questions were used in Paper IV.

Open-ended questions were used in the end of each section in the online survey in Paper IV. The experts were encouraged to give creative answers or express themselves about their thoughts by answering the open-ended questions. The advantages of this type of questions include that it can get adequate answers to complex issues, and sometimes it can get unexpected or unique answers. For instance, the experts in Paper IV did not only explain their preference for school interventions but also gave suggestions or concerns that were not covered by the survey. Still, the open-ended questions have some drawbacks comparing to the close-ended questions. First, it is not easy to compare, correlate, or conduct statistical analysis with the answers from the open-ended questions. Second, the participants may feel tired if there are too many open-ended questions. Even though the online survey in Paper IV only took each participant around 15 minutes, one participant escaped a few open-ended questions in the last part of the online survey. It was highly possible that this participant found the open-ended questions annoying or he/she was too tired to answer them. In general, keeping a balance of close-ended and open-ended questions is important. In Paper IV, these two types of questions were conjoined in a logical way in order to deliver reasonable answers to the research question.

5.2.2. Mixed methods

Paper III used mixed methods – a combination of qualitative and quantitative methods. By using mixed methods, the research problem is explored in multiple ways [180], and it is commonly used in many research areas, such as the Public Health education research [181]. In

Paper III, qualitative methods were used to explore the phenomenon of using health apps, meanwhile quantitative methods were used to generalize the key findings from the phenomenon. Research about apps is fairly new and not very evolved: when this study was designed, there were very few papers about the effectiveness of using health apps, and there was no validated questionnaire about app usage. With very limited knowledge in this area, a qualitative method was suitable to use to explore the phenomenon as a first step, to understand people's views of using health apps. Then quantitative measures were developed based on the qualitative outcomes.

Based on the experience from Paper III, the mixed methods were very useful since it provided an approach for developing an app questionnaire, and a more complete and comprehensive understanding of the app usage than either using quantitative or qualitative methods alone. Besides these advantages, it was time consuming and it was logistically more challenging to design the study. More resources were needed to plan and implement this type of study than using either quantitative or qualitative methods alone.

Using the mixed methods in Paper III identified perceived effectiveness of using apps for health. An alternative approach to test the effectiveness of app usage is to have a controlled experiment. In a controlled experiment, a set of data is taken from a control group (e.g. people do not use the app) and from an experimental group (e.g. people use the app), where all conditions are identical to the control group except the app usage. Then the effectiveness of using the app for health can be identified by comparing the difference between the control group and the experimental group. This method can evaluate the precise effectiveness other than the perceived effectiveness from the users. However, this type of study needs cooperation among app developers, participants, and researchers, and it probably needs a long time follow up. Paper III tested the perceived effectiveness of using apps as a first step in this relatively new research area, and it suggested that the future studies should use controlled experiments to test the precise effectiveness.

5.2.3. Pilot test

Pilot tests were used in all four papers. A pilot test aims to pre-test the feasibility and duration of, as well as discover potential problems in a planned study before conducting it in full-scale [182, 183]. The results from the pilot test can facilitate the researchers to adjust the methods before conducting the full-scale study. Therefore, conducting a pilot test can increase the likelihood of designing a successful study [182].

The pilot tests were useful in all of the four papers in this thesis. In Paper I, the online tool was a new set-up, thus it was very important to test the online tool before using it at high schools. The pilot tests were done with two different groups to allow different types of feedbacks: 1. the tool was carefully tested by 14 food teachers (lectures, researchers, and professors). They gave feedbacks about how easy they could follow the introductions of the tool, how feasible the tool was, and which aspects should be improved. 2. The tool was tested by seven university students who were at a similar age to the target group. They gave feedbacks about how feasible the tool was in an environment at high schools, and how long time they needed to finish the study. The general feedbacks from the first group and the specific feedbacks from the second group were carefully taken into consideration when the online tool was modified for improvement. For instance, one picture on a product was considered inappropriate because it could give a healthy impression based on the Norwegian food culture. This picture was replaced by a neutral one. In Paper II, the third task was tested by 17 university students, and all three tasks were tested by four university students. They gave feedbacks about feasibility of the tasks. In Paper III, the app questionnaire was tested by six food researchers and three university students. They gave feedbacks about how easy they could follow the questions and which aspects should be improved. Layouts of some questions were changed and small amendments were made to make sure that the questionnaire was clear and concise. In Paper IV, the survey was pre-tested by three researchers, and they gave feedbacks about how to present the 15 illustrative interventions more clearly, how to introduce the three strategies in a better way, how long time they needed to finish the survey, and about the layout of the survey. Accordingly, small changes were made to ensure a clear and more user-friendly survey. In sum, the pilot tests were very useful to test the study methods before conducting the full-scale study [184].

5.3. Discussion of main results in context of the Theory of Planned Behavior and the Social Cognitive Theory

The key findings in Paper I and Paper II were that the Norwegian adolescents were familiar with the Keyhole label, and they perceived that the Keyhole label as indicating a healthier food product. This shows an opportunity for using the Keyhole label to promote healthier food choices. Based on the Theory of Planned Behavior, the adolescents may perceive that it is easy to choose products with the Keyhole label (Keyhole products), which influences the perceived behavioral control. Then they have a higher behavior intention to choose the healthier food. In addition, Keyhole products are commonly available and easily accessed in the Norwegian food market, and they are often competitively priced. Based on the Social Cognitive Theory, this enabling food environment supports adolescents to choose Keyhole products, which may facilitate them to form a habit of choosing the healthier options.

The key finding in Paper III was that the app users perceived diet and PA apps as effective in promoting healthy eating and physical activity. Based on the Theory of Planned Behavior, using apps can influence all of the three constructs (attitude towards the behavior, perceived behavioral control, and subjective norms) that contribute to the behavior intention. First, by receiving feedbacks from the apps about user's performance, the user may get a positive attitude towards healthy eating/physical activity. Second, by using apps, user gained experience in healthy eating/physical activity, and thus the user may perceive that it is easy to perform the healthy behavior. Third, the users can share their outcomes from the apps to their social network, and then the subjective norm, which is the perception about the healthy behavior, can be promoted. All of these three constructs can increase the behavior intention. In sum, using apps can influence all of the three constructs in the Theory of Planned Behavior, hence it has the potential to promote the user's intention to perform the relevant healthy behavior.

The key finding in Paper IV was that healthy food availability and accessibility at school were very important. According to the Social Cognitive Theory, food environment is an important determinant of performing healthy eating behavior. Even if the students at school have the intention to choose healthy food, they cannot perform the intention if they do not have or only

have limited access to healthy food, which is often the case at schools. Therefore, offering a food environment that guarantees the availability and accessibility of healthy food is one of the key factors to promote healthy eating behavior at school. The experts in Paper IV confirmed the importance of the healthy food environment.

5.4. Limitations

Some limitations in the four papers are worthy of discussion. First, representativeness of the participants in the studies needs to be kept in mind when interpreting the study results. In Paper I and Paper II, the participants were recruited from two counties (Oslo and Akershus) in Norway, mainly from Akershus county. The invitations were sent to all (36) high schools in the Akershus county. School rectors decided which classes could participate, and no random selection was used. Even though Akershus county shares common culture, socioeconomic environment, and public health threats in Norway [185, 186], the representativeness of the participants in these two studies may be questionable. In Paper III, the focus group participants were recruited from the Norwegian University of Life Sciences, and the questionnaire participants were randomly selected from a national pool. The questionnaire participants could be representative of the national population of 18 to 35 years old in terms of gender. In Paper IV, topic-related experts participated in the study. There was no need to generate the results since this study was only aiming to collect attitudes and opinions from the experts. However, 12 out of 31 participants in this study did not indicate their nationalities in the online survey. The missing values blocked an in-deep analysis of the country differences.

Second, the online tool in Paper I simulated an online setting, not a real-life shopping environment. The paper discussed this weakness, and declared that the results in this study should not be generalized to a real world situation. However, the results could be useful in an online shopping situation, which becomes more and more common [187] and young consumers are increasingly exposed to online food shopping opportunities.

Third, the app questionnaire in Paper III was newly developed based on the outcome from the focus group discussions. Even though the survey was designed according to published

instructions [152], there might be other potential issues. In order to minimize the issues, self-reported effectiveness was clearly stated as perceived effectiveness. Behavior changes were individually analyzed instead of being categorized.

Fourth, self-reported questionnaires were used in the four papers. Using self-reported questionnaires to obtain personal attributes, e.g. food behavior, is an efficient way. However, this method has limitations: 1. the data relies on the honesty of the participants, 2. the participants may lack introspective ability to provide accurate responses, 3. the participants may misunderstand the questions, or have other personal bias [188]. In addition, using rating scales instead of yes/no answers may cause another problem, because people interpret the scale differently. Here, in order to minimize the problems from the self-reported questionnaires, multiple items were used to measure each attribute, and validated questionnaires were used if there were appropriate ones from the previous publications. Internal reliability of responses was measured, whereas no other estimate measurement was used.

Last but not least, the questionnaires in Papers I, II, and III were translated into Norwegian by a native speaker, who was knowledgeable in both the research topics and languages [189]. Since no back translation was carried out, no comparison between the Norwegian and English texts could be conducted to control the quality and accuracy of translation [190].

5.5. Scientific contributions

Four papers in this thesis explored three health communication channels – nutrition label (Paper I and Paper II), health app (Paper III), and interventions at school (Paper IV) to promote healthy eating. These three channels are all easily accessible channels to the Norwegian adolescents and young adults. The target groups, especially the adolescents, have not been fully studied in the area of health communication in Norway. Therefore, these four papers contributed new scientific insights into this research field. The contribution of each paper is individually shown as follow:

Paper I was the first study to investigate how Norwegian adolescents used nutrition labels to determine the healthiness of food products. It was also the first study about the potential usage of 'Keyhole symbol' among adolescents in Norway. This study showed adolescents, as a group of consumers with limited nutrition knowledge and limited experience in food choices and healthy eating, preferred simple nutrition labels when they estimated healthiness of food products. This result was in agreement with another study that showed that simple nutrition labels could help consumers with low nutrition knowledge to indicate important nutrients when they rated healthiness [191].

Paper II was the first study to investigate whether the Keyhole symbol affected Norwegian adolescents' perception of snacks. There are mixed results in previous studies regarding whether health food information influences taste perceptions [191-194]. This study is in agreement with a French study with undergraduate students that healthy equals tasty, and in contrast with a Nordic study among adults that health claims reduced taste perception. This study contributed to the mixed results with a new target group. It was also the first study to show that Norwegian adolescents might have issues using the %DVs.

Paper III was the first study to investigate how diet apps and PA apps affected app users in Norway. It evaluated perceived effectiveness by app users, and it was also the first study to investigate if using apps was associated with changes in food behavior and physical activity behavior. In addition, this study also investigated barriers of using apps, and the results were in agreement with some previous studies [195, 196] that personalization of apps is needed to promote app usage.

Paper IV discussed health communication at school and summarized advice from 31 experts from three countries, including Norway, for future school interventions to promote healthy eating. School is a real-life environment for health promotion, and many school interventions use communication strategies to promote healthy eating. This study was the only study in this thesis to discuss health communication in a real-life environment. The results were in agreement with some previous studies. For instance, food availability and accessibility were important [197, 198] and parent involvement was crucial [199]. This study offered direct advice

from the experts, which were worth trying for people who work on promoting health communication at school.

6. Implementation

The Keyhole symbol is well known in Norway. Using the Keyhole symbol to choose healthier food products requires low health literacy and low self-efficacy, and it is suitable for fast decision-making. NNR 2012 has already recommended using the Keyhole symbol.

Based on the results from this thesis, the Keyhole symbol can be helpful with a specific target group – adolescents. Adolescents can use it to guide themselves to make healthier food choices in snack and light meal occasions. From a public health point of view, it will be good to have health campaigns to promote the use of the Keyhole symbol among adolescents; although there are some promotions of the Keyhole symbol, they are not specifically focused towards adolescents. In addition, promoting Keyhole symbol usage can also be done as part of multicomponent interventions, such as health campaigns that combine Keyhole symbol usage and marketing promotion of Keyhole products. These campaigns may be more efficient in promoting healthy eating.

Health apps users generally perceived that using apps facilitated healthy actions and healthy behaviors, e.g. healthy eating and physical activity. Using apps brings influence to users' knowledge, motivation, actions, and social life. Hence, health communication through apps can be considered as a multicomponent intervention. The effectiveness of health intervention with specific health app construction needs further evaluation.

Adding the Keyhole symbol campaign and Keyhole products in Norwegian diet apps can be a good idea. Users may find it easier to find Keyhole products in the supermarket and they can get experience with using the Keyhole symbol to choose healthier foods while using the apps.

Multicomponent interventions at school have been discussed in this thesis. Experts recommend multicomponent interventions, which at the same time target both healthy eating education and healthy food environment at school. These multicomponent interventions are theoretically more efficient than single component interventions. This is worthwhile to conduct in the future.

7. Future perspectives

Keyhole symbol regulations are revised regularly, based on new knowledge and food market changes in the Nordic countries [200]. Results from the studies suggested that using the Keyhole symbol for healthy snack choices should be considered too. Implementation of labeling with the Keyhole symbol on healthier snacks needs to be investigated in a real-life shopping environment in Norway.

Lack of personalized diet information and being time-consuming to use are two obstacles of using diet apps for healthy eating. There is a new label – the smart label, which is a slip of paper, plastic or other material on a product that contains a radio-frequency identification tag in addition to bar code data. Technologies with the smart label are matured and well-standardized. This label can provide personalized food information and may also save time spent on recording food intake to the diet apps. This label may help to overcome the obstacles that are present for using diet apps for healthy eating. The smart label is a modern technology that provides up to 350 information attributes including health claims, animal welfare information, sustainability information, and so on [201]. Consumers can access the information that they want to check by scanning the smart label in the supermarket. In this way, information for the consumers about the food product can be personalized. The personalized information can be tailored health communication that is more satisfying, more interesting, and more personally relevant [202]. Meanwhile, if linking the information in the smart label to the diet apps, users can easily scan the food items to record their food intake to the diet apps. This process requires far less time than recording the food items manually. Recording through the smart label will be more accurate and efficient. Since 2008, the smart label has been produced in high volumes, which brings this label closer to commercial availability. It has generated interest from supermarket chains in many countries, such as the UK, France, and the US [203]. Within five years, 80% of food will be featured with the smart label in the US [204]. Smart labels on food products will come online in shops and supermarkets across Turkey in 2016 with the aim of bringing food products sold in Turkey up to EU standards [205]. Using the smart label to register food intake in diet apps can be a practical, good idea to eliminate some obstacles of using the diet apps, and to disseminate health communication messages.

Carefully designed multicomponent interventions to promote healthy eating at school should be conducted and evaluated. In order to get clear insight into how to design effective school interventions to promote health, strong evidence of the effectiveness of multicomponent interventions is required. Hence, well-planned evaluation of the interventions is essential in future implementations. Mixed designs, before and after comparisons, and examinations from various perspectives are options for good evaluation that can be taken into consideration. Solid evidence of the effectiveness of these interventions can facilitate school program experts, school administrators, and public health workers to make further decisions about how to promote healthy eating at school.

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Paper I

Article Title Page

[Article title]

Use of nutrition information on labels by adolescents when evaluating the healthiness of new food products

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Structured Abstract:

Purpose - Nutrition labelling is regarded as an important instrument to facilitate healthier eating patterns. Adolescents' interests in nutrition information on food packaging and their ability to decide on the healthiness of nutrition labels are unclear. The aim of this study was to investigate which nutrition label information adolescents check and use to evaluate the healthiness of food products using an online tool. In addition, this study investigated relationships between adolescents' attributes and the nutrition information that they checked.
Design/methodology/approach - Adolescents (176), aged 16 to 20, from six Norwegian high schools examined new and commercially unavailable products presented electronically. They evaluated the healthiness of the food products based on the information they accessed through the food labels in an online tool. Information about personal attributes were obtained from an online questionnaire.
Findings - Adolescents checked and used several types of nutrition information to evaluate the healthiness of food; in particular, simple nutrition labels. They were not familiar with some quantitative nutrition labels, such as percentage daily values. Adolescents who considered themselves to be knowledgeable about nutrition, checked nutrition claims less often than those who did not consider themselves to be knowledgeable about nutrition.
Originality/value - This study highlighted that simplified nutrition information, e.g. the Keyhole label, tailored to adolescents, and encouragement of using detailed information, may be helpful for adolescents to evaluate the healthiness of food products.

Keywords Adolescents, nutrition labelling, Norway

Article Classification Research paper

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Running Heads:

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Introduction

The increasing prevalence of overweight and obesity among children and adolescents has attracted attention worldwide, including in the Nordic countries (Júlíusson *et al.*, 2010; Ogden *et al.*, 2012). The Norwegian Directorate of Health reported that 16-17% of Norwegian 15-16 year olds were overweight or obese in 2011 (Norwegian Health Directorate, 2012). Being overweight is a precursor for the problems associated with obesity, which can include both short- and long-term physiological and psychological issues. Overweight and obese adolescents have reported lower scores in health-related quality of life, and lower scores in physical and social functioning (Keating *et al.*, 2011). Fairly consistent evidence has shown adverse long-term effects of higher body mass index in childhood (Reilly and Kelly, 2011), including increased risk of cardiovascular disease in adulthood and premature mortality (Baker *et al.*, 2007; Falkstedt *et al.*, 2007; Bjorge *et al.*, 2008; Neovius *et al.*, 2009).

Consumption of foods that contain high levels of sugar, fat, sodium, and saturated fatty acids has increased in the last years, in all age groups including adolescents (Kearney, 2010). An imbalance between energy intake and expenditure is one factor contributing to overweight and obesity. In adolescents, this imbalance can be linked to easy accessibility and marketing of energy dense food, insufficient knowledge and/or education in nutrition, and insufficient physical activity (Doak *et al.*, 2006). Establishing a balanced eating pattern is essential in the fight against overweight and obesity.

To facilitate balanced eating, food information and nutrition information are provided to consumers on food packages. Nutrition labelling is an important instrument to inform consumers about nutrient content in the food and to help consumers to judge the healthiness of the food (Grunert and Wills, 2007).

Different consumer groups have different responses to nutrition labels. Women, older consumers, dieters, and more health conscious consumers have a higher perceived importance of qualifying and disqualifying nutrients in food choices (Hoefkens *et al.*, 2011). Adolescents, as a special group of consumers, may have different interests, knowledge, preference, and understanding of nutrition labels. They may lack relevant nutrition knowledge, they may have limited food-shopping experience, and they are usually not as concerned about their health as adults (Neumark-Sztainer *et al.*, 1999). There is very little knowledge about whether adolescents will check nutrition information to evaluate the healthiness of food products, and which sections of nutrition labels they would use.

Consumers typically prefer front-of-package (FOP) labels, such as traffic light labels and Guideline Daily Amounts-based labels, to aid their shopping (Grunert and Wills, 2007; Draper *et al.*, 2013). The Nordic 'Green Keyhole' label (Keyhole label) is a widely used FOP label in the Nordic countries. It is a symbol for healthier food options, and aims to encourage consumers to choose reduced-fat and fibre-enriched food products without reading detailed nutrition information (Larsson *et al.*, 1999). However, whether adolescents engage with the Keyhole label is unknown.

