

# Empowering Young Adolescents to Choose the Healthy Lifestyle: A Persuasive Intervention Using Mobile Phones

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**Abstract.** Overweight is one of the major health problems in the Netherlands. Young adolescents with a lower socioeconomic background are especially vulnerable to overweight. This study examines the potential of mobile applications to influence the unhealthy behaviour of young adolescents. A mobile application is proposed to assist in the prevention of overweight using persuasive technology. The application encourages young adolescents to increase fruit consumption and decrease snack consumption. Results of the evaluation show that participants perceive the app as easy to use and useful. Overall, participants showed a more positive attitude and self-efficacy regarding the consumption of fruit, and a more negative attitude towards snacks, which is subsequently expected to influence their behaviour in the long term. According to participants, social influences generated by the app further contribute to this change in attitude and behaviour.

**Keywords:** Persuasive technology, overweight, behaviour change, attitude - social influence - efficacy model, Fogg's behaviour model, theory of change.

## 1 Introduction

Overweight and obesity are considered to be one of the worldwide risk factors that are associated with increased mortality and morbidity [1]. Several diseases may result from overweight and obesity, such as cardiovascular diseases, diabetes, several types of cancer, and non-fatal diseases such as arthritis. According to the National Institute for Public Health and the Environment (RIVM), 40 to 50% of the Dutch population has overweight, and approximately 10% is obese [2]. They either fail to achieve the standard of physical exercise or, moreover, do not meet the required daily intake of fruit and vegetables. Although behaviour of exercising and healthy consumption has not worsened for several years, more than half the Dutch do not meet the standards for healthy nutrition. This indicates that a change in healthy lifestyle is required.

According to both the World Health Organization (WHO) and RIVM, people with a lower socioeconomic position are especially at risk to become overweight and

obese. In a study by Pigeot et al. [3], worldwide statistics regarding overweight were combined from several large organizations such as the WHO. Their results show that overweight is also a worldwide problem for adolescents, as an increasing number of children between the age of 2 and 20 weight too much.

### 1.1 Target Group and Target Behaviour

The present study focuses on encouraging changing the behaviour of young adolescents. One of the major problems contributing to overweight in the Netherlands is the unhealthy consumption of adolescents [4]. Their unhealthy lifestyle generally entails low fruit consumption, skipping breakfast and the consumption of many high-fat snacks. The habits of adolescents are still weak at this age and can be influenced more easily than those of older people. Improving nutritional habits of this target group can prevent diseases in later stages of their lives. Adolescents with moderate overweight are especially relevant in this regard as their health problems do not yet require medical intervention, and problematic overweight (i.e. obesity) can still be prevented.

As overweight is predominantly a problem for people with a low socioeconomic background, we focus on pupils of VMBO (preparatory secondary vocational education) which is the lowest regular high-school education in the Dutch school system. This results in the following research question: *How can VMBO adolescents between the age of 12 and 15 with moderate overweight be persuaded to eat healthier, using mobile technology?* The main purpose of this study is to examine the motives for fruit and snack consumption of adolescents, and to develop a mobile persuasive interface that targets these motives. This paper also presents the results of an early evaluation of this interface.

The Health council of the Netherlands advises young adolescents to eat at least two pieces of fruit each day, and reduce the consumption of saturated fat (snacks) to less than 10% of the total energy intake. Young people often do not meet these guidelines [5]. Meeting the guidelines of the Health council of the Netherlands will thus be the ultimate goal of the proposed intervention.

## 2 Persuasive Mobile Healthcare and Previous Work

This study aims at changing the inapt eating behaviour of adolescents using mobile persuasive technology. Previous research has shown that web-based tailored nutrition education is appreciated better and has more impact on the intention to change behaviour than traditional nutrition information [6]. Computer technologies have the ability to reach many people on a daily basis with persistent messages. This strategy is called persuasive technology, and aims at changing people's attitude and behaviour via interactive computing systems [7]. In the past few years, more researchers have started using mobile phones for persuasion because mobile technology provides further benefits such as the possibility of push messages without any time and location constraints, location based intervention, and always availability of a mobile device for relevant intervention.

A large number of mobile applications have already been created to assist people in making healthier food choices. To date, no mobile application could be found that focuses specifically on adolescents of 12 to 15 years old. The majority of the applications aim at young adults, with for instance grocery advice or calorie counters. More importantly, commercial applications that have been developed so far, are rarely evaluated on their effectiveness. This is confirmed in a review article by Tufano and Karras [8], who state that “there are no evaluation studies of these tools currently available in the published literature”. Furthermore, research on existing eHealth interventions provides indecisive results. This is in agreement with a review of 23 eHealth interventions by Enwald and Huotari [9], who state that “the evidence of the effectiveness of these interventions was inconclusive”.

### 3 Conceptual Framework

The conceptual framework of this study is primarily based on the ASE model, Fogg’s behaviour model and the theory of change. Each of these frameworks is examined during user research and subsequently used in the design and evaluation of the proposed persuasive intervention.

The attitude - social influence - efficacy (ASE) model states that an individual’s attitude, self-efficacy and social influences predict the behavioral intention, and that the behavioral intention subsequently determines whether he or she will carry out a given behaviour [10]. Adolescents are at an age where they become responsible for their own nutrition and are prone to social influences (of friends and other external factors such as the media). These influences can be used to change their attitude and efficacy.

According to Fogg’s behaviour model (FBM), three elements must simultaneously occur for behaviour to take place, which are motivation, ability and triggers [11]. Both the ability and motivation to perform a given behaviour should be high for that behaviour to occur. Motivation can be established by creating core motivators (e.g. pleasure, hope or social acceptance) and an individual’s ability can be enhanced by making the behaviour easier to perform. In addition, a trigger relating to the behaviour that needs to be changed must be present in order for the target behaviour to occur. Nearly 50% of the young adolescents accesses the internet on their mobile phone [12], indicating the potential of reaching adolescents via their smartphones. Triggers can thus be transferred via this medium to enhance motivation and ability.

The theory of change states that people undergo five stages while changing addictive behaviour, which are pre-contemplation, contemplation, preparation, action and maintenance [13]. Adolescents with moderate overweight are generally in the stage of contemplation. They are aware of their problem and want to change the behaviour, but have not committed themselves to do so. They often do not know what ‘healthy’ precisely entails as they are unaware of the Dutch recommendations [2]. In some cases, adolescents are in the stage of pre-contemplation, which means that they are not aware of their health problems yet. The persuasive intervention should thus create awareness for this group, and create knowledge for the group in the stage of contemplation.

The general objective of the persuasive method is to increase fruit intake and decrease snack intake. The ASE model is used to determine needs and current behaviour of the target group. Fogg's behaviour model is applied to establish triggers that contribute to an improved ability and motivation to eat fruit (and the opposite for snacks). The theory of change helps to determine in which stage adolescents are and which behaviour change is required. The study aims to assist adolescents up until the action stage, when they perform the target behaviour and meet the recommendations of the Health council of the Netherlands.

## 4 User Research

Seven adolescents participated in a longitudinal user research. All participants were 12 to 15 years of age and studied preparatory secondary vocational education (VMBO). Privacy concerns made it infeasible to recruit more participants with moderate overweight in this age group.

**Procedure.** A semi-structured interview was used to assess the determinants of fruit and snack consumption. After this interview, participants recorded their fruit and snack consumption for seven consecutive days, which provides insight into the habits and consumption behaviour of adolescents. A post-test interview was used to assess the awareness of habits of participants and their underlying attitudes and beliefs regarding those habits.

**Measures.** Four major measurements were done to obtain the relevant information, which include i) theory of change (consumption pattern, knowledge and awareness), ii) ASE model (attitude, social influence, self-efficacy), iii) mobile application use and iv) Fogg's behaviour model (motivation, triggers and ability).

**Theory of Change.** As expected, participants are in between the stage of pre-contemplation and contemplation. However, they do not know how their snack consumption relates to the Dutch recommendations. Most participants were unaware of their consumption pattern, though a clear pattern was found when the results of the interviews and diaries were compared. Keeping track of their habits assisted in creating this awareness.

**ASE Model.** Results show that attitude towards snacks overrules the positive attitude towards fruit, causing participants to choose a snack over fruit. The positive attitude towards the ease and availability of snacks should make place for reminders to eat fruit. Participants were predominantly influenced by friends to eat snacks (at school) and by their family members to eat fruit (at home). Furthermore, the number of locations where fruit is consumed should be increased, causing an automatic decrease of snack consumption to reduce hunger.