The aim of this study was to investigate which nutrition label information was checked and used by adolescents when they evaluated the healthiness of food products. In addition, this study investigated associations between nutrition information that adolescents checked and their personal attributes.

Methods

Sampling and procedure

Schools were recruited in Oslo and Akershus counties, Norway. These neighbouring counties cover 23.5% of the Norwegian population (Statistics Norway, 2015). Schools were approached based on their locations (north, south, east, west or Oslo city center) by considering the fact that inhabitants from different districts and counties have differences in life expectancies (Statistics Norway, 2013) and possibly different health behaviors. This method guaranteed a range and diversity of physical, cultural, and socio-economic environments. All of the high schools in Akershus County and one high school in Oslo were contacted, and six school headmasters decided to take part in this study. The response rate was 17%. Recruitment was done by school-defined classes. In total, 176 adolescents, aged 16 to 20, took part in this study, of whom 48.3% were enrolled in specialized food or health high school education programmes. Informed consent had been obtained ahead of the study from participants as well as parents if the child were under 16. All participants took part in the study voluntarily. This study neither directly nor indirectly identified personal data. According to the regulations issued by the Data Protection Official for Research in Norway, this type of study does not need ethical approval from an ethics committee (Data Protection Official for Research).

Participants completed the two parts of the study in the presence of two researchers and one teacher. A small number of students dropped out due to technical difficulties or other issues. In total, 166 participants completed the first part, 143 the second part, and 118 completed both parts. All study materials for the study were in Norwegian.

Part 1: Assessment of use of nutrition label information

Typically, studies on how adolescents use nutrition labels have been performed through surveys (Wojcicki and Heyman, 2012). However, surveys provide subjective information, because what people say they do is not always what they actually do. When one wants to examine what type of nutrition labels attract consumers' attention when evaluating the healthiness of food products objectively, methods such as eye tracking can be used (Jones and Richardson, 2007). However, the eye tracking instrument is not practical for data collection in high schools, and it is not suitable for a large sample population. Computer mouse-tracking is a more convenient and practical alternative (Freeman and Ambady, 2010). Based on the considerations mentioned above, a special online tool was designed to objectively examine how participants checked nutrition information to evaluate the healthiness of the foods. This tool did not mimic a shopping environment, but instead provided the participants with a situation in which they had time to check the information that they wanted to utilise in evaluating the healthiness of food products. Participants saw 20 different types of food information listed on the left and the right of the product, and all information was typical for what consumers see on food products. The food products in this online tool were hypothetical, and unspecified food products. The food information the participants viewed was designed by creating hypothetical recipes and calculating nutrient content from public nutrient tables and reassessing labels to be used. This approach prevented participants from being influenced by their opinions regarding whether a food category is healthy or unhealthy. Information made available to participants and an example of the application of the online tool are shown in Figure 1.

Comparing to detailed nutrition information in the nutrition facts, simple nutrition labels (organic labels, health claims, nutrition claims, and FOP labels) deliver simplified nutrition information to consumers. In total, there were five options for information of the simple nutrition labels. Three options showed a nutrition label and two options showed 'no information is available'. Each participant saw one of these options per product. The five options were displayed randomly among the five food products. In this way, the participant saw all of the five options once. The online tool measured which nutrition labels were checked by adolescents, and recorded their evaluations of the healthiness of food products.

The tool was pilot tested by seven students and 14 teachers with a background in food science at the Norwegian University of Life Sciences. The pilot suggested that the online interface was both user friendly and feasible for use in large groups. Feedback from the pilot was applied to optimize the online tool before it was used by the participants.

The 176 students in the actual study were asked to check the information provided for the four hypothetical food products included in the tool and then evaluate the healthiness of the products. The participants received instructions on how to use the tool. Participants were allowed to evaluate each food product for two minutes. This time frame guaranteed that the entire study could be completed within one school session (45 minutes). Participants could click all or some of the 20 links based on their personal interests, and they could recheck links as many times as they wanted within

the time frame. After completing this process, participants used a visual analogue scale (0 = not healthy at all, 100 = very healthy) to allocate a healthiness score to each product based on the information they checked.

Participants were requested to scrutinize a fifth product and answer eight nutrition questions that tested their ability to use the nutrition information to calculate energy and nutrient content (Byrd-Bredbenner *et al.*, 2000), as well as six agree-disagree questions about their preference for food labels on the fifth product.

Part 2: Assessment of socio-demographic and other variables

A self-administered online questionnaire was used to assess the participants' backgrounds, perceptions of their health, involvement in cooking, whether they or their family members followed a particular diet, and physical activity habits (18 questions in total); as well as eating behaviors, nutrition knowledge, food and health concerns, and experiences in using nutrition labelling (39 questions in total). Nutrition knowledge questions included, 'which of these foods should I eat more of according to health experts?' (response options included: vegetables, sugary foods, meat, fatty foods, high fibre foods, fruit, salty foods) and 'which fat is most important for me to cut down on?' (response options included: monounsaturated fat, polyunsaturated fat, saturated fat, not sure) (Parmenter and Wardle, 1999). Food and health concerns were examined with the questions, 'I am concerned about getting a lot of… (salt/fat/sugar) in my food' and 'I am concerned about gaining weight' using five-point response scales (Kähkönen *et al.*, 1997). Experiences in using nutrition labelling were determined by asking 'How often do you look at food labels to select food that is better for your health?' and 'How often do you look at…(nutrition facts/serving sizes/ingredients list/health information on the front of a food product)'. Question development was based on relevant published questions/assessments, and the personal attributes were categorized by following these publications as well (Kähkönen *et al.*, 1997; Parmenter and Wardle, 1999; Stang *et al.*, 2007; Fitzgerald *et al.*, 2008).

Statistical Analysis

The first product assessed by participants was used as a training opportunity to familiarize them with the online tool. Products 2 to 5 were used for the analysis. Some information in the online tool was optional (the links marked 'b' in Figure 1). Therefore, there were three groups of participants: participants who did not click the link (not accessed), participants who clicked the link and saw no information (accessed but no information available), and participants who clicked the link and saw information (accessed and information available). For the final product, the number of correct answers for the eight nutrition questions, as well as participants' degree of liking the label, was calculated (agree = 1, disagree = 0). Due to incorrect browser erasing with the online tool, some records turned out to be incomplete, resulting in the elimination of 46 product evaluations.

Descriptive statistics were used to describe the study population by gender (Table I). As the number of times participants checked information from each link was not normally distributed, the Kruskal-Wallis one-way analysis of variance and Wilcoxon signed rank t-tests were used to compare frequency of clicks between the different links. Linear mixed models were used to investigate the associations between exposure to simple nutrition labels (accessed and information available) and the healthiness score (dependent variable). The simple nutrition labels included were organic labels,

health claims, nutrition claims, and FOP labels. They were as fixed factors in the model, and the participant as a random factor. The Akaike information criterion was used for the stepwise model selection, in order to find the model with the best fit.

Poisson regressions and chi-square tests were used to examine the association between nutrition information that participants checked (dependent variable) and their personal attributes. The model included participants' gender, educational background, perception of knowledge of nutrition, food and health concerns, nutrition knowledge, whether they care about the healthiness of food, involvement in cooking at home, familiarity with the Keyhole label, whether family members or participants follow a special diet, and their experience in using nutrition labelling. Ordinal regressions and multiple linear regressions were used to examine the association between personal attributes and eight nutrition questions (dependent variable) and preference for food labels in the online tool (dependent variable) respectively. Results were considered significant if the P-values were lower than 0.05 for two-sided tests. R version 2.15.1 was the statistical software used for all analyses.

Results

Label use

The number of times that the participants checked the 20 links is summarised in Figure 2. Participants checked 20 links differently ($W(19) = 759.27$, $p < 0.001$). In general, the clicks were often on nutrition information and some other nutrition related information. They checked the nutrition facts most often (7% of total clicks), and they checked the ingredients list often (6.5% of total clicks). Among other nutrition and nutrition related information, participants checked health claims, nutrition claims, FOP labels and organic labels more often than percentage labelling, serving sizes and percentage daily values (%DVs, all $p < 0.001$). They also checked health claims, nutrition claims, FOP labels and organic labels more often than most non-nutrition related information links (all $p < 0.05$, except the name and the date marking).

The association between nutrition information exposure (the simple nutrition labels - organic labels (Torjusen *et al.*, 2011), health claims, nutrition claims, and FOP labels) and the healthiness scores of the food products was examined using a linear mixed model (Table II). Participants seemed to evaluate food products with health claims as healthier foods than products without health claims ($F(2,613) = 6.91$, $p = 0.001$).

Linking personal attributes to nutrition information preference

Associations between the number of times participants checked (clicked on) specific nutrition information (organic labels, health claims, nutrition claims, and FOP labels) and caring more or less about the healthiness of foods, as well as perceiving to be knowledgeable about nutrition or not are presented in Figure 3. There was no association between clicking organic labels and health claims for both characteristics, and also no association between clicking on FOP labels and perception of being knowledgeable on nutrition or not. Clicking on nutrition claims and FOP labels was significantly higher in those who cared more about the healthiness of foods ($\chi^2(1, N = 437) = 5.30$, $p = 0.02$, $\chi^2(1, N = 437) = 5.09$, $p = 0.02$, respectively, Figure 3A). Clicking on nutrition claims was significantly higher in

those who did not perceive themselves as being knowledgeable on nutrition ($\chi^2(1, N = 437) = 6.19$, p =0.01, Figure 3B).

Participants' ability to obtain nutrition information from nutrition labels was evaluated by eight nutrition questions in the observation study. There was no relationship between personal attributes and ability to answer the eight nutrition questions (all p >0.05). There was also no relationship between personal attributes and their preferences for food labels (all p >0.05).

Discussion

This study showed that participants checked a variety of nutrition information when evaluating the healthiness of hypothetical food products. They checked the nutrition facts and ingredients list. They also checked health claims, nutrition claims, FOP labels and organic labels. They checked percentage labelling, serving sizes and %DVs less than the previous simple nutrition labels. They had different preferences for checking different kinds of nutrition information in order to estimate the healthiness of food products in an online environment.

Results show that being exposed to health claims resulted in a higher healthiness score for the food products in the online tool. However, as health claims are not easily approved in the EU (The European Parliament and the Council of the European Union, 2006). Adolescents are not frequently exposed to such claims when purchasing foods. Not all research supports that notion that health claims have a positive effect on willingness to buy a product. Research by Raghunathan *et al.* (2006) mentioned an 'unhealthy equals tasty' intuition in the US, while a French study reported a healthy equals tasty intuition (Werle *et al.*, 2013). One Nordic study reported a slight decrease in perceived tastiness of food with health claims (Lähteenmäki *et al.*, 2010). Health claims signalling a healthier food alternative to adolescents may thus reduce taste expectations. This lower taste expectation may actually result in health claims being a barrier for adolescents in choosing healthy foods in a real shopping environment.

Interestingly, almost all (97.4%) participants in this study claimed to be familiar with the Nordic Keyhole label. It is a common FOP label in Norway. It is a simple tool for consumers to identify healthier food alternatives within particular food categories. Participants in this study checked (clicked on) the FOP labels for the healthiness evaluations, and they tended to give a higher healthiness score to products with Keyhole labels (59.4) than those without (54.6), although this trend was not significant. Nevertheless, promoting the use of the Keyhole label among adolescents may be a good strategy for stimulating healthier food choices, since Norwegian adolescents are already familiar with the Keyhole label.

Nutrition knowledge has been shown to affect general label use, degree of use, and use of nutrient content information (Drichoutis *et al.*, 2005). In this study, the frequency of checking nutrition claims was higher in participants who did not perceive themselves as being knowledgeable on nutrition. It might be hard for adolescents to interpret the quantitative nutrition labels, but the simplified nutrition information might help them to evaluate healthiness. The simple nutrition information, e.g. the keyhole label or the nutrition claims does not request interpretation of quantitative nutrition information. Jones and Richardson (2007) also found that traffic light labels, another example of a

simplified nutrition label, helped consumers with low nutrition knowledge to indicate important nutrients when they rated healthiness. It would be interesting to further investigate adolescents' preferences for different kinds of simplified nutrition labels and their ability to use those labels.

Percentage daily values (%DV), as a part of the nutrition information conveyed on food labels, aim to enhance consumers' ability to accurately discern the nutritional contribution of food products (Food and Drug Administration, 1993). This type of information is considered to be associated with the most consistent nutritional benefits to consumers (Drichoutis *et al.*, 2006). However, in this study, from all nutrition information available, participants checked %DVs the least. It is thus possible that they were less familiar with the %DVs than the other types of information. As mentioned above, adolescents probably lack experience in using nutrition labelling, and they may have difficulties in understanding quantitative nutrition labels. These may be the reasons why they were less familiar with the %DVs.

The online tool used in this study was a newly developed tool based on the idea of combining observation and social media together to build a simple and practical method for observing information use. The online tool mainly measured the type of information participants checked for the healthiness evaluation of food products. The records were based on the mouse tracking method (Freeman and Ambady, 2010). However, this experimental setting differs significantly from the real world. In this study, participants had two minutes to check information on one food product, while in a real world situation, consumers use much less time: in general, they spend around 30 seconds or even less to make a food choice in a supermarket (Grunert *et al.*, 2010; Saarela, 2014). Consumers may want to check all the information on food products when they have plenty of time for shopping, but in a time-pressured situation, they may prefer to only check simplified nutrition labels. Results from this study can therefore not be generalized to a real shopping situation, and future studies could test in-store use of information by adolescents.

In general, nutrition labelling is important, because consumer choice of healthier food products is influenced by the use of nutrition information (Barreiro-Hurlé *et al.*, 2010). Clear nutrition information in general on labels was suggested by the World Health Organization (2000) as one effort to prevent obesity, thus a priority action in childhood obesity prevention is to offer consistent and clear information to facilitate consumers in choosing food products (Lobstein *et al.*, 2004). Adolescents also consider 'better labelling of food products' to be a facilitator for healthy eating (Shepherd *et al.*, 2006). Norwegian adolescents in this study checked quantitative nutrition labels, such as serving sizes and %DVs, less often than simplified nutrition labels. Another Norwegian study showed that food education was demanded by the consumers as a strategy to help Norwegians to eat healthier (Oostindjer *et al.*, 2015). Therefore, education on quantitative nutrition labels may be able to help adolescents obtain more usable information from nutrition labels and facilitate healthier food choices.

Conclusion

This study revealed how adolescents checked nutrition information to evaluate the healthiness of food products in an online environment. They checked simple nutrition labels, but not some quantitative nutrition labels. Adolescents seemed to evaluate food products with health claims as

healthier food than products without health claims. The results of this study should be incorporated in future studies that investigate the use of nutrition information in a real world situation, in order to create successful information strategies to facilitate healthy food choices among adolescents.

Competing interests

The authors declare no competing interests.

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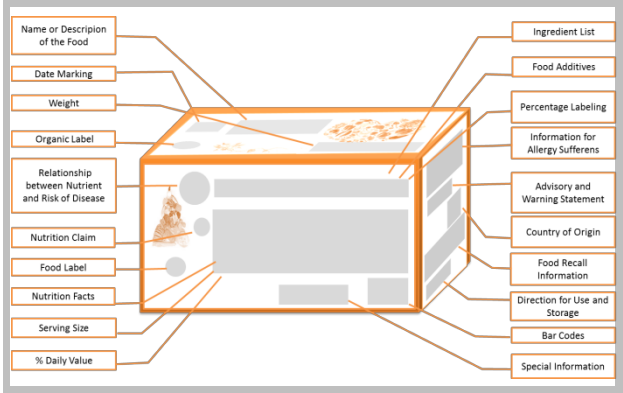
A. Introduction for participants

Dear participants,
You will spend 20 minutes on this webpage. Firstly, you will look at 4 new food products. For each product, there are 20 different links found next to it. When you click any of those links, you will be shown the label or other information that corresponds to it. For example, by clicking on the link 'Weight', you will see how much the product weighs. In some cases there may not be any information available for that link; you will then see: no information is available. You can click on each link as many times as you want. To go back to the main product, just click anywhere. You are allowed to spend 2 minutes to familiarize each product, and then you will answer a question about how healthy you think the product is.

Secondly, you will see another new food product in the same format. You will answer 8 questions about this product after you spend 2 minutes to check the food information. You can go back and forth between the product screen and the questions. You will be asked to show your thoughts about the label design of this food product afterwards.

After this task you will be redirected to the final questionnaire.

B. One example of food products



C: Accessible information upon clicking 20 links

Links	Items[a]
1	Name
2	Date marking
3	Weight of the product
4	Organic labels[b]
5	Health claim[b] such as 'Heart Healthy' or 'Contains Antioxidants' or 'Helps Reduce Cholesterol'.
6	Nutrition claim[b] such as 'Great source of dietary fiber' or 'Without added salt and oil' or '0 trans-fat'
7	Front-of-pack nutrition labels[b] such as 'Keyhole label' or Guideline Daily Amount
8	Nutrition facts
9	Serving sizes[b]
10	%DVs[b]
11	Ingredients list
12	Food additives[b]
13	Percentage labeling[b]
14	Information for allergy sufferers[b]
15	Advisory or warning statement[b]
16	Country of origin
17	Food recall information
18	Directions for use and storage[b]
19	Bar codes
20	Special information[b]

[a] Between replicates, information shown under each link was randomized showed to participants.
[b] 'No information available' was displayed if there was no information available corresponding to certain link.

D. Evaluation of healthiness of food

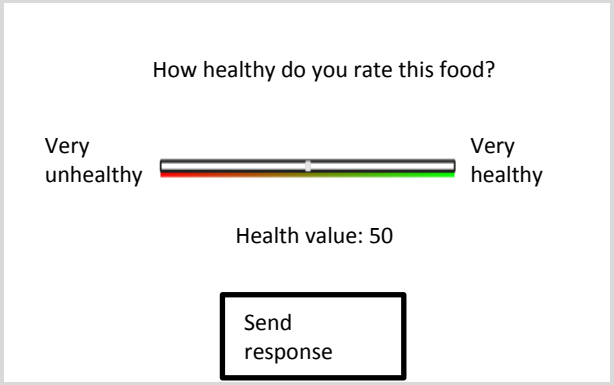


Figure 1. A flow chart shows the process of using the online tool and the information for participants. Picture A shows the introduction that adolescents received. Picture B shows one example of food products. Picture C shows 20 types of food information (20 links) that adolescents could check. Picture D shows the question of healthiness evaluation. Materials in Norwegian were translated into English for this figure.

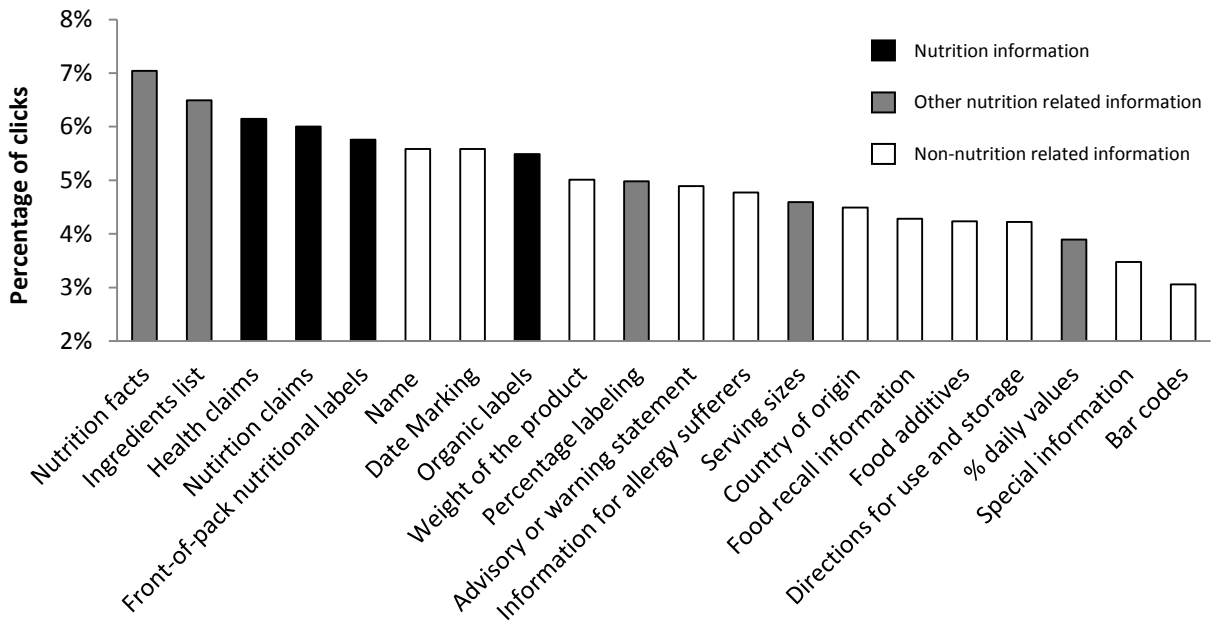


Figure 2. Frequencies of participants checking the 20 information links in the online tool.
Participants checked the links to obtain food product information for the food healthiness evaluations. Figures are in percentage of total number of clicks. Black bars indicate nutrition information, grey bars indicate other nutrition related information, and white bars indicate non-nutrition related information.

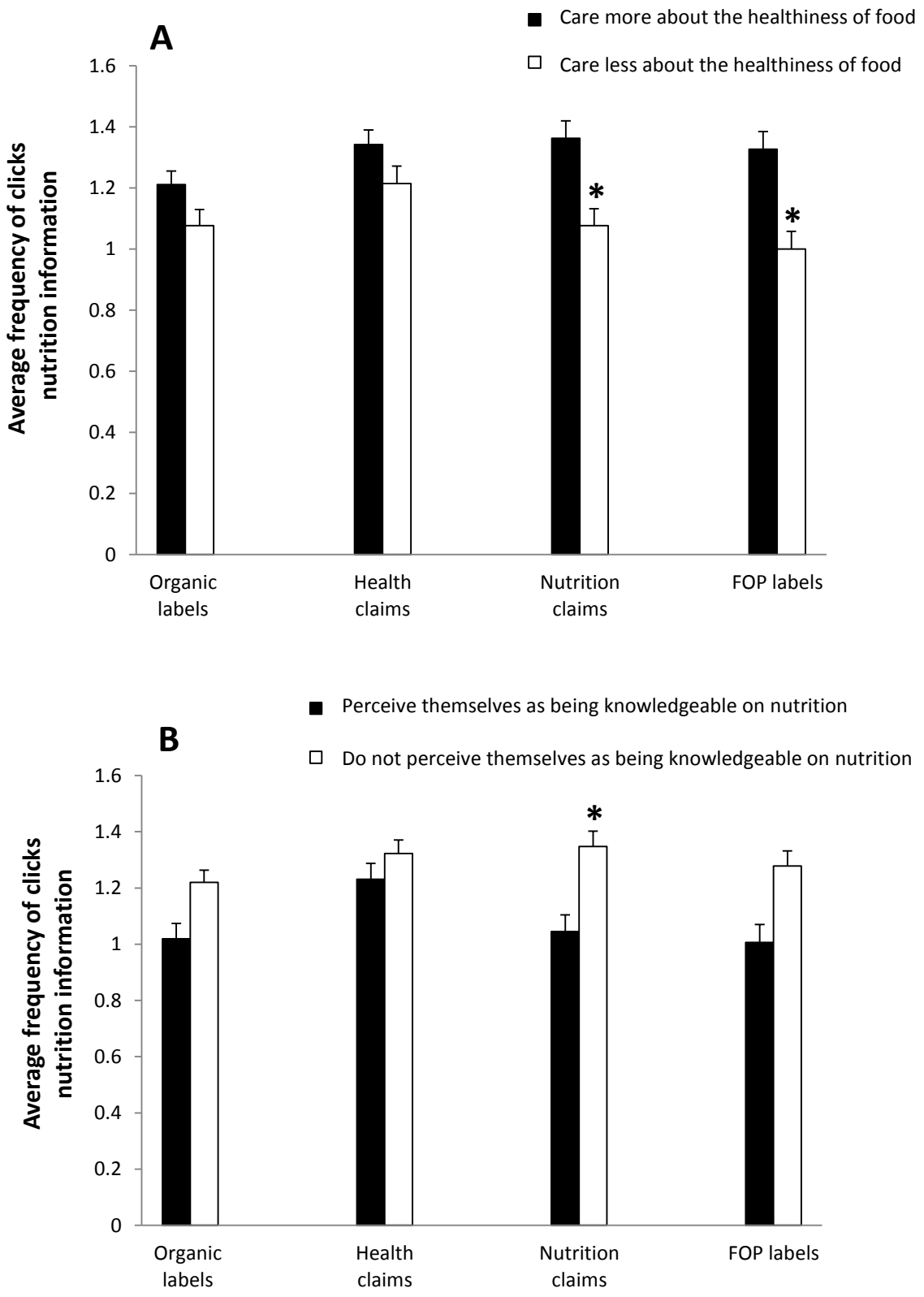


Figure 3. Number of times participants checked nutrition information in different subgroups. Nutrition information is information from organic labels, health claims, nutrition claims, and FOP labels. *p <0.05, Chi-square tests. A - whether they care about the healthiness of food, B – whether they perceive themselves as being knowledgeable on nutrition.

Table I. Personal attributes of participants who completed both parts of the study, as obtained during the questionnaire.

Sample characteristics	Female (n=61)*	Male (n=57)*	Total (n=118)*
Average age, year (±SD*)	16.5±0.6	16.6±0.8	16.6±0.7
Physical activity hours/week (±SD*)	4.9±3.9	8.1±5.9	6.6±5.3
Major in food or health	28 (45.9%)	29 (50.9%)	57 (48.3%)
The other majors	33 (54.1%)	28 (49.1%)	61 (51.7%)
Perceive themselves as being knowledgeable on nutrition	18 (30.5%)	25 (43.9%)	43 (37.1%)
Do not perceive themselves as being knowledgeable on nutrition	41 (69.5%)	32 (56.1%)	73 (62.9%)
High food and health concern	19 (31.1%)	3 (5.3%)	22 (18.6%)
Low food and health concern	42 (68.9%)	54 (94.7%)	96 (81.4%)
High nutrition knowledge	60 (99.8%)	53 (93.0%)	113 (95.8%)
Low nutrition knowledge	1 (0.2%)	4 (7.0%)	5 (4.2%)
Care more about the healthiness of food	42 (70.0%)	22 (39.3%)	64 (55.2%)
Care less about the healthiness of food	18 (30.0%)	34 (60.7%)	52 (44.8%)
Involved in cooking at home	43 (71.7%)	37 (64.9%)	80 (68.4%)
Not involved in cooking at home	17 (28.3%)	20 (35.1%)	37 (31.6%)
Familiar with the Keyhole label	59 (96.7%)	54 (98.2%)	113 (97.4%)
Unfamiliar with the Keyhole label	2 (3.3%)	1 (1.8%)	3 (2.6%)
Family members or participant follow a special diet	10 (16.4%)	8 (14.0%)	18 (15.3%)
Family members or participant do not follow a special diet	51 (83.6%)	49 (86.0%)	100 (84.7%)
Never use label	11 (18.0%)	18 (31.6%)	29 (24.6%)
Use label sometimes	32 (52.5%)	36 (63.2%)	68 (57.6%)
Use label often	18 (29.5%)	3 (5.2%)	21 (17.8%)

*n varies owing to missing values (missing values ≤ 2).

Table II. Effects of exposure to nutrition information on the healthiness evaluations in the online tool. Nutrition information consisted of organic labels, health claims, nutrition claims, and FOP labels. The healthiness evaluations are healthiness scores from 0 to 100. Linear mixed model and the reduced model were summarized in the table.

	Average healthiness score (0 to 100, 0 = very unhealthy, 100 = very healthy)			Mixed model	Reduced model
Nutrition information	**Not accessed**	**Accessed but no information available**	**Accessed and information available**	**p value**	**p value**
Participant code (random)				0.14	
Organic labels	56.23	58.17	57.41	0.13	
Health claims	52.07	55.43	60.49*	0.17	0.001*
Nutrition claims	57.48	58.66	56.68	0.83	
FOP labels	53.42	54.58	59.72	0.15	

*p <0.05, Linear mixed models

Paper II

Research Article

Snacks With Nutrition Labels: Tastiness Perception, Healthiness Perception, and Willingness to Pay by Norwegian Adolescents

Qing Wang, MSc[1]; Marije Oostindjer, PhD[1]; Gro V. Amdam, PhD[1,2]; Bjørg Egelandsdal, PhD[1]

ABSTRACT

Objective: Consumers tend to have the perception that healthy equals less tasty. This study aimed to identify whether information provided by the Keyhole symbol, a widely used front-of-package symbol in Nordic countries to indicate nutritional content, and percent daily values (%DVs) affect Norwegian adolescents' perception of the healthiness of snacks and their intention to buy them.

Design: Two tasks were used to evaluate adolescents' perception of snacks with the Keyhole symbol: with %DVs or with no nutrition label. A third task was used to test their abilities to use %DVs (pairwise selections). A survey obtained personal attributes.

Participants: A total of 566 Norwegian adolescents.

Main Outcome Measures: Taste perception, health perception, and ability to use %DVs.

Analysis: Linear mixed models and logistic models that tested effects of labels and personal attributes on main outcome measures.

Results: The Keyhole symbol increased health perception without influencing taste perception of snacks. Norwegian adolescents had limited abilities to use information from the %DVs correctly to identify healthier foods.

Conclusions and Implications: Norwegian adolescents had a positive perception of the Keyhole symbols. Keyhole symbols as a simple, heuristic front-of-package label have potential as an information strategy that may influence self-efficacy in promoting healthy snack choices among adolescents.

Key Words: adolescents, nutrition labels, snacks, Norway (*J Nutr Educ Behav*. 2016;48:104-111.)

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INTRODUCTION

Nutrition labels are cost-effective tools in the battle against obesity.[1,2] Many different nutrition labels are available, but previous studies indicate that consumers prefer simplified front-of-package (FOP) labels[3] that summarize nutritional information as a supplement to quantitative nutrition labels provided on the back of food packages. There are various kinds of FOP labels: for instance, traffic lights and the Nordic Keyhole symbol. For more than 20 years, the Keyhole symbol has been widely used in the Nordic countries to support a healthier diet (Figure 1).[4] Over 90% of Nordic consumers recognize it.[5]

Front-of-package labels are simple, direct, heuristic, and easy to use in decision making.[6] Interpretation of the Keyhole symbol and other FOP labels does not require advanced nutrition knowledge or high cognitive capacity.[6] Front-of-package labels may remove some obstacles for consumers with low self-efficacy or even increase their self-efficacy. Self-efficacy refers to a sense of control over one's behavior.[7,8] It reflects consumers' confidence in their ability to control their nutrition and, for example, to choose healthier options. Therefore, FOP labels have the potential to increase nutritional self-efficacy of consumers more so than quantitative nutrition labels, which, owing to their complexity, may even reduce consumer confidence in making healthy choices. For example, information on percent daily values (%DV), which corresponds to the percentage of the daily requirements or allowance for a particular nutrient based on a 2,000-cal diet, requires interpretation. Consumers with limited nutrition knowledge may be unable to understand or use quantitative nutrition labels to identify healthier options.[9]

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Conflict of Interest Disclosure: The authors' conflict of interest disclosures can be found online with this article on www.jneb.org.

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Figure 1. Keyhole symbol. The Keyhole symbol aims to help consumers identify healthier options. A product with the Keyhole symbol is a healthy product in its own food category (eg, it is a healthy yogurt that contains less fat than other types of yogurt). This product meets criteria such as less fat, less sugar, less salt, or more fiber.

Nutrition labels are sometimes associated with a reduced perception of product tastiness among consumers. Nordic adults reported a decrease in taste perception of foods with health claims.[10] Consumers tend to have the perception that healthy equals less tasty, which affects taste inference. If consumers perceive a product to be healthy because of its nutrition label, their taste perception of this product may decrease. The decrease in taste perception lowers the expected quality of the product, and then limits consumers' intention to buy the product.[11] This process can be a barrier for promoting the use of nutrition labels for healthy food choices. The perception that healthy equals less tasty has not been tested with the Keyhole symbol.

This study targeted nutrition labels on snacks. In Nordic countries, snacks and light meals are common and contribute to 25% to 35% of daily energy intake.[12] There is a debate regarding snack consumption and subsequent weight gain of consumers.[13,14] However, considering that most snacks are of poor nutritional quality, unhealthy snack consumption should be limited.[13] To the authors' knowledge, the impact of nutrition labels on adolescents' perception of snacks has not been evaluated previously.

Adolescents constitute a consumer group that may be characterized by limited nutrition knowledge and limited experience in food shopping. The purpose of the study was to identify whether the Keyhole symbol and the %DVs affected adolescent consumers' perception and intention to buy snacks with such labels. It also investigated whether Norwegian adolescents could obtain nutrition information from the %DVs to identify healthier foods. The researchers tested 2 hypotheses: The Keyhole symbol decreases taste perception in adolescents, and adolescents in Norway would prefer the Keyhole symbol over %DVs.

METHODS

Sampling

This study was conducted in Akershus County, which is the second largest county by population in Norway. Akershus County has food and school environments that represent the densely populated regions around the capital of Norway. This study covered the large differences in socioeconomic status among the north, east, and west regions of the county.[15,16]

The authors sent invitations to school principals and leaders of 36 high schools in Akershus County. School principals and school leaders decided whether the schools would like to participate and which classes were available. Students in these classes were free to choose whether they wanted to participate in the study.

Informed consent was obtained from the adolescents and from the parents of those who were aged < 16 years. This study did not directly or indirectly identify personal data. According to the regulations issued by the Data Protection Official for Research in Norway,[17] this type of study did not require approval from an ethics committee.

Procedure and Measures

The adolescents had 1 school period (40 minutes) to finish 3 tasks (25 minutes) and 1 survey (15 minutes). They received an introduction that described the tasks and they completed questions individually. The study was conducted in Norwegian. A flowchart (Figure 2) shows the snack labels and the 3 tasks.

Ten snacks were used in this study, each of which had 3 types of labels: (1) Plain labels that included product name, best-before date, weight of the product, ingredient list, food additives, and bar codes; (2) plain labels plus the Keyhole symbols; and (3) plain labels plus %DVs in nutrition facts (Figure 2A). The 10 snacks were lemon soda, ice cream, chips, teacake, milk flower candy, dark chocolate, fruit, yogurt, nuts, and baby carrots. Nine of the 10 snacks covered known healthy and unhealthy snacks, and 1 of the 10 snacks—milk flower candy—was not familiar to Norwegian adolescents. Paper labels were distributed to adolescents before each task.

Task 1. For each of the 10 snacks, 1 of the 3 label types (plain, Keyhole, or %DVs) was randomly assigned to each adolescent (Figure 2B).[18,19] Thus, each participant saw 10 labels: 4 plain, 3 Keyhole, and 3 %DVs, 1 label per snack, but the combination of label types among the 10 products varied among participants. Adolescents were asked to examine the labels and answer questions regarding how tasty and how healthy they thought these snacks were, using 9-point scales. They also indicated their intention of buying the snacks (*yes* or *no*).

Task 2. Because of limited time, the adolescents examined only 3 snacks (ice cream, chips, and yogurt) in task 2 (Figure 2C).[20] These 3 snacks are the most common in Norway. The measured response was willingness to pay (WTP) for the snacks. To investigate how much adolescents liked the labels, the authors chose yogurt, because it is a relatively health-neutral product (confirmed in this study, because it ranked as neither very healthy nor unhealthy in the healthiness score given by participants). Therefore, it was used to test both whether the yogurt labels were liked and whether the yogurt was liked.[20] The adolescents were told that the average price of the snacks was 25 Norwegian Kroner (NOK). They were asked how much they were willing to pay for the snack on a scale from 10 to 40 NOK in 3-NOK increments. The adolescents provided

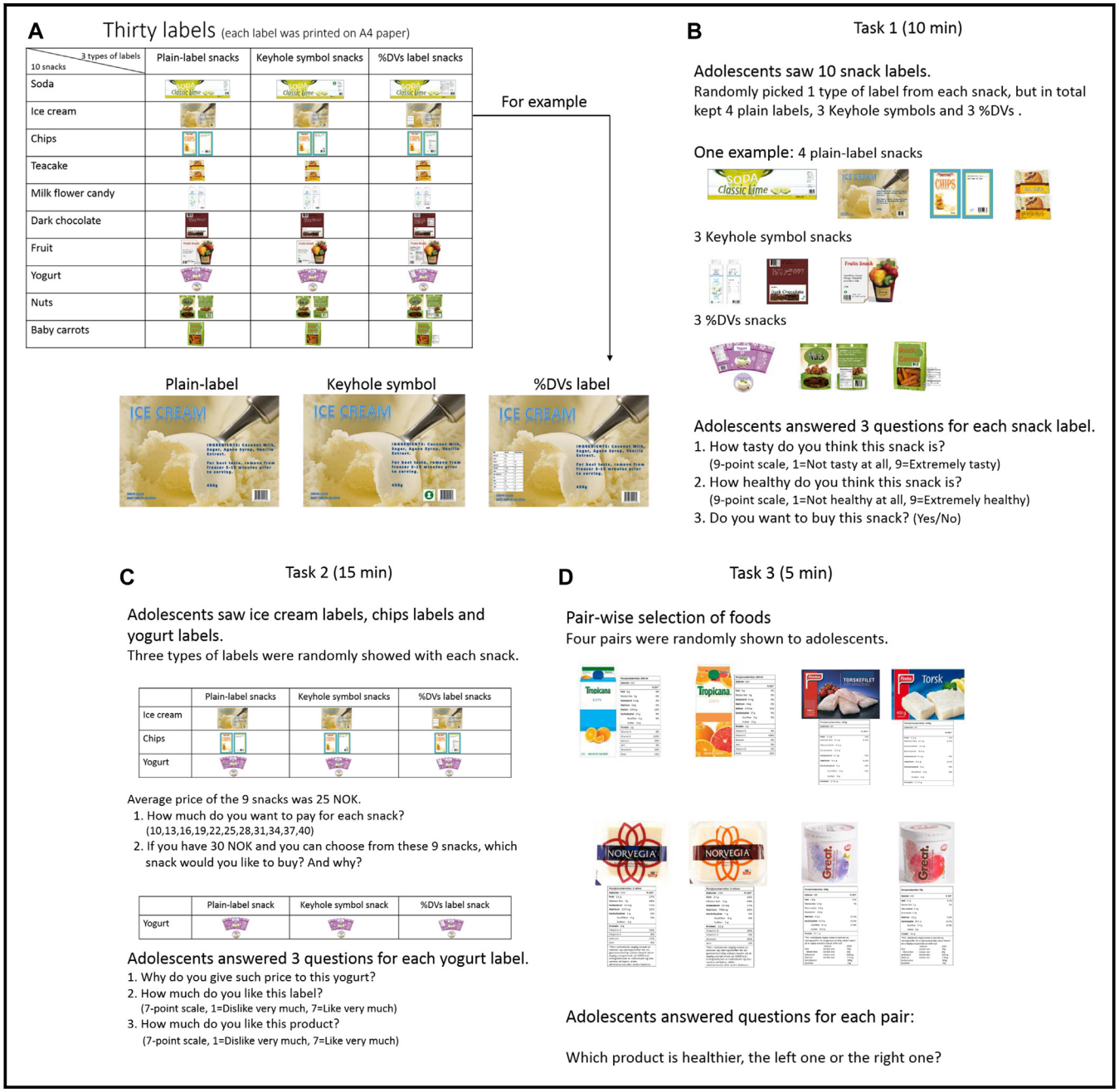

Figure 2. Snack labels and flowchart of 3 tasks in this study. (A). Thirty labels that show 10 snacks with 3 types of labels. (B) Task 1: Adolescents examined 10 snack labels and answered questions regarding how tasty and how healthy they thought the product was, and their intention to buy the snacks. %DVs indicate percent daily values. (C) Task 2: Adolescents examined 3 snacks and answered questions regarding willingness to buy, whether they liked the labels, and whether they liked the products, and made a purchase. NOK indicates Norwegian Kroners. (D) Task 3: Pairwise selection of foods to test whether Norwegian adolescents could obtain nutrition information from the %DVs to identify healthier foods.

clarification comments to their WTP for the yogurt. They also purchased 1 snack under the assumption that they were spending 30 NOK, and gave reasons for their purchase.

Task 3. This task tested whether adolescents could use the information from %DVs to identify healthier foods. They were asked to identify healthier food items in pairwise selection of foods (Figure 2D).[21] Each food pair contained 1 healthier product and 1 less healthy product. For 1 pair, both products had %DVs. The healthier variant contained less fat, saturated fat, sugar, sodium, and energy, or more vitamins or minerals than its counterpart. Two of the pairs involved a consideration of portion size. The adolescents gained 1 point for each correct answer. By comparing 4 pairs, they could obtain scores from 0 to 4. Participants with scores ≥ 2 points were considered good at using %DVs whereas participants with

scores < 2 points were considered poor at using %DVs. A score of 2 points could be obtained by guessing.

Survey

The survey collected demographic information such as gender, age, educational background, place of residence, involvement in cooking, knowledge about nutrition,[14] and whether participants cared whether their food was healthy (yes or no). All questions came from validated surveys.[22-24] Adolescents' food and health concerns were determined through the statements "I am concerned about getting a lot of … [salt/fat/sugar] in my food" and "I am concerned about gaining weight," with 5-point response scales, "I am extremely concerned" (5) to "I am not at all concerned" (1).[22] Based on these questions, the survey had good reliability of responses (Cronbach coefficient $\alpha = .75$). Adolescents' approach to nutrition labels was determined through the questions "How often do you look at food labels when selecting food?" and "How often do you look at … [nutrition facts/serving sizes/ingredient list/health information in front of a food product]?"[23] The researchers used 2 questions to identify active and inadequately active adolescents: "Outside school hours: How often do you usually exercise in your free time, so much that you run out of breath or sweat?" and "Outside school hours: How many hours do you usually exercise in your free time, so much that you run out of breath or sweat?"[24] Adolescents were identified as inadequately active if they engaged in physical activity < 2 times a week or for less than half an hour a week. In addition, adolescents answered questions about how hungry they were and whether they chose the snacks based on healthiness. They also were asked whether they thought that they would be laughed at if they ate fruit or vegetables, whether their friends ate healthy foods, and which nutrient they would most like to see on the front of the food packages.

Statistical Analysis

The researchers used descriptive statistics to examine the study population. Data were checked for normality and model assumptions. Linear mixed models identified whether different labels affected adolescents' taste and health perceptions. The models were Taste/health perception = labels + snacks + interaction between labels and snacks + adolescents (random factor). A general logistic model identified whether different labels influenced adolescents' intention to buy snacks. This model was Intention to buy = labels + taste perceptions + health perceptions + snacks. Interactions among the labels and the rest of the factors (taste perceptions, health perceptions, and snacks) were included in this model. A multinomial logistic model (MLM 1) identified whether adolescents were willing to pay different prices for foods with different labels. Multinomial logistic model 2 identified whether different labels affected the whether the yogurt labels were liked or whether the yogurt itself was liked, and whether the differences in liking were associated with the personal attributes identified by the survey. The model was Liking = labels + personal attributes (gender + education background + living regions + care whether their food was healthy + food and health concerns + knowledge about nutrition + obtaining nutrition information from labels + experiences in using nutrition labels + help cooking at home + physical activity habits). Interactions between labels and personal attributes were considered in this model. Multinomial logistic model 3 identified relationships between the food purchases and personal attributes, degree of hunger, whether they chose the products because of healthiness, whether they believed they would be laughed at if they ate fruit or vegetables, and whether their friends ate healthy foods. Multinomial logistic model 4 identified whether personal attributes were associated with adolescents' ability to use information correctly from the %DVs. Chi-square tests identified whether adolescents had different preferences for seeing certain nutrient information on the front of food packages and whether there were gender differences in preferences for each nutrient.

Statistics software package R (R Development Core Team, Vienna, Austria, 2013) and R Commander (library umb, version 2.15, John Fox, McMaster University, Hamilton, Ontario, Canada, 2013) was used for all analyses. $P = .05$ was considered significant in a 2-sided test.

RESULTS

Personal Attributes of Adolescents

Five schools from both east and west regions participated in this study (response rate of 14%). In total, 566 adolescents (aged 15–20 years) participated (17% of total students in the 5 schools), 29% of participants came from a high-income municipality (west of Akershus), 40% came from an average-income municipality (south of Akershus), and 31% came from a relatively low-income municipality (northeast of Akershus). Average age of adolescents was 16.2 ± 0.8 years. Fifty-two percent were female and 24.0% had an educational background in food or health. The adolescents receive food and/or nutrition education for 17 out of 35 hours of education per week. Table 1 summarized personal attributes from the survey.

Nutrition Labels Affected Health Perception but Did Not Affect Taste Perception

Health perception was affected by the nutrition labels ($F_{2,4861} = 3.56$; $P = .03$; linear mixed model). *Post hoc* tests revealed no significant differences between labels, although the Keyhole symbol had higher average health perception than %DVs and plain labels. A coefficient test revealed that health perception for the Keyhole symbols was higher than health perceptions for the plain labels ($t[2] = -2.55$; $P = .01$). Taste perception was not affected by the nutrition labels ($F_{2,4861} = 0.92$; $P = .40$). Both health and taste perceptions varied for different snacks (all $P < .001$) (Table 2).

Nutrition Labels Did Not Affect Intention to Buy, WTP, Liking of Labels, or Liking of Snacks

Intention to buy snacks was not influenced by nutrition labels ($P = .97$; general logistic model) but it was

Table 1. Norwegian Adolescents' Personal Attributes From Survey (n [%]) (n = 561)

Personal Attributes	Female (n = 284; 51%)	Male (n = 277; 49%)
Concern about healthy food*		
Care whether their food is healthy	194 (35%)	167 (30%)
Do not care whether their food is healthy	90 (16%)	107 (19%)
Missing	0	3 (0%)
Food and health concerns		
Low concern about food and health	224 (40%)	257 (46%)
High concern about food and health	60 (11%)	19 (3%)
Missing	0	1 (0%)
Knowledge about nutrition		
Consider themselves to be knowledgeable about nutrition	133 (24%)	140 (25%)
Do not consider themselves to be knowledgeable about nutrition	149 (27%)	134 (24%)
Missing	2 (0%)	3 (0%)
Obtain nutrition information from labels*		
Obtain enough nutrition information from food label	136 (24%)	168 (30%)
Do not obtain enough nutrition information from food label	139 (25%)	103 (18%)
Missing	9 (2%)	6 (1%)
Experience in using nutrition labels		
Often use nutrition labels	79 (14%)	65 (11%)
Sometimes use nutrition labels	179 (32%)	172 (31%)
Do not use nutrition labels at all	26 (5%)	39 (7%)
Missing	0	1 (0%)
Help cooking at home		
Does help cook at home	205 (37%)	180 (32%)
Do not help cook at home	78 (14%)	95 (17%)
Missing	1 (0%)	2 (0%)
Physical activity habits		
Inadequately active	77 (14%)	42 (7%)
Active	200 (36%)	231 (41%)
Missing	7 (1%)	4 (1%)

*$P < .05$.

affected by the perception of taste and type of snack (all $P < .001$). Adolescents wanted to buy tasty snacks (9-point scales; snacks that adolescents wanted to buy had an average taste perception of 7.14; snacks that adolescents did not want to buy had an average taste perception of 4.10). They wanted to buy fruit (76%), chips (70%), ice cream (65%), and lemon soda (49%) more often than baby carrots (33%) and milk flower candy (9%).

The WTP was affected only by the type of snack ($\chi^2[20] = 1{,}159$; $P < .001$; MLM 1). Nutrition labels did not affect the WTP ($P = .33$). Adolescents were asked to give reasons for the prices they paid for the yogurt. In total, 29% claimed that they assigned the prices to the Keyhole symbol yogurt because it was a healthy product. The proportion of adolescents who claimed that %DVs yogurt and plain-label yogurt were healthy products was 16% and 10%, respectively.

Nutrition labels did not affect whether the yogurts or their labels were liked ($P = .74$ and $P = .88$, respectively; MLM 2). Females, adolescents who cared whether their food was healthy, adolescents who considered themselves to be knowledgeable regarding nutrition, adolescents who had no educational background in food or health, and adolescents who said they could not obtain enough nutrition information from labels assigned higher scores to liking the yogurt (all $P < .05$). Females, adolescents who had no educational background in food or health, those who did not help cook at home, those who sometimes used the nutrition labels, and those who had low food and health concerns had a higher probability of assigning higher scores to liking the yogurt labels (MLM2; all $P < .05$).

Adolescents Would Like to Purchase Snacks With the Keyhole Symbols

Adolescents were asked to make a purchase from among ice cream, chips, and yogurt, assuming that they had 30 NOK to spend. In total, 47.2% of adolescents chose snacks with the Keyhole symbols, 25.8% adolescents chose snacks with the %DVs, and 27% chose plain-label snacks. Adolescents who chose a snack for its healthiness were more likely to choose a Keyhole symbol snack than a snack with 1 of the other 2 kinds of labels ($P < .001$; MLM 3). In addition, females were more likely to purchase Keyhole symbol snacks than were males ($P = .03$).

Table 2. Adolescents' Health and Taste Perceptions, With Plain Label, Keyhole Symbol, and Percent Daily Values, and 10 Snacks

	Health Perceptions (Score, 1–9)		Taste Perceptions (Score, 1–9)	
Factors	**Mean Score**	***P***	**Mean Score**	***P***
Labels				
Plain	4.63	.03	5.39	.40
Keyhole symbol	4.73		5.49	
% Daily value	4.68		5.39	
Snacks				
Chips	2.51	< .001	6.34	< .001
Ice cream	2.75		6.71	
Lemon soda	2.79		5.58	
Teacake	3.08		3.75	
Dark chocolate	4.06		5.44	
Yogurt	4.70		5.66	
Milk flower candy	5.45		3.21	
Nuts	6.01		4.96	
Baby carrots	7.30		5.36	
Fruit	7.68		7.35	

Note: Nine-point scales evaluated health perceptions and taste perceptions (1 = *not tasty/healthy* and 9 = *extremely tasty/healthy*). Linear mixed models tested the effect of labels and snacks on adolescents' health and taste perceptions.

Adolescents' Ability to Use Information Correctly From the %DVs to Identify Healthier Foods

Adolescents had difficulty answering the 4 %DV questions correctly: 72.5% could correctly find the healthier alternatives in the simple comparisons (nutrient differences) whereas 24.4% could correctly find the healthier alternatives in difficult comparisons (when asked to consider portion size differences). Personal attributes did not affect adolescents' ability to use information from the %DVs (MLM 4). The average correct number of answers was close to 2 out of 4, and thus did not differ from chance.

Nutrient Information That Adolescents Wanted to See on the Front of the Food Package

Adolescents mainly wanted to see total energy, fat, and carbohydrate content information on the front of the food packages (Figure 3). Females and males had different preferences for nutrients to be listed on the front of the packages ($\chi^2[4] = 51.5$; $P < .001$). Males preferred to see mainly energy, carbohydrates, fat, and proteins on the front of food packages. Females had a lower preference for information about protein ($\chi^2[1] = 38.8$; $P < .001$) but a higher preference for information about fat information ($\chi^2[1] = 9.2$; $P < .005$).

DISCUSSION

This study investigated adolescents' perceptions regarding the Keyhole symbol and the %DVs. Keyhole symbols increased health perception but did not affect the perception of taste or willingness to pay. Adolescents had limited abilities to use information correctly from %DVs to identify healthier foods.

Currently, consumers usually make quick decisions in which they invest less time to evaluate the healthiness of food products.[25] The Keyhole symbol could help consumers identify healthier food products and make efficient decisions[25] because it is heuristic and easy to use in purchase practice. The Nordic Nutrition Recommendations 2012[26] formed the basis of the Keyhole symbols to advise consumers on the best available options on the retail market from a nutrition point of view. In this study, adolescents had positive attitudes toward the Keyhole symbols.

There are mixed results regarding whether health food information influences taste perceptions. One study reported the perception that unhealthy equals tasty in undergraduate students in the US.[18] A Nordic study reported reduced taste perception of food with health claims in adults.[10] In contrast, a different study reported the perception that healthy equals tasty in French undergraduate students.[19] In this study, the taste perceptions of the Keyhole symbol snacks did not differ from those of plain-label snacks. Considering that foods contain complex combinations of nutritional and taste characteristics and people usually choose food based on taste because it offers immediate gratification, rather than based on long-term health benefits of proper nutrition,[27] the Keyhole symbol can deliver healthy food information to adolescents efficiently without undermining taste perceptions regarding the food.

Generalizability of the study's findings may be limited by the low response rate from 1 county in Norway. This study was a simulation and not a real-life investigation.

The %DVs aim to increase consumers' abilities to distinguish accurately among nutritional levels in food products.[28] Yet, the value of %DVs is limited when consumers are unable to use the information correctly. In this study, Norwegian adolescents had limited ability to use the information from %DVs properly to identify healthier foods. A previous study found that consumers with greater nutritional knowledge were better at using the information provided by the %DVs,[9] and another study showed that adolescents can learn how to read and understand nutrition facts labels through an educational program.[29]

IMPLICATIONS FOR RESEARCH AND PRACTICE

This study shows that the Keyhole symbols can increase the health

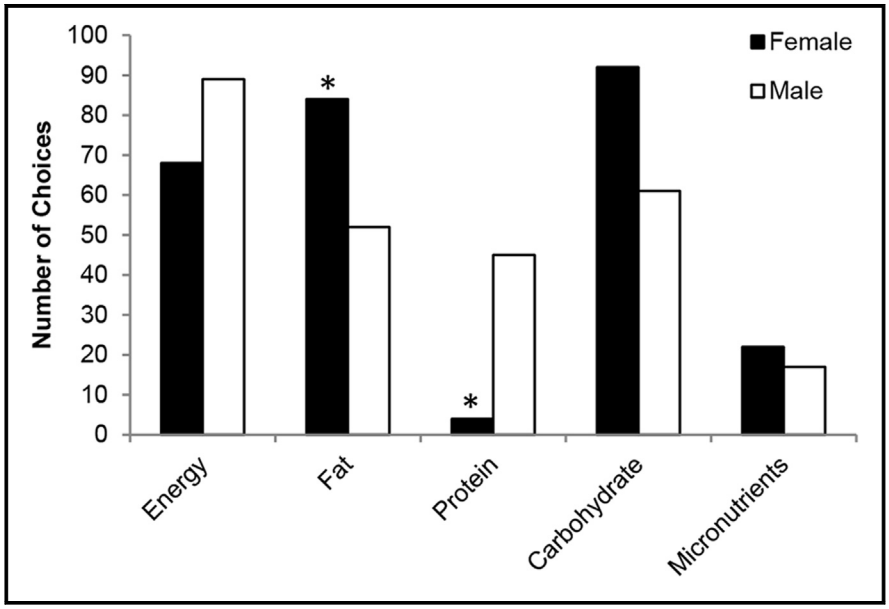

Figure 3. Nutrients that adolescents wanted to see on the front of the food package, by gender. Number of choices reflects the number of adolescents who indicated wanting to see total energy, fat, and carbohydrate content information on the front of food packages. *$P < .05$.

perception of snacks among adolescents. As a simple, heuristic FOP label, the Keyhole symbol has potential as an information strategy that promotes healthy snack choices in adolescents without affecting expectations of taste. Adolescents with low self-efficacy may benefit from education about the Keyhole symbol. It targets healthier foods and increases their confidence to choose healthier food. Educational efforts that include both the Keyhole label and %DV labels may be worth exploring.

A new Keyhole symbol regulation will be revised by Norway, Sweden, and Denmark, and serial changes will be made based on new knowledge and food market changes.[30] Results from this study suggest that the use of Keyhole symbols for snacks should be considered, but because the Keyhole symbol is a Nordic label, implementation should be investigated in a real-life shopping environment in a Nordic study.

ACKNOWLEDGMENTS

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CONFLICT OF INTEREST

The authors have not stated any conflicts of interest.

Paper III

Original Paper

Diet and Physical Activity Apps: Perceived Effectiveness by App Users

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Abstract

Background: Diet and physical activity apps are two types of health apps that aim to promote healthy eating and energy expenditure through monitoring of dietary intake and physical activity. No clear evidence showing the effectiveness of using these apps to promote healthy eating and physical activity has been previously reported.

Objective: This study aimed to identify how diet and physical activity (PA) apps affected their users. It also investigated if using apps was associated with changes in diet and PA.

Methods: First, 3 semi-structured focus group discussions concerning app usability were conducted (15 app users and 8 nonusers; mean age 24.2 years, SD 6.4), including outcome measures such as motivations, experiences, opinions, and adherence. Results from the discussions were used to develop a questionnaire. The questionnaire, which contained questions about behavior changes, app usage, perceived effectiveness, and opinions of app usability, was answered by 500 Norwegians, with a mean age of 25.8 years (SD 5.1).

Results: App users found diet and PA apps effective in promoting healthy eating and exercising. These apps affected their actions, health consciousness, and self-education about nutrition and PA; and were also a part of their social lives. Over half of the users perceived that apps were effective in assisting them to eat healthily and to exercise more. Diet apps were more effective when they were frequently used and over a long period of time, compared to infrequent or short-term use (P=.01 and P=.02, respectively). Users who used diet and PA apps, perceived apps as more effective than users who only used one type of app (all P<.05). App users were better at maintaining diet and PA behaviors than nonusers (all P<.05). Young adults found apps fun to use, but sometimes time consuming. They wanted apps to be designed to meet their personal expectations.

Conclusions: App usage influenced action, consciousness, self-education about nutrition and PA, and social life. It facilitated maintaining a healthy diet and exercising more. Diet and PA apps of the future can be further strengthened by being tailored to meet personal needs.

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KEYWORDS

diet app; physical activity app; perceived effectiveness; behavioral changes

Introduction

Since the mainstream adoption of smartphones during the last decade, consumers have since had easy access to a tremendous amount of health information through websites, social media, and health apps [1]. Health apps provide information to users whenever and wherever they want, and are tools for users who have a goal to improve their health. Diet apps and physical

activity (PA) apps are 2 types of health apps that aim to promote healthy eating and increased energy expenditure through monitoring dietary intake and PA. Using apps to affect eating behavior and PA behavior can be explained by the theory of planned behavior [2,3]. This theory shows that behavioral intention (eg, healthy eating, exercising) is driven by 3 constructs: attitudes towards the behavior, perceived behavioral control, and subjective norms. Attitudes are users' positive or negative evaluations of self-performance of the behavior. Perceived behavioral control is users' perceived ease or difficulty of performing the behavior. Subjective norms are users' perceptions of the behavior. Using apps may influence users' attitudes towards healthy eating or exercising, and it may relieve difficulties related to users engaging in healthy eating and exercise.

Many different types of diet and PA apps exist in app stores on different platforms. Diet/caloric intake apps and PA apps (fitness/training) are among the most popular in the "health and wellness" categories in app stores [4]. A diet app typically requires users to manually register what they eat each day. It converts food consumption into nutrition intake, summarizes results in plots and graphs, compares results with nutrition goals, offers nutrition and dieting information, and allows users to add their social network [5]. A PA app typically has GPS tracking to record physical activities, such as walking, jogging, and cycling. It also accurately records duration, frequency, and intensity of activities through an integrated gyroscope and/or accelerometer [6,7]. In addition, it calculates calorie expenditure, summarizes performance trends over time periods, and allows users to share their performance with friends on social networks.

Up to now, studies on diet and PA apps have evaluated the content of these apps and whether they were guided by relevant theory, or followed nutritional recommendations [8-10]. More research and evaluation is needed to show the perceived effectiveness of using these apps on healthy eating or increase in PA [11,12]. One approach is to evaluate how effective apps are from the users' point of view, and if they believe that app usage in general, independent of their detailed construction, will actually result in an intended behavior. Perceived effectiveness has been used for app evaluation [5]. It presents the effectiveness of the information system (perceived by the users [13]). This perceived effectiveness, thereby, reflects the user's self-assessment, and does not necessarily reflect actual effectiveness [14]. In general, previous studies evaluated health behavior change by using apps through qualitative methods [15] or only focused on one kind of app [16,17]. This study included both diet and PA apps, and evaluated perceived effectiveness through both qualitative and quantitative methods.

The objectives of this study were to identify how users perceive that they are affected by app use, and to investigate whether the use of apps was associated with improved diet and PA. Outcomes would indicate the potential of diet and PA apps for improving health.

Methods

This study used a combination of qualitative and quantitative methods. Three semi-structured focus group discussions were conducted with 15 app users (2 groups) and 8 nonusers (1 group), with a mean age of 24.2 years (SD 6.4). Participants discussed motivations for, experiences with, opinions about, and adherence to using health apps. The discussion results were summarized for a number of key topics, which were transformed into a questionnaire. The resulting questionnaire (Multimedia Appendix 1) was answered by 500 Norwegians, with a mean age of 25.8 years (SD 5.1).

Focus Group Discussions

Participants were students and staff at the Norwegian University of Life Sciences. They were recruited by email, and participated voluntarily. Selection of participants aimed to obtain a sufficient sample size of both app users and nonusers. Two focus group discussions with 2 male app users and 13 female app users, with an average age of 22.3 years (SD 7.3), were conducted and lasted 1.5 hours each. One focus group discussion with 6 male nonusers and 2 female nonusers, with a mean age of 24.8 years (SD 4.2), was conducted and lasted 1 hour. Female app users showed a higher interest in participating in focus group discussions, so there were more female app users than male app users in the focus groups. The 23 participants had 15 different university majors and lived in Akershus County and Oslo, near the university. Participants received monetary compensation for their participation (NOK 300/US $36). An experienced moderator led all 3 focus group discussions. In addition, an observer was present to take notes. The sessions were videotaped after consent was obtained from the participants.

Focus group discussions started with a general discussion about being healthy. Participants talked about methods they used to check health information and how they used health-related apps on a mobile phone, tablet, or computer. App operating systems were almost exclusively Android and iPhone OS. Users shared app usage motivation, goals, experiences, what they considered to be apps' pros and cons, and expectations for future apps. Nonusers shared personal opinions about health apps, reasons and barriers for not using apps, and expectations for future apps. This completed the discussion of whether using health apps could help people keep healthy, and how to adapt future apps to meet the needs of users.

Focus group discussions were transcribed and translated from Norwegian to English. Key topics were defined through indexing and categorizing [18]. The key topics included duration of use, adherence to using apps, goals, motivations, perceived effectiveness, and barriers for using apps. Two types of health apps were mentioned most frequently: diet apps and PA apps. An app questionnaire was developed based on the key topics derived from the focus group discussions, focusing on diet and PA apps only.

App Questionnaire

A cross-sectional Web-based questionnaire (Multimedia Appendix 1), aimed to assess dietary and PA changes and app usage among Norwegian young adults, was distributed in April 2015 through a market analysis company (Faktum Markedsanalyse AS, Oppegård, Norway). Participants were recruited by email from a national pool, and invited based on their age, which ranged from 18 to 35 years old; they had a

balanced sex distribution; and half were health app users, while half were nonusers. Individuals participated voluntarily. Personal attributes of the participants are shown in Table 1.

The first question in the questionnaire was "Have you used diet apps or PA apps on a mobile phone, tablet, or computer during the last 12 months?" Participants who had app usage experience were categorized as users, and those who did not were categorized as nonusers. The questionnaire consisted of 4 parts: (1) questions about changes in dietary behavior and PA during the last 12 months; (2) questions about using diet apps and/or PA apps during the last 12 months; (3) questions about opinions about using apps; and (4) general personal attribute questions. Users answered all 4 parts. Nonusers answered parts 1, 3, and 4. This questionnaire took 10-20 minutes to complete, depending on whether subjects were users or nonusers and how many types of apps they used.

The first part of the questionnaire contained 10 questions about dietary behavior and PA changes. This section was presented first in the questionnaire before the app questions, to prevent participants from being prompted about the effectiveness of apps. Diet-related changes included paying attention to calorie information, choosing healthier food (low-fat products and mineral water instead of sweetened beverages), cooking at home more than buying ready-made meals, and searching for food or cooking information on the Internet or in books/magazines. Physical activity-related changes included becoming a gym member, having activity competitions, sharing information about PA on social networks, and searching for activity-related information on the Internet or in books/magazines. Participants indicated whether they showed these behaviors before April 2014 (ie, 1 year before the questionnaire) and whether they showed these behaviors in April 2015 (ie, when they answered the questionnaire). Four questions asked participants about their goals and efforts to improve their diet and increase their PA in the last 12 months. A five-point scale (a lot less, a little bit less, about the same, a little bit more, a lot more) was used to measure their changes in food consumption and PA. Two questions examined weight loss goals and weight change during the last 12 months.

The second part of the questionnaire contained 12 questions. It first introduced general concepts of the apps and gave an example of a diet app ("myfittnesspal") and an example of a PA app ("Moves") [19,20]. Both apps were available for Android and iOS. Then, participants were asked about their duration and frequency of using the app in both the first and last month (if they stopped using the app before the questionnaire), goals (single choice) and motivations for using the apps, and perceived effectiveness of using diet and PA apps. The diet apps' effectiveness in assisting users to eat more low-fat alternatives in place of dairy products, eat more fruit and vegetables, eat less sausages, drink less sweetened beverages, eat less fast food, and choose healthier food products was evaluated. These diet changes were included based on the Nordic Nutrition Recommendations 2012, 5th edition [21]. The PA apps' effectiveness in assisting users to increase time spent on exercising, exercise more often, increase exercise intensity, and diversify their activities was measured using a 4-point scale (very effective, somewhat effective, slightly effective, or not effective).

The third part of the questionnaire contained 15 questions. A 7-point agree/disagree scale (disagree strongly, disagree moderately, disagree slightly, neutral, agree slightly, agree moderately, or agree strongly) was used to measure participants' opinions about apps and barriers for using those apps. Barriers included "it is hard to obtain information from apps," "it is time consuming to use apps," and "the apps do not fit personal expectations."

The fourth part of the questionnaire contained questions about gender, age, living region, weight, height, marital status, education, employment situation, yearly income, and food and health concerns. Food and health concerns were examined with the questions, "I am concerned about getting a lot of… (calories/fat/sugar) in my food" and "I am concerned about gaining weight" using a 5-point scale, from "I am extremely concerned" (5) to "I am not concerned at all" (1) [22]. Based on these questions, the survey had good reliability of responses (Cronbach alpha =.85).

The questionnaire was pretested by 6 food researchers and three master's students from the Department of Chemistry, Biotechnology, and Food Science, Norwegian University of Life Sciences. Small amendments were made to ensure that the questionnaire was clear, concise, and user-friendly.

Analysis of Questionnaire Data

App usage among app users was described by 4 factors from the questionnaire data: user type (users who used both diet app and PA apps; users who used only one type of apps); duration (0-1 months, 1-6 months, 6-12 months, or over 12 months); adherence (less frequently, same frequency, or more frequently); and goals. The goals for using diet apps were categorized into 4 types: to track food intake, to facilitate weight loss, to be healthy, and other goals. The goals for using PA apps were categorized into 4 types: to track PA, to do more PA, to facilitate weight loss, and other goals. The perceived effectiveness of using apps was categorized into effective, not effective, and do not know. The behavior changes were summarized into 4 categories (maintain, develop, give up, or never have the behavior) based on whether people had the behavior before April 2014 and whether they still had the behavior in April 2015. Food and health concern scores were calculated and participants were divided into 2 groups (high or low food, and health concern). Weight status (underweight, normal, overweight, or obese) was categorized based on body mass index (BMI) calculations from the questionnaire data.

All statistical analyses were performed using the statistical program R and R Commander version 3.2. Data were checked for model assumptions. Multinomial logistic models (MLM) identified associations between perceived effectiveness of using apps and app usage. The model was perceived effectiveness = user type (use both apps, or use only one type of apps) + duration + adherence + goals. MLM also identified associations between dietary behavior changes and app usage, association between PA changes and app usage, and association between weight change and app usage. The model was behavior changes

= user type (use both apps, use only diet apps, use only PA apps, or nonusers) + food and health concerns + weight status. Chi-square tests identified differences among app user groups. Associations between app usage and food consumption changes were identified by chi-square tests to explain weight changes among app users. Chi-square tests also identified associations between app usage and opinions about apps.

Table 1. Personal attributes of questionnaire participants (N=500).

Variable		%
Sex	Male	50.0
	Female	50.0
BMI [a]	Underweight (<18.5)	4.4
	Normal weight (18.5-24.9)	57.9
	Overweight (25-29.9)	24.0
	Obese (>30)	13.8
Living region	Northern Norway	8.7
	Mid Norway	13.3
	Western Norway	28.0
	Southern Norway	8.5
	Eastern Norway	41.7
Employment situation	Employed for wages	45.4
	Self-employed	3.8
	Unemployed	5.2
	Staying at home	3.4
	Student	35.6
	In the military	1.2
	Unable to work	5.4
Food and health concerns	High concern about food and health	16.8
	Low concern about food and health	83.2
Highest education	Primary school	13.2
	Secondary school	47.0
	College or university up to bachelor	28.2
	College or university up to master or PhD	11.6
Yearly income	0-200,000 NOK[b]	44.6
	200,000-400,000 NOK	26.2
	400,000-600,000 NOK	18.0
	600,000-800,000 NOK	6.0
	800,000-1,000,000 NOK	1.8
	>1,000,000 NOK	3.4
Marital status	Not married, without children	59.2
	Not married, with children	6.6
	Married or domestic partnership, without children	16.2
	Married or domestic partnership, with children	15.0
	Separated/Divorced/Widowed, without children	1.4
	Separated/Divorced/Widowed, with children	1.6

[a] BMI: body mass index

[b] NOK: Norwegian Kroner

Results

Focus Group Outcomes: A Model of Apps' Effects on Users

A model was summarized from the focus group discussions (Figure 1). It showed the influences of apps on users, according to the focus groups, categorized into 4 themes. Overall, apps offered an overview of how much one ate and exercised. For instance, diet app users obtained nutritional information about their daily consumptions of calories, carbohydrates, fat, and protein. These apps summarized and evaluated users' food intake. For example, one user said the following:

> *The app told me if I ate too few carbs relative to fat or protein intake*. [Female, 21 years]

Thus, by knowing their nutritional intake, users could adjust their eating to reach their goal of a balanced diet. Meanwhile, through this process, users gained experience and knowledge of nutrition and healthy eating. Using apps influenced self-assessment of diet, PA, and consciousness. Some users reported that they felt good about themselves because of their app usage, while other users felt stressed about using diet apps, mainly because it was time-consuming to register all the food items they consumed. Users felt that using apps could lead to higher awareness of the nutritional content of food, and higher awareness of and motivation for healthy eating and exercising. There were 2 examples given by users, who summarized the functions of diet and PA apps:

> *[You get] inspiration, information, [and] motivation to make healthier choices and confirmation that you have made the right choices, and guidance and tips about new food*. [Female, 19 years]

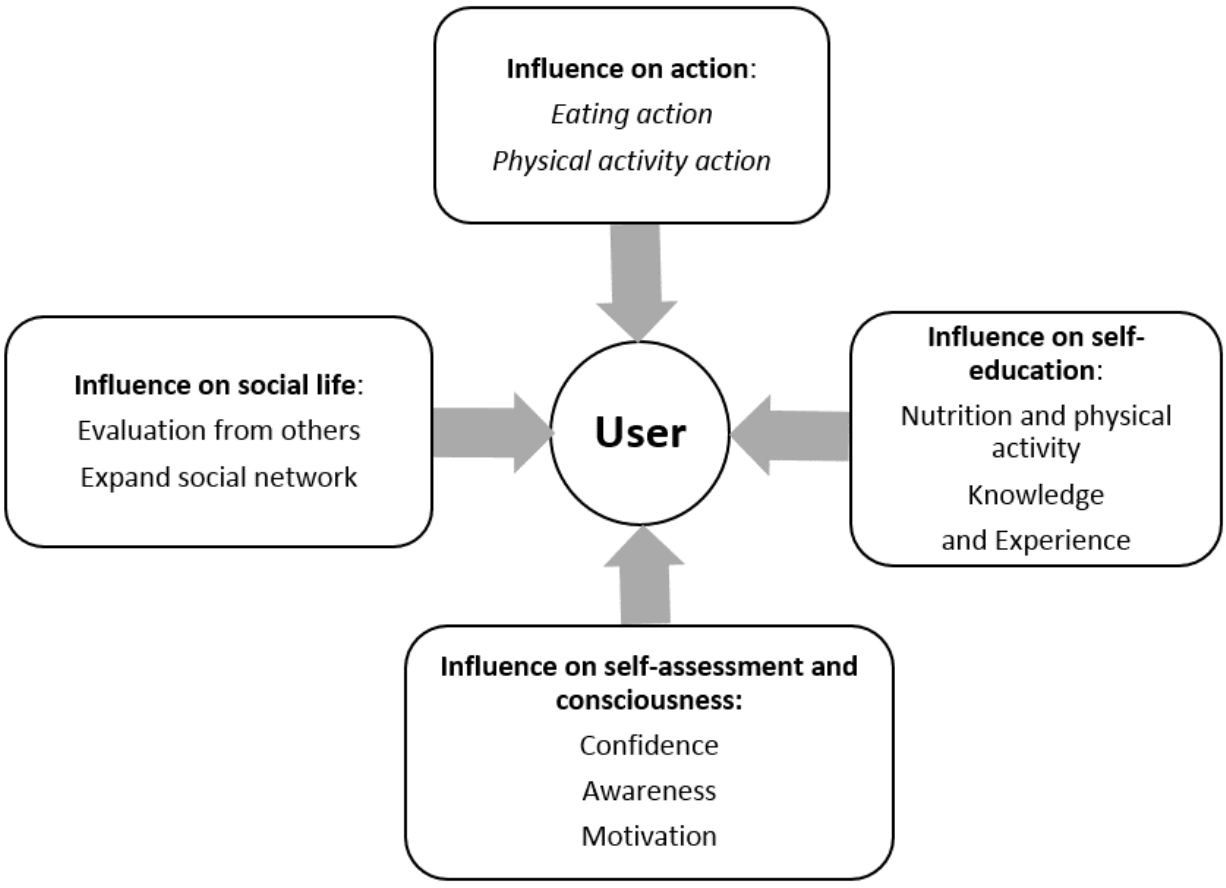
> *I have used an exercise app to get an overview of my activity. I used it to get some graphs and so on. It was motivating*. [Male, 24 years]

Influence on social life was another key point in the discussion. Users received positive or negative feedback from their friends or family. They could easily share the outcomes from apps on the Internet, especially those from the PA apps.

> *Results of training are fun to share*. [Male, 24 years]

Users could also be enrolled in a social network using apps, such as weight loss or dieting groups. They could either make new friends or strengthen relationships with old friends or family. Sharing diet or exercise outcomes on the Internet became one important motivation for participants to continue using apps.

Figure 1. Qualitative influences perceived by app users based on focus groups. Four themes were summarized from focus group discussions.



Questionnaire Outcomes: Perceived Effectiveness of Using Diet Apps

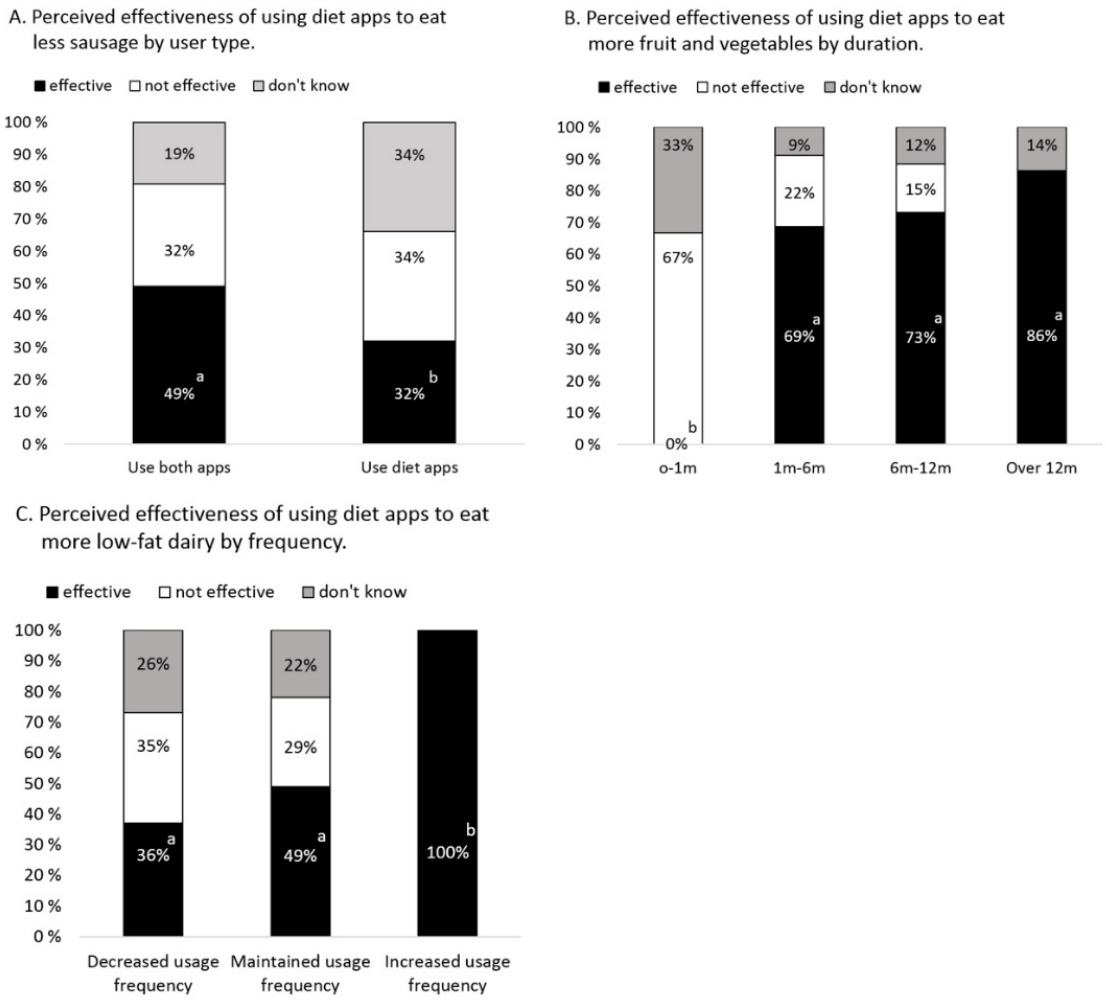
Overall, 186 diet app users and 192 PA app users answered the questionnaire, among whom 128 used both diet and PA apps. In general, diet and PA app users felt that apps were effective to facilitate their healthy food intake and activities. More than half of the diet app users felt that diet apps effectively assisted them to eat more fruit and vegetables (133/186, 71.5%), eat less fast food (117/186, 62.9%), choose healthier food products (117/186, 62.9%), and drink less sweetened beverages (106/186, 57.0%). Nearly half of diet app users found diet apps effective in assisting them to eat more low-fat dairy products (91/186, 48.9%) and less sausages (88/186, 47.3%). The majority of PA app users felt that PA apps effectively assisted them to exercise more often (144/192, 75.0%) and increase the intensity of exercises (139/192, 72.4%). More than half of the PA app users found that PA apps were effective in assisting them to increase time spent exercising (129/192, 67.2%) and diversify activities (106/192, 55.2%).

Perceived Effectiveness of Diet Apps Influenced by User Type, Duration, and Adherence

User type, duration, and adherence influenced perceived effectiveness of eating less sausages (P=.03), eating more fruit and vegetables (P=.01), and eating more low-fat dairy (P=.02), respectively. Goals did not influence perceived effectiveness. App usage, duration, adherence, and goals did not influence users' perceived effectiveness of diet apps for choosing healthier food products, drinking less sweetened beverages, or eating less fast food.

Users of both diet and PA apps had a higher probability of reporting that diet apps effectively assisted them to eat less sausages than users who only used diet apps, χ^2_1=4.2, P=.04 (Figure 2, Part A). Duration was associated with perceived effectiveness of eating more fruit and vegetables. Users who used diet apps for more than one month had a higher probability of reporting that apps were effective in assisting them to eat more fruit and vegetables than users who used diet apps for less than one month (all P<.05, Figure 2, Part B). Adherence was associated with perceived effectiveness of eating more low-fat dairy. Diet app users, who had increased the frequency of using apps in the past 12 months, had a higher probability of reporting that apps were effective in assisting them to eat more low-fat dairy than users who decreased their app usage frequency, χ^2_1=11.1, P<.001, or users who maintained the same frequency of using apps, χ^2_1=7.4, P=.007 (Figure 2, Part C).

Figure 2. Percentages of different diet app user categories and their evaluation of the effectiveness of using diet apps to assist their food intake.

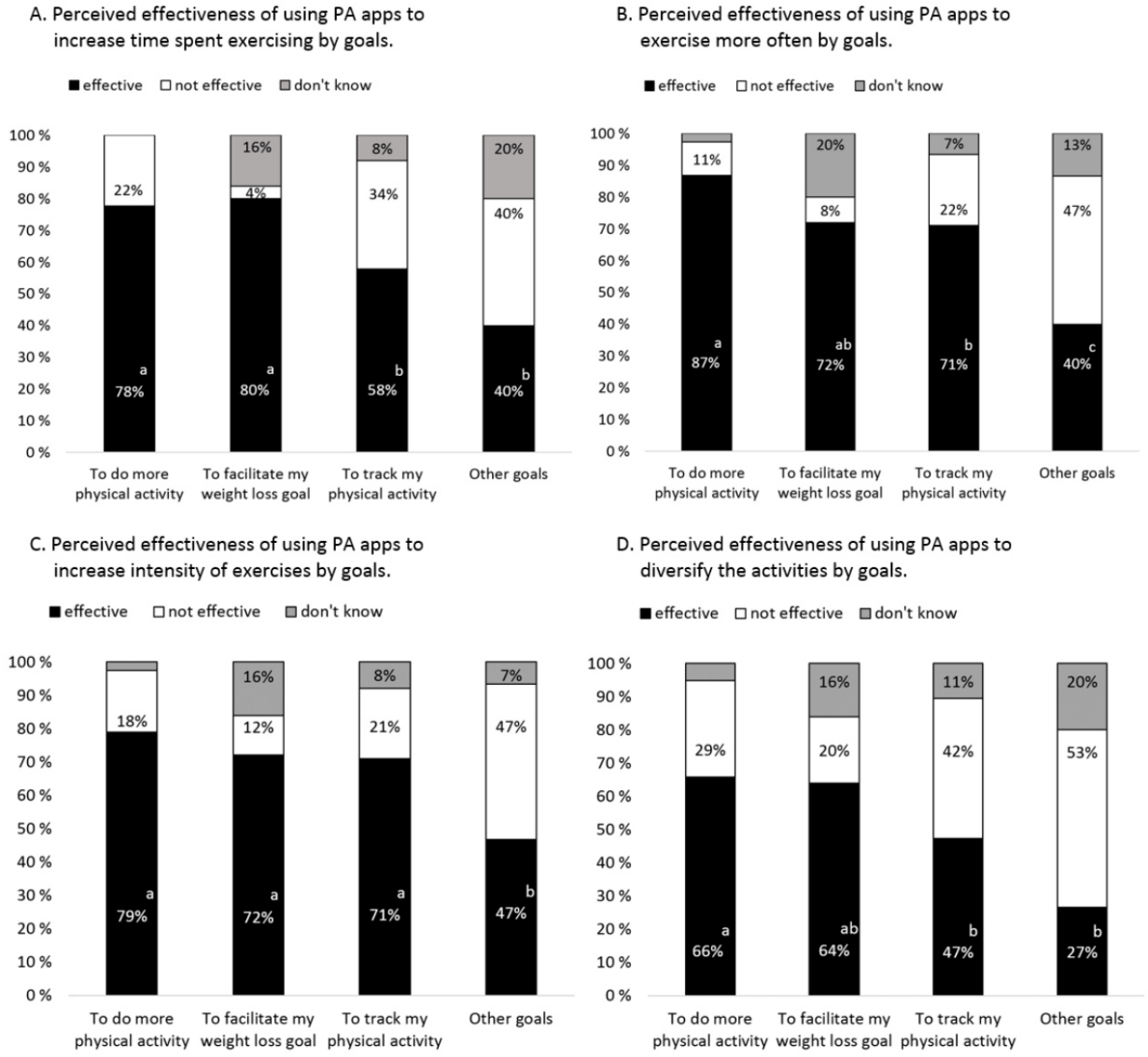


Perceived Effectiveness of Using PA Apps Influenced by App Usage and Goals

App usage influenced the perceived effectiveness of diversifying physical activities (P=.003). Duration of and adherence to using apps did not influence users' perceived effectiveness of PA apps. Goals influenced perceived effectiveness for increasing time spent exercising, exercising more often, increasing intensity of exercises, and diversifying activities (all P<.05).

App usage was associated with perceived effectiveness of diversifying activities. More users of both diet and PA apps reported that PA apps effectively assisted them to diversify activities than did those who used only PA apps, χ^2_1=12.2, P<.001. Goals were associated with perceived effectiveness of using PA apps (Figure 3). PA app users with a goal to do more PA or to lose weight had a higher probability of reporting that apps were effective in assisting them to increase time spent on exercising, than did users who only wanted to track their PA (P=.009 and P=.046, Figure 3, Part A). PA app users who had a goal to do more PA had a higher probability of reporting that apps were effective in assisting them to exercise more often or to diversify their activities than users who had a goal to track their PA (both P=.02) or who had other goals (P<.001 and P=.005, Figure 3, Parts B and D). More PA app users who had a goal to do more PA, to reach a weight loss goal, or to track PA, reported that apps were effective in assisting them to increase the intensity of exercises than did users who had other goals (all P<.05, Figure 3, Part C).

Figure 3. Percentages of PA app users with different goals and their evaluation of the effectiveness of using PA apps to assist their physical activities.



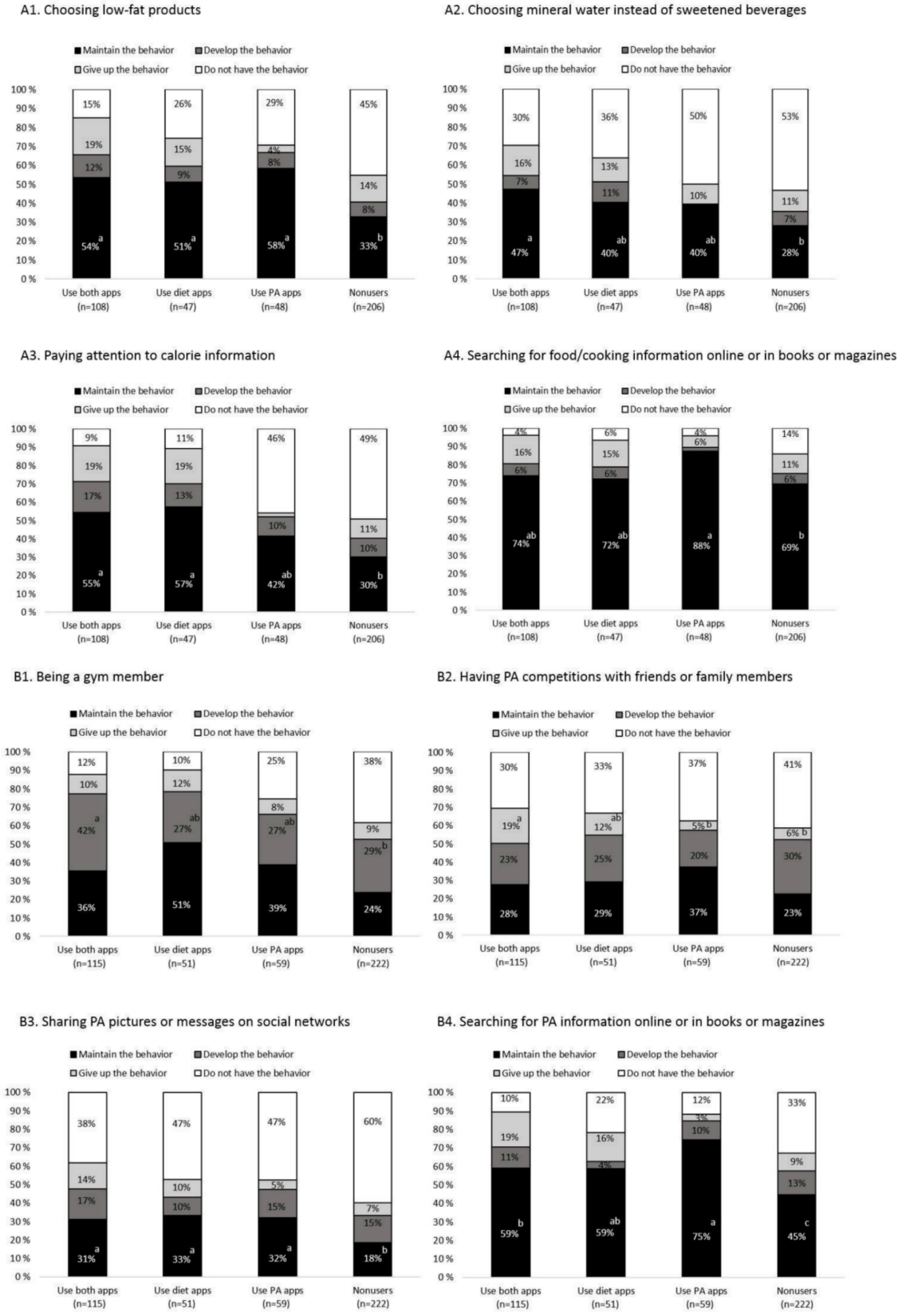
Dietary and Physical Activity Behavior Changes and Weight Change Associated With App Usage

Dietary Behavior Changes Influenced by App Usage

App usage was associated with the following dietary behavior changes: choosing low-fat products, choosing mineral water instead of sweetened beverages, paying attention to calorie information, and searching for information about food and cooking (all $P<.05$, Figure 4A). App usage did not influence the behavior change of cooking at home instead of buying ready-made meals. Food and health concerns were associated with paying attention to calorie information and cooking at home instead of buying ready-made meals ($P<.001$ and $P=.03$). Weight status was not associated with dietary behavior changes (all $P>.15$).

App users had a higher probability of maintaining the behavior of choosing low-fat products instead of ordinary products compared to nonusers (all $P<.05$, Figure 4A1). Users of both diet and PA apps had a higher probability of maintaining the behavior of choosing mineral water instead of sweetened beverages compared to nonusers ($\chi^2_1=11.4$, $P<.001$, Figure 4A2). Diet app users—who used both diet and PA apps or only diet apps—had a higher probability of maintaining the behavior of paying attention to calorie information than nonusers (both $P<.001$, Figure 4A3). Those who used only PA apps had a higher probability of maintaining the behavior of searching for information about food or cooking on the Internet, or in books or magazines, than nonusers ($\chi^2_1=6.4$, $P=.01$, Figure 4A4).

Figure 4. Percentages of dietary behavior change and physical activity behavior change among different participants (use both apps, use diet apps, use PA apps, and nonusers). A1-A4. Dietary behavior changes. B1-B4. Physical activity behavior changes.



Physical Activity Behavior Changes Influenced by App Usage

App usage was associated with changes in PA including becoming a gym member, having competitions with friends and family members, sharing pictures or messages related to exercises on a social network, and searching for PA information on the Internet or in books or magazines (all $P<.05$, Figure 4B). Food and health concerns, as well as weight status, were associated with the PA behavior change of having competitions with friends or family members ($P=.009$ and $P=.02$). Food and health concerns, and weight status, were not associated with the other PA behavior changes.

Users of both diet and PA apps had a higher probability of becoming gym members than nonusers ($\chi^2_1=7.2$, $P=.007$, Figure 4B1), and a higher probability of giving up having PA (eg, running, skiing) competitions with friends or family members than nonusers ($\chi^2_1=6.3$, $P=0.01$) and those who only used PA apps ($\chi^2_1=13.1$, $P<.001$, Figure 4B2). They also had a higher probability of continuing to share pictures or messages related to their exercises on a social network than nonusers ($\chi^2_1=7.1$, $P=.007$, Figure 4B3). Those who used only PA apps had a higher probability of continuing to search for PA information on the Internet, or in books or magazines, than those who used both diet and PA apps ($\chi^2_1=4.1$, $P=.04$) or nonusers ($\chi^2_1=16.8$, $P<.001$, Figure 4B4).

Weight Change Influenced by App Usage

App users and nonusers differed in their weight change ($P=.001$). Food and health concerns and weight status did not affect weight change. Those who used both diet and PA apps and those who used only diet apps had a higher probability of weight loss during the last 12 months compared to nonusers ($P<.001$ and $P=.01$) and users who used only PA apps ($P=.001$ and $P=.03$). Diet app users ate more fruit and vegetables and a lower total amount of food during the last 12 months compared to PA app users and nonusers ($P=.04$ and $P=.002$, respectively). There was no significant difference in low-fat food, processed meat, sweetened beverage, and fast food consumption between PA app users and nonusers (all $P>.1$).

Opinions About Apps

Both app users and nonusers provided their opinions about the apps (Table 2). In sum, 339 out of 500 participants (67.8%) thought that mobile phones, tablets, or computers were easy for them to use and they liked using them; and 319 out of 500 participants (63.8%) felt apps were not hard for them to understand. Half of the participants thought it was not hard to obtain information from apps, and only 143 out of 500 participants (28.6%) thought it was time consuming to use these apps. In total, 160 out of 500 participants (32.0%) felt it was fun to use apps.

Generally, the app users had positive opinions about using health apps. Their opinions were more positive than nonusers' perceptions of app usage. Comparing to nonusers, there were more app users who agreed with opinions that they were concerned about health, and so they wanted to use health apps and found it fun to use them (both $P<.001$). More app users disagreed with opinions that apps could not help them to be healthy, that it was hard to get information from apps, that it was time consuming to use apps, or that they could not find an app that fit their expectations, compared to nonusers (all $P<.001$).

Table 2. Opinions about apps—percentages of disagreement/agreement with nine statements about health apps (N=500).

Opinions	Disagree strongly	Disagree moderately	Disagree slightly	Neutral	Agree slightly	Agree moderately	Agree strongly
I like to use smartphones, tablets, or computers.	6.4%	3.8%	4.2%	17.8%	12.2%	15.8%	39.8%
It is easy for me to use smartphones, tablets, or computers.	3.6%	3.8%	3.4%	14.4%	9.4%	13.2%	52.2%
It is hard for me to understand how health-related apps work on smartphones, tablets, or computers.	37.0%	16.6%	10.2%	25.6%	6.2%	2.6%	1.8%
I am concerned about my health, so I want to use health-related apps.	28.8%	13.8%	7.4%	30.2%	12.0%	5.8%	2.0%
I think health-related apps cannot help me to be healthy.	14.8%	13.4%	18.0%	31.0%	9.2%	8.0%	5.6%
It is hard for me to get information from health-related apps.	17.2%	19.2%	13.6%	38.2%	7.6%	1.6%	2.6%
It is time consuming for me to use health-related apps.	11.2%	11.6%	15.2%	33.4%	18.0%	6.6%	4.0%
I find it fun to use health-related apps.	10.6%	7.6%	9.0%	40.8%	15.8%	11.6%	4.6%
I cannot find a health-related app that fits my expectations.	12.2%	9.2%	10.8%	48.4%	11.2%	4.8%	3.4%

Discussion

Principle Findings

This study suggests that users find diet and PA apps effective in promoting healthy eating and more exercise through effects on their actions, health consciousness, self-education about nutrition and PA, and social life. Apps were particularly effective when they were used frequently and over a long period (eg, more than 1 month). App usage was also associated with actual self-reported behavior, particularly maintenance of healthy behaviors, and also, depending on the goal, adoption of new behaviors in the case of PA apps.

In the focus group, users and nonusers discussed and evaluated the apps' influence on diet and PA. Users reported that using apps influenced eating and exercising. Based on responses to the questionnaire, they perceived that they ate healthier foods and exercised more when using apps. A previous qualitative study showed that users considered an app's ability to record and track behavior and goals as valuable [23]. By recording and tracking food intake and physical activities, apps give feedback to users on how well they are doing in reaching their goals. One study reported that feedback significantly increased users' motivation to engage in PA [24]. Apps act as a reminder or evaluator for users. They also give suggestions and alternatives related to dieting and exercising that aim to help users achieve their goals. In the focus group discussions, users felt more confident about themselves when they experienced success in healthy eating and increased exercising. Frequent use over time can result in positive evaluation of self-performance, and in response, an improved attitude towards the behavior (in this case healthier eating or increased exercising), particularly when the app has options to show users their progress over time. Increased knowledge and awareness, which often were brought up in the focus groups, can make it easier for users to perform a behavior, and thus increase perceived behavioral control. Users also experienced interactions between social networks and app usage, which may in turn affect social norms. They received both positive and negative comments and feedback from friends and family members, and sometimes even used apps together with friends, which facilitated sharing of outcomes. Based on the theory of planned behavior, using apps influenced all three constructs (attitudes towards the behavior, perceived behavioral control, and subjective norms), which strengthened the behavior intention. The stronger the intention, the more likely it was that users would execute a healthy behavior [25]. In this study, app users perceived that apps were effective in facilitating their food intake and activity. Results from this study showed that diet apps could be effective in promoting users to follow the Nordic Nutrition Recommendations, and PA apps could be effective in promoting users to increase duration, frequency, intensity, and diversity of exercise. Using apps strengthened users' intentions and behavior performance.

The findings of this study support the concept that app usage can expand eHealth literacy. eHealth literacy reflects people's ability to seek, find, understand, and appraise health information from electronic sources and apply that knowledge to make a health-related decision [26]. Users explored eHealth information through the apps. By seeking, understanding, and appraising eHealth information, they processed it to guide their actions. At the same time, limited eHealth literacy can preclude some populations from accessing health information. Prior research has shown that individuals' education, health status, and motivation influences eHealth literacy [27]. Furthermore, younger and more educated people have higher eHealth literacy than their counterparts [28]. However, in general, users find apps easy and convenient to use [29,30]. These findings coincide with those of this study, in that half of the survey population thought it was not hard to obtain information from apps.

Since using apps could strengthen behavioral intention and expand eHealth literacy, this study also examined whether using apps led to self-reported health behavior changes during the last 12 months. Health behavior change is a central objective of health promotion, and new health behaviors are often not maintained [31,32]. Results of the questionnaire showed that app usage was associated with maintenance of healthy behaviors. App users continued to choose low-fat products instead of high-fat alternatives and mineral water instead of sweetened beverages, and continued to look for diet-related and PA-related information more often than the nonusers. Using apps advanced self-regulation skills and ability, and supported users to engage in healthy behaviors [33]. In addition, over 66.7% (128 out of 192) of the app users used both diet and PA apps, and monitored both food intake and energy output. These individuals maintained health behaviors better than those who only used diet or PA apps. Future studies could provide details on the role of combined app usage in changing health behaviors, to give more specific advice.

In this study, there was no direct evidence showing a relationship between app users' perceived effectiveness of using apps and their actual health behavior changes. This study had a few examples showing a weak link between perceptions and behavior. For example, more than half of the app users perceived that PA apps effectively assisted them to be active; meanwhile, this group of people had a higher probability of becoming a gym member as an actual behavior. However, perceptions may not always match behaviors. The relationship between perceived effectiveness of using apps and actual behavior change needs further evaluation.

Users reacted in various ways toward the apps. According to the questionnaire, 97 out of 500 participants (19.4%) agreed that they could not find an app that met their expectations. Further development of diet and PA apps could involve tailoring to match requirements on a personal or subgroup level, such as for teenagers, young adults, middle-aged adults, or older adults. These subgroups differ in knowledge, experience, health situations, and goals. Each user has individual needs, so personalization of apps is necessary. Tailoring apps to meet personal needs has been discussed and suggested in previous studies [23,34,35]. In this study, in the focus group discussions, some users complained that they had difficulty finding Norwegian brands and foods in diet apps, since most were not developed based on the Norwegian food market. Both users and nonusers mentioned that tailoring apps to fit personal interests would be a good idea for the future development of apps. Thus, users would benefit more if apps were tailored to their

expectations and personal needs. Meanwhile, since nonusers' perceptions of app usage were less positive than users in this study, tailoring apps to fit nonusers' needs may increase their interest in using apps.

This study evaluated perceived effectiveness and self-reported behavior changes associated with app usage through a questionnaire. It revealed the effects of apps on healthy eating and exercising; however, these effects were not validated in a randomized controlled trial. Future studies should evaluate the strengths of the reported effects in randomized controlled trials with adequately powered sample sizes. The sample population in this study may be a limitation, and larger sample sizes should be implemented in future work.

Conclusions

Using diet and PA apps influenced actions, consciousness, self-education about nutrition and PA, and social lives of users. App usage facilitated healthy eating and increased exercising, as well as the maintenance of healthy behaviors. The apps were considered fun to use; however, some (eg, dietary apps) were time-consuming. Future apps could be tailored to meet personal needs, and future studies could use app tracking data to measure actual food consumption and PA changes rather than perceived changes through self-reports.

Acknowledgments

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Conflicts of Interest

The authors have no declared conflicts of interest.

Multimedia Appendix 1

Study questionnaire.

[PDF File (Adobe PDF File), 272KB - mhealth_v4i2e33_app1.pdf]

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Abbreviations

PA: physical activity

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Application Survey

1. Have you used diet app, or physical activity app on smartphone, tablet or computer during the last 12 months?
    a. Yes, I have used at least one of the three apps during the last 12 months, and I am currently using it/them.
    b. Yes, I have used at least one of the three apps during the last 12 months, but I am not currently using it/them.
    c. No, I have used none of the three apps during the last 12 months, but I know at least one of them.
    d. No, I have used none of the three apps during the last 12 months, and I know none of them.

Behavior questions

Answer following questions based on your normal routine during the last 12 months.

2. Here are statements about food behavior. Please choose the answers that fit you the best.

	I did it before the last 12 months, but I no longer did it in the last 12 months	I did it before the last 12 months, and I still did it in the last 12 months.	I did not do it before the last 12 months, but I started to do it in the last 12 months.	I did not do it before the last 12 months, and I still did not do it in the last 12 months.	I do not know
I paid attention to calorie information.					
I chose low-fat products instead of ordinary products.					
I chose mineral water instead of sweetened beverage.					
I cooked at home instead of bought ready meals.					
I searched for information about food or cooking on line or in books or in magazines.					

3. Here are statements about getting fit. Please choose the answers that fit you the best.

	I did it before the last 12 months, but I no longer did it in the last 12 months	I did it before the last 12 months, and I still did it in the last 12 months.	I did not do it before the last 12 months, but I started to do it in the last 12 months.	I did not do it before the last 12 months, and I still did not do it in the last 12 months.	I do not know
I was a member of gym.					
I had physical activity (e.g. running, skiing) competitions with friends or family members.					
I shared pictures or messages related to my exercises on my social network (e.g. Facebook, Twitter).					
I searched for information about physical activity on line or in books or in magazines.					
I searched for information about weight loss on line or in books or in magazines.					

4. Did your weight change during the last 12 months?
   I lost weight. (If people choose this one, they get additional question to fill in how many kg they had lost.)_____kg.
   I gained weight. (If people choose this one, they get additional question to fill in how many kg they had gained.)_____kg.
   My weight did not change.

5. Did you have a specific goal to lose weight during the last 12 months?
   Yes
   No

6. Did you have a specific goal to improve your diet during the last 12 months?
   Yes
   No (escape the next question)

If you had a goal to improve your diet, Om du hadde et mål om å forbedre kostholdet ditt,

7. what methods did you try to improve your diet during the last 12 months? (Single choice or multiple choices)
   Followed specific diets
   Consulted dietitians
   Went to slimming courses
   Used diet apps
   Learned cooking or healthy food choices from TV, book or online.
   Other _____ (Fill in)

8. How did your food intake change during the last 12 months?

	A lot less	A little bit less	About the same	A little bit more	A lot more	I do not eat this kind of food
Total amount of food per day						
Fruit and vegetables						
Low-fat products						
Processed meat (anything cured, smoked, or bought from deli)						
Beverages with added sugar						
Fast food (e.g. McDonald's)						

9. Did you have a specific goal to increase physical activity during the last 12 months?
   Yes
   No (escape the next question)

If you had a goal to increase physical activity, om du hadde et mål om å øke din fysiske aktivitet

10. what methods did you try to increase physical activity during the last 12 months? (Single choice or multiple choices)
    Went to gym
    Consulted personal trainers
    Used physical activity apps
    Joined sport clubs
    Participated sport competitions such as marathon race
    Used private exercise room
    Other _____ (Fill in)

11. How did your physical activity change during the last 12 months?

	A lot less	A little bit less	About the same	A little bit more	A lot more	I do not do this kind of physical activity
Physical activity in general						
Walking						
Active involvement in games and sports with children or walking domestic animals						
Running						
Fast cycling, skiing, or swimming						
Football, volleyball, hockey or other competitive sports						
Exercise in gym						
Other activity_____ (Fill in)						

App questions

Section 1: diet app

Here is <u>an example</u> of a diet application (app) that enables users to track dietary intake, and gives relevant information about food and diet.

12. Have you used a diet app (on smartphone, tablet, or computer) during the last 12 months?
    a. Yes, I have used a diet app during the last 12 months, and I am currently using it.
    b. Yes, I used a diet app during the last 12 months, but I am not currently using it.
    c. No, I know about diet apps, but I do not use them. (If participants choose this answer, they should jump to section 2.)
    d. No, I do not know what a diet app is. (If participants choose this answer, they should jump to section 2.)

13. How long have you used a diet app? _____months

    Please specify the period that you have used the app: (Fill in the sentence that fits you best)

    From ____ (month, let people choose from 12 months), _____ (year) to now

    Or

    From ____ (month, let people choose from 12 months), _____ (year) to ____ (month, let people choose from 12 months), _____ (year)

Please think about the period that you use/used the diet app, and answer the following two questions.

14. How often did you use the diet app **during the first month after you started using it**?

    More than once per day

    1 time per day

    1-6 times per week

    1-3 times per month

    Less than 1 time per month

15. How often did you use the diet app **during the last month**?
    More than once per day
    1 time per day
    1-6 times per week
    1-3 times per month
    Less than 1 time per month

16. To what extent do you agree with the following statements? Please choose the answers that fit you the best.

	Disagree strongly	Disagree moderately	Disagree slightly	Neutral	Agree slightly	Agree moderately	Agree strongly
It is easy for me to understand how the diet app works.							
It is time consuming for me to use the diet app.							
It is easy for me to get information from the diet app.							
It is boring to use the diet app.							
It is easy for me to reach my goal by using the diet app.							

17. What is your main goal to use diet apps?
    To track my calorie intake
    To check nutrients in my food
    To check information because I have allergy, celiac disease, or other food-related health issues.
    To get an overview of my food consumption
    To facilitate my grocery shopping
    To facilitate my weight loss goal
    To facilitate my work (dietitian, sports coach etc.)
    To help me to eat healthier in general
    Other _____ (Fill in)

18. What are your motivations to use diet app to achieve your goal? Please choose the answers that fit you the best.

	Disagree strongly	Disagree moderately	Disagree slightly	Neutral	Agree slightly	Agree moderately	Agree strongly
I think it is easy to obtain food information from the diet app.							
I need to pay attention to my diet, because my family has disease history, e.g. cardiovascular disease or cancer.							
I want to have diet competitions with friends or family numbers.							
I want to share my diet on social network.							
Other _____ (Fill in)							

19. How effective has the diet app been in assisting your diet?

	Very effective	Somewhat effective	Slightly effective	Not effective	I do not know
To eat more low-fat alternatives of dairy					
To eat more fruit and vegetables					
To eat less sausages					
To drink less sweetened beverages					
To eat less fast food, which it typically high in salt and saturated fat					
To choose more healthy food products, such as food products with Keyhole label					
Any comments _____ (Fill in)					

20. How effective is using app to reach your goal, compared to these methods?

	Very effective	Somewhat effective	Slightly effective	Not effective	I do not know
Using app is …. than on specific diets.					
Using app is …. than slimming courses.					
Using app is …. than learning cooking or healthy food choices from TV, book or online.					

Section 2: physical activity app

Here is <u>an example</u> of a physical activity application that enables users to track physical activity throughout the day, or track physical activity during specific events such as running, biking, aerobics, and gives relevant information about exercise.

21. Have you used a physical activity app (on smartphone, tablet, or computer) during the last 12 months?
    a. Yes, I have used a physical activity app during the last 12 months, and I am currently using it.
    b. Yes, I used a physical activity app during the last 12 months, but I am not currently using it.
    c. No, I know about physical activity apps, but I do not use them. (If participants choose this answer, they should jump to section 3.)
    d. No, I do not know what a physical activity app is. (If participants choose this answer, they should jump to section 3.)

22. How long have you used a physical activity app? _____months
    Please specify the period that you have used the app: (Fill in the sentence that fits you best)
    From ____ (month, let people choose from 12 months), _____ (year) to now
    Or
    From ____ (month, let people choose from 12 months), _____ (year) to ____ (month, let people choose from 12 months), _____ (year)

Please think about the period that you use/used the physical activity app, and answer the following two questions.

23. How often did you use the physical activity app **during the first month after you started using it**?
    More than once per day
    1 time per day
    1-6 times per week
    1-3 times per month
    Less than 1 time per month

24. How often did you use the physical activity app **during the last month**?
    - More than once per day
    - 1 time per day
    - 1-6 times per week
    - 1-3 times per month
    - Less than 1 time per month

25. To what extent do you agree with the following statements? Please choose the answers that fit you the best.

	Disagree strongly	Disagree moderately	Disagree slightly	Neutral	Agree slightly	Agree moderately	Agree strongly
It is easy for me to understand how the physical activity app works.							
It is time consuming for me to use the physical activity app.							
It is easy for me to get information from the physical activity app.							
It is boring to use the physical activity app.							
It is easy for me to reach my goal by using the physical activity app.							

26. What is your main goal to use physical activity app?
    - To track my physical activity
    - To do more physical activity
    - To facilitate my weight loss goal
    - To facilitate my work (dietitian, sports coach etc.)
    - Other _____ (Fill in)

27. What are your motivations to use physical activity app to achieve your goal? Please choose the answers that fit you the best.

	Disagree strongly	Disagree moderately	Disagree slightly	Neutral	Agree slightly	Agree moderately	Agree strongly
I have health issues that can be managed by physical activity.							
I have high risk of some disease due to family disease history, e.g. cardiovascular disease or cancer.							
I want to have good body shape.							
I want to have physical activity competitions with friends or family numbers.							
I want to share my physical activity on social network.							
Other _____ (Fill in)							

28. How effective has the physical activity app been in assisting your physical activity?

	Very effective	Somewhat effective	Slightly effective	Not effective	I do not know
To increase time spent exercising					
To exercise more often					
To increase intensity of exercises					
To diversity the activities					
Any comments _____ (Fill in)					

29. How effective is using app to reach your goal, compared to these methods?

	Very effective	Somewhat effective	Slightly effective	Not effective	I do not know
Using app is …… than consulting personal trainers.					
Using app is …… than joining sport clubs.					
Using app is …… than using private exercise rooms.					

30. How did using the physical activity app change your frequency of exercising in number of days? Choose one sentence that fits you the best to fill in the number of days.
    After using the physical activity app, I exercised_____ less days per week than before.
    After using the physical activity app, I exercised_____ more days per week than before.
    Number of days that I exercised did not change.

31. How did using the physical activity app change the number of hours that you exercise? Choose one sentence that fits you the best to fill in the number of hours.
    After using the physical activity app, I exercised_____ hours less per time.
    After using the physical activity app, I exercised_____ hours more per time.
    Number of hours that I exercised did not change.

App usability questions

32. What are your opinions about new technology and health-related apps (such as diet app, and physical activity app)? Please choose the answers that fit you the best.

	Disagree strongly	Disagree moderately	Disagree slightly	Neutral	Agree slightly	Agree moderately	Agree strongly
I like to use smartphones, tablets or computers.							
It is easy for me to use smartphones, tablets or computers.							
It is hard for me to understand how health-related apps work on smartphones, tablets or computers.							
I am concerned about my health, so I want to use health-related apps.							
I think health-related apps cannot help me to be healthy.							
It is hard for me to get information from health-related apps.							
It is time consuming for me to use health-related apps.							
I find it fun to use health-related apps.							
I cannot find a health-related app that fits my expectations.							
Any comments _____ (Fill in)							

33. What is your main problem with health-related apps? (Open question)

General questions

34. How do you identify your gender?
    - Male
    - Female

35. What is your age? (Dropdown menu with the possible ages, 18-35)

36. What are the first 3 digits of your postcode? _____

37. My height is (fill in): _____ centimeters

38. My weight is (fill in): _____ kilograms

39. What is your marital status?
    - Not married, without child/children.
    - Not married, with child/children.
    - Married or domestic partnership, without child/children.
    - Married or domestic partnership, with child/children.
    - Separated/Divorced, without child/children.
    - Separated/Divorced, with child/children.
    - Widower/widowed, without child/children.
    - Widower/widowed, with child/children.

40. Are you currently…?
    - Employed for wages
    - Self-employed
    - Jobless
    - Staying at home
    - A student
    - In the military
    - Unable to work

41. What is your highest level of education attained?
    - Primary (Barneskolen/Ungdomsskolen)
    - Secondary (Videregående teoretisk, Videregående profesjon)
    - College/University (høyskolen/universitet)
    - Graduate/Professional (i.e. Master's/PhD)

42. Which of these categories best approximates how much you earn in a year, before tax (including student loan if you have one)? (Remember, your identity will be anonymous).
    - Less than 200,000 Kr
    - 200,000-400,000 Kr
    - 400,000-600,000 Kr
    - 600,000-800,000 Kr
    - 800,000-1,000,000 Kr
    - 1,000,000 Kr or more

43. I am concerned about getting a lot of fat in my food.
    - I am not concerned at all
    - I am concerned a little
    - I am concerned
    - I am concerned a lot
    - I am extremely concerned

44. I am concerned about getting many calories.
    - I am not concerned at all
    - I am concerned a little
    - I am concerned
    - I am concerned a lot
    - I am extremely concerned

45. I am concerned about getting a lot of sugar in my food.
    - I am not concerned at all
    - I am concerned a little
    - I am concerned
    - I am concerned a lot
    - I am extremely concerned

46. I am concerned about gaining weight.
    - I am not concerned at all
    - I am concerned a little
    - I am concerned
    - I am concerned a lot
    - I am extremely concerned

Thank you for completing this questionnaire.

Paper IV

Promoting Healthy Eating Behavior at School: Experts' Opinions about Promising Intervention Strategies

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ABSTRACT

BACKGROUND: Schools are generally considered to be important places for implementing interventions to promote healthy eating behaviors in adolescents. Yet, there is relatively little consensus among experts and professionals on which interventional approaches are the most suitable to improve the dietary patterns of adolescents. This study aimed to explore experts' assessments of the potential effectiveness of three strategies (law, education, and marketing) for designing healthy eating interventions at school.

METHODS: Experts (N=31) active in the field of healthy food policies at high schools participated in an online-administrated survey. The survey addressed the evaluation of 15 illustrative interventions in three approaches (law, education, and marketing).

RESULTS: The majority of experts (N=28) were in favor of combining interventions, which was considered to be more cost-effective than not combining interventions. Nutritional education at school was seen as necessary, but not sufficient. Interventions focusing on healthy food availability and accessibility (particularly fruit and vegetables) were identified as important.

CONCLUSIONS: More comprehensive school nutrition policies were supported by experts in the field. Limiting exposure to unhealthy foods and increasing healthy food accessibility, coupled with nutritional education, were seen as most promising. Overall, a shared responsibility among individual students and schools was essential for effective interventions. (200 words)

Keywords: school intervention; intervention strategy; expert opinion; healthy eating

Health services are facing diet-related challenges for adolescents. The main challenges include a steady increase of overweight and obesity,[1] eating disorders, and iron-deficiency anemia. Diet plays a key role in those diseases and conditions.[2] Significant changes in diet have been obvious in recent decades: people eat larger amounts of food, and foods which are of lower nutritional quality. Consumption of large quantities of high-sugar, high-fat, and energy-dense snacks contribute to the increasing prevalence of overweight and obesity.[3] Snacking occasions have significantly increased,[4] and, as a consequence, the energy intake from increased snacks can now – together with light meals – contribute to 25-35% of the daily energy intake.[5] In the countries that serve school meals, snacks sold at school are considered competitive foods in competition with the school meal. Meanwhile, many adolescents skip breakfast or lunch[5,6] for reasons including pressure from society's obsession about the 'perfect' body, which encourages omission of meals. Taken together, these habits have given rise to two unhealthy extremes: overconsumption and under-consumption. Besides the issue food quantity, the quality of food is another concern. For instance, adolescents' intake of fast food and junk food is associated with poor diet quality and a high prevalence of overweight and obesity.[7,8] Therefore, encouraging healthy eating behavior among adolescents has become an important priority in public health.

School is a good environment to form a healthy eating behavior.[9] Adolescents spend at least eight hours per day at school and consume a large portion of their daily energy during this time. Adolescents can have lunch, snacks, and sometimes breakfast at school. Either they bring food to school, or they buy or get free food. There are several school interventions that target healthy eating behavior worldwide, for example, food education, gardening, and school fruit programs.[10] These interventions aim to help adolescents establish or shape their eating behavior.

Three Strategies in School Interventions

Although several different intervention classifications exist, Rothschild's classification is particularly appropriate to study school interventions as we discuss in this paper. Three strategies in Rothschild's classification are law, education, and (social) marketing.[11-13] Law is defined as 'non-voluntary adaptations of behavior by using coercion and by punishing consumers for non-compliance.' It includes policies that intend to change the market environment by, for instance, changing prices or restricting food availability. These policies can be at the national level or tailored to individual schools. Education refers to voluntary adaptation of behavior by providing information to consumers, and includes health communication and food education at school. A nutrition curriculum, gardening, cooking courses, and health information through videos, posters, and booklets are all approaches to educate adolescents about healthy food and healthy eating. Marketing refers to voluntary adaptations of behavior; however, this is done by reinforcing consumers and targeting the food environment at school. Healthy school meals, healthy competitive snacks in vending machines, and fruit and vegetables at school are practices to create a healthy food environment through improving the healthy food availability and accessibility. Nudging is another example; for instance, providing sliced fruit at school, healthy

food at the eye level, and healthy snacks at the checkout counter: all efforts to encourage adolescents to choose healthy alternatives rather than unhealthy ones.[14-16]

Over the past decades, numerous studies have reported school interventions that incorporate elements from some or all of these three strategies.[10, 17-19] The studies were heterogeneous in design, intervention, participants, and outcomes.[20] Evidence of the effectiveness of the various approaches is mixed.[17, 20-22] Since evidence of effectiveness is unavailable, interventions require the opinions of experts.[23] Experts, who, working in the field of school nutrition, may give some explanations about why certain interventions are feasible (while others are not) according to their own experience in practice.

The question of which interventions to implement is a complex one. To support the development of healthy school policies, it is essential to capture the type and spread of opinions, and critical elements that are crucial for successful implementation. Therefore, opinions from various relevant perspectives need be considered and integrated. Experts, such as school administrators, nutrition experts, school program managers, policy makers, and researchers, can use their experience in practice to assess the importance of the three strategies. This article aims to provide multiple perspectives on school interventions, and to discuss potential action points for future school interventions.

METHODS

Participants

We invited 89 experts with knowledge on the issue of 'promoting healthy eating behavior at school' from Norway, the Netherlands, and the US. In total, 31 experts chose to participate in the study. These experts consisted of 5 policy makers, 5 school workers, 9 nutrition/school project experts, and 11 researchers. One expert's working field was unknown. They filled out an online-administrated survey that contained questions about how efficient three strategies could be in practice at high schools. Data was collected from March to July, 2015.

Procedure

After the experts provided informed consent prior to participation, we presented 15 illustrative interventions, five for each strategy (Table 1), based on previous research on how to encourage healthy eating at school.[18, 21, 24-29] Experts needed to state whether they supported/opposed or were neutral to each intervention. Thereafter, they explained why they supported or opposed the interventions, as they had indicated, in the form of open questions. Next, they expressed to what extent healthy eating habits were the responsibility of the school or the responsibility of the student, on a 9-point scale (1=entirely student, 9=entirely school). After that, the three strategies (law, education, and marketing) were introduced to the experts with definitions and one example for each strategy. Experts were asked the following questions: 1. "Which of the three strategies is the most effective in a school context? Make a rank (1=most effective, 3=least effective)," 2. "Interventions can be combined. Please indicate the extent to which you agree with a statement 'Combining interventions is more effective in changing eating

habits than not combining' with a 5-point agree/disagree scale," and 3. "Which of these strategies is the most cost-effective in a school context: law, education, marketing, or combining intervention strategies?" Experts gave explanations to their ranking and their agreement.

Data Analysis

Survey results were summarized numerically. Responses to open-ended questions were analyzed for emerging themes. At the general level, the dominant themes of evaluations of school interventions relate to: (1) the need to offer and promote healthy foods at school, (2), fruit and vegetables as target intervention foods, (3) restricting unhealthy foods at school within limits, (4) necessity of education, and (5) comprehensiveness of a set of interventions. Quotes from experts that matched each of the themes were identified. Results were discussed for different expert groups (policy makers, school workers, nutrition/school project experts, or researchers).

RESULTS

In general, the experts believed that both the school and students should share responsibility in forming healthy eating behavior (mean score=5.1 (SD±1.8), 1=entire responsibility of the student, 9=entire responsibility of the school). Experts' attitudes towards the 15 illustrative interventions are summarized in Table 2.

The Need to Offer and Promote Healthy Foods at School

Several experts (N=22, 71%) supported the intervention of "Offering a majority of healthy snacks in vending machines at school." As might be expected, experts consistently argued that offering and promoting healthy foods at school was necessary. One policy maker referred to the World Health Organization 2006 slogan: "Make the healthy choice the easy choice." The majority of experts (N=23, 74%) also supported the intervention described as "redesigning school canteens to make it easier to access healthy snacks and harder to access unhealthy snacks." This intervention refers to restructuring the environment such that students are automatically guided towards healthier foods and drinks.

"(The school food) environment has to support an easy choice for healthy food." (Researcher)

Nevertheless, from all marketing-based interventions, the promotion of healthier foods by famous athletes received less support.

"I think famous athletes can give the wrong focus. Not everyone has to be an athlete." (School worker)

Interventions Targeted for Fruit and Vegetables Are Met with Enthusiasm

A large majority of experts (N=26, 84%) supported the intervention, "Improving school lunch programs to offer more fruit and vegetables." No expert was against it. Two experts suggested offering free fruit and vegetables to the students.

"*Free fruit two days a week*." (School worker)

Fruit and vegetable interventions were perceived to be feasible, in contrast to most law-based interventions, which were seen as impractical to implement or unfair (e.g. taxing high caloric foods).

Restricting Unhealthy Food at School, but Limiting Food Choices Could Be a Problem

The majority of the experts (N=26, 84%) supported the policy of restricting in-school availability of high-sugar and high-fat foods and beverages. No policy maker, school worker, or researcher was directly against this intervention. However, one expert working at a school did indirectly oppose this intervention by arguing that students must learn to make choices by themselves. In this manner, they could take the responsibility for what they eat, and, as a result, they would acquire the essential skills on how to choose to eat healthily, also when school was over. Although no researchers were against this intervention, one of them shared the opinion that totally restricting unhealthy foods might not be effective, as students could get a higher desire to eat 'forbidden' foods.

"*School policy should be on providing only healthy food, also in vending machines, but the students may still choose to bring and eat whatever they like*." (Nutrition/school project expert)

Education Is Necessary, but Not Sufficient

The majority of the experts (N=23, 74%) supported the intervention, "More lessons given by teachers to improve knowledge, attitudes, and eating habits", whereas 65% (N=20) of the experts supported interventions based on school gardening and involving parents in nutrition education. Experts were aware of the fact that young people were a particularly hard to reach group when using conventional health promotion practices, as they did not see nutrition messages as personally relevant to them. One nutrition/school project expert pointed out the importance of addressing parental influence, and one researcher indicated that parent involvement in education might be key if they had limited nutrition knowledge. Some experts were more critical of the educational approach.

"*Education alone has proven to be only mildly effective*." (Researcher)

"*It will be important to have lots of interventions to encourage healthy eating, both restricting and supporting, and educational*." (Policy maker)

No Single Intervention Stands Out as Most Effective, and Complementary Interventions Need to Be Considered

The experts evaluated the effectiveness of three intervention strategies (Figure, 24 experts answered the questions). Marketing and law had more support than education (40% (N=10) of the experts chose marketing as the most effective strategy, while 36% (N=8) chose law, and 24% (N=6) chose education).

"*Laws are easier to gain acceptance from the youth. Education informs and raises awareness (about) why there are laws in this field. Marketing helps to get things to be a trend*." (School worker)

Most of the experts agreed with the idea that combining interventions was more effective in changing eating habits than not combining (N=28, 90% of the experts agreed or strongly agreed with it).

"*Support from each direction will have impact on behavior and possibilities to make the right choice, and, finally, will impact habits*." (Researcher)

In addition, 71% (N=22) of the experts thought that the combined interventions were the most cost-effective. All of the policy makers (5) thought that combing interventions was the most cost-effective strategy. More than half of the school workers (7 out of 9), researchers (6 out of 11), and nutrition/school project expert (3 out of 5) agreed on this idea.

"*A combination of measures has proven to be more effective, for instance with smoking. Giving information and subsequently increasing prices sends a stronger message than each one alone."* (Researcher)

DISCUSSION

The current study aimed to examine experts' assessments of the potential effectiveness of three strategies (law, education, and marketing) for designing healthy eating interventions at school. According to a large majority of experts involved in school food policies and research, there was no "one size fits all": different experts preferred different strategies or interventions. Nevertheless, this study identified types of approaches that had the strongest support among people working in the field of school nutrition in Norway, the Netherlands, and the US. Although several experts emphasized the need for complementary intervention strategies, an increase in access to healthy foods at school was one approach that was seen as essential to ensure a lasting change in eating behavior. Previous studies reported that fruit and vegetable availability and accessibility were associated with fruit and vegetable consumption.[30, 31] Adolescents can choose breakfast, lunch, and snacks based on food availability and accessibility at school, however, the variety of food at school tends to be limited. In a school environment, students only have access to the foods that are available at the school canteen or in the vending machines. Therefore, food availability at school can directly affects students' food choices, and a limited availability and accessibility of healthy foods can be a challenge for creating or maintaining healthy eating behavior. Law and marketing strategies both aim to improve healthy food availability and accessibility. Restricting food with high amounts of fat or sugar by law, and offering healthy snacks, fruit, and vegetables at school, were widely supported by experts in this study. They also supported marketing interventions that involve upgrading the social eating environment at school.

Another approach was that, in general, experts had common views on education as an approach to change students' eating habits for the good. Most people are familiar with education in a school setting to promote healthy eating behavior. The experts in this study also pointed out the importance of parent involvement – including parents in education might be essential if parents had limited nutrition knowledge. Since the 1970s, studies have started to discuss parent involvement in health promotion.[32] Parents are crucial for implementation and maintenance of

new health behaviors in young children and in adolescents.[32, 33] Importantly, a key finding of this study and in other two studies was that, although informative, experts thought that conventional approaches of educating children/teenagers could hardly influence healthy eating behavior.[34,35] In other words, education at school was necessary but not sufficient. Combining educational approaches with other interventions was seen as essential for designing healthy eating interventions at school. Moreover, using innovative approaches to reach young students to promote healthy eating has become a hot topic,[36] for instance, using text messages or using health applications on smartphones.

Limitations

There are some limitations of this study, which may hinder its generalizability. A selection bias may exist as experts came from different countries and areas of expertise and had different experience regarding promoting healthy eating behavior at school. For example, school workers evaluated and commented on the interventions based on their own experience at their schools, while researchers evaluated and commented on the interventions based on their studies or others' studies, which were usually interventions involving multiple schools in more than one country. The majority of the experts came from Norway, and few from the Netherlands and the US. School food policies and school food environments in these three countries are quite different. Norway and the Netherlands do not have a compulsory system of school meals,[37] while the US has several school meal programs that provides free or reduced price school meals to students.[38] Future research could use a larger and more random sample of experts to discuss how to design a healthy eating intervention at school. Finally, the experts who agreed to participate in the study may have, by chance, been a more proactive group who were willing to support these suggestions of changes being made in this field.

IMPLICATIONS FOR SCHOOL HEALTH

In summary, the results from this study provided a relevant glance at the importance of, and concerns about, a large range of interventions from the point of view of several experts in the field of promoting healthy eating behavior at school. In order for school nutrition policies to be effective, it is important to take experts' viewpoints into account. The largest support in this study was found for a school nutrition policy that increased healthy food availability and accessibility at school (i.e. fruit and vegetables) without entirely banning less healthy options. In addition, experts believed that parents should be involved. Generally, interventions to promote healthy eating behavior should consider the combination of education with other interventions, such as social marketing interventions.

Human Subjects Approval Statement

This study did not directly or indirectly identify personal data. According to the regulations issued by the Data Protection Official for Research in Norway,[39] this type of study did not require approval from an ethics committee.

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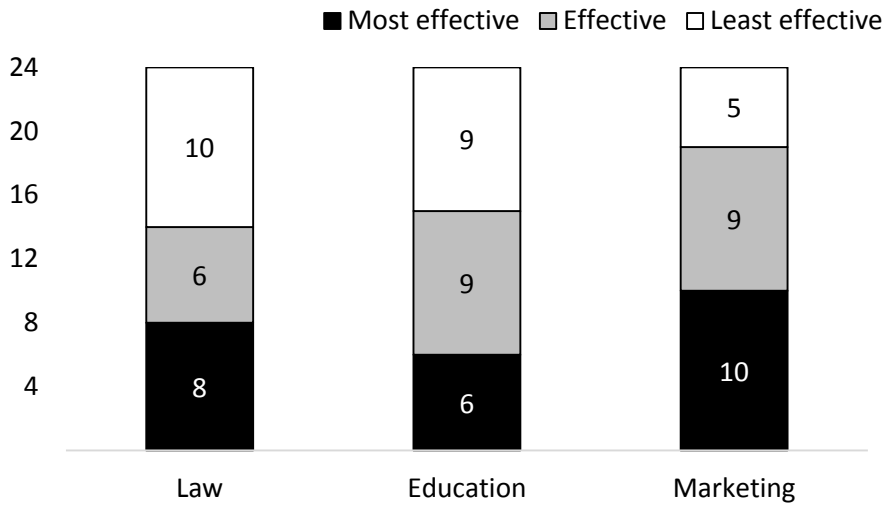

Figure. **Number of Experts Who Ranked Three Strategies (Law, Education, and Marketing) from the Most Effective to the Least Effective**

Table 1. **Fifteen Illustrative Interventions Presented to Participants (5 for Each Strategic Approach)**

		Illustrative interventions				
Strategic approaches	**Law**	Not allowing fast food outlets within one kilometer of school	Not allowing fast food or soft drink companies to sponsor adolescents' sport	Removing food high in fat or sugar from school canteen	Adding a 20% tax on foods high in fat or sugar to increase their price	Restricting in-school availability of high-sugar, high-fat foods and beverages
	Education	More lessons given by teachers to improve knowledge, attitudes and eating habits	School gardening or similar activities	Involving parents in nutrition education	Using new technology (apps on smartphone or tablet) to track diet information in school canteen	Provide information about how to create low-calorie eating habits on campus
	Marketing	Promoting healthier foods (e.g. a low calorie drink) by famous athletes	Offering a majority of healthy snacks in vending machines at school	Redesigning school canteen to make it easier to access healthy snacks and harder to access unhealthy snacks	Improving school lunch program to offer more fruit and vegetables	Redecorating school canteen to offer a good sociocultural environment

Table 2. **Number of Experts Who Supported, Opposed, or Was Neutral toward the 15 Interventions: 5 Law Interventions, 5 Marketing Interventions, and 5 Education Interventions**

Law interventions	Not allowing fast food outlets within one kilometer of school	Not allowing fast food or soft drink companies to sponsor adolescents' sport	Removing food high in fat or sugar from school canteen	Adding a 20% tax on foods high in fat or sugar to increase their price	Restricting in-school availability of high-sugar, high-fat foods and beverages
support	32%	3%	7%	39%	3%
neutral	39%	16%	32%	26%	13%
oppose	29%	81%	61%	35%	84%
Education interventions	More lessons given by teachers to improve knowledge, attitudes and eating habits	School gardening or similar activities	Involving parents in nutrition education	Using new technology (apps on smartphone or tablet) to track diet information in school canteen	Provide information about how to create low-calorie eating habits on campus
support	6%	6%	3%	19%	13%
neutral	19%	29%	32%	48%	48%
oppose	74%	65%	65%	32%	39%
Marketing interventions	Promoting healthier foods (e.g. a low calorie drink) by famous athletes	Offering a majority of healthy snacks in vending machines at school	Redesigning school canteen to make it easier to access healthy snacks and harder to access unhealthy snacks	Improving school lunch program to offer more fruit and vegetables	Redecorating school canteen to offer a good sociocultural environment
support	16%	13%	3%	16%	3%
neutral	45%	16%	23%	84%	32%
oppose	39%	71%	74%		65%