**Fogg's Behaviour Model.** Participants are generally not intrinsically motivated to eat fruit, which is why triggers are often not activated. Extrinsic motivational factors have the greatest impact on participant's behaviour, which are the availability and social influences. In general, fruit is not triggered at all, while there are too many triggers for snacks. Participants suggest goal setting, an alarm and a weekly schedule as triggers. With the schedule, they can justify their choice for a snack on a specific day (they will

eat more fruit the next day), and overcome habits as they follow a structured consumption pattern. Goal setting and an alarm will create awareness about their aims and produce triggers with immediate call for action. Feedback and daily messages could further motivate them to improve their behaviour.

**Mobile Application Use.** Most participants possess a smartphone and all of them use it to play games or contact others. The majority accesses social media via their smartphone and uses his or her smartphone for other informative and entertaining purposes (e.g. travel information, news and photo editing). Participants indicate that they do not use an app when it is too complex, although they enjoy games that require active involvement and multiple routes.

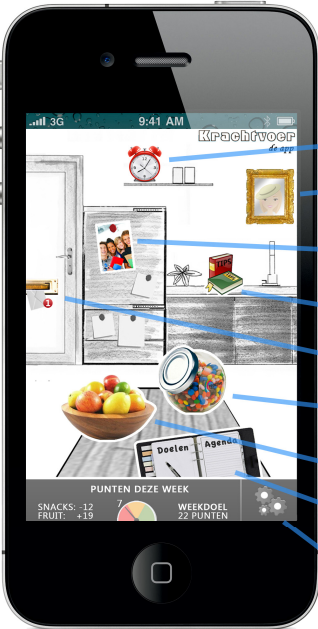
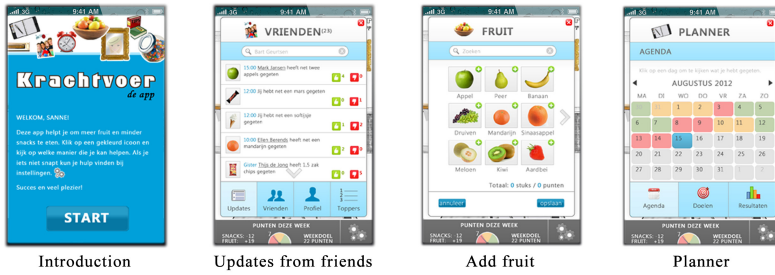
## 5 Design

User research resulted in design requirements, as previously described. The requirements were processed into three design alternatives, of which a final design was chosen. The design consists of a real life kitchen with multiple items that users can click on. These items include all aspects of the design requirements (i.e. an alarm, goals, tips, consumption records, view consequences and friends). The progress of goals is shown with a barometer below the kitchen screen. A major consideration for choosing this design is that the target group becomes engaged in a playful manner. To remove initial errors and assess the first impression of the target group, a paper prototype test was developed (Figure 1).



Fig. 1. Paper prototype with the home screen (left) and ten sub screens

Results of the paper prototype test were processed into a final design. The final design (described in figure 2) is based on results of the user research, and provides users with motivation (consumption record, tips, messages, a mirror and friends), triggers (goal setting, alarm and a planner) and ability (alarm and tips). A point system is included to create a point of reference for users and compare their own behaviour to that of others. In the persuasive tool, users are triggered by push messages, either by means of a spark, facilitator or a signal.



- Introduction** (prior to the home screen) Create a profile and information about the user's BMI
- Home** Kitchen layout with clickable functionalities in colour. The lower bar shows a user's progress of points.
- Alarm** Set an alarm or change existing alarms. The alarm sends push messages (default), and the alarm shakes when it rings.
- Mirror** View the appearance in relation to the consumption; an avatar becomes fatter and gets pimples etc., when eating unhealthy.
- Friends** Includes: a) Updates from friends, b) Friends overview, c) Profile, and d) Top scores (with one user weekly highlight).
- Tips** Advice about limiting snack consumption and increasing fruit consumption.
- Messages** Messages from friends and general messages from the system with feedback about the performance.
- Candy jar** Enter snack consumption. There is a distinction between unhealthy snacks (minus 2 points) en less unhealthy snacks (minus 1 point).
- Fruit bowl** Enter fruit consumption. Users receive 3 points for each fruit intake.
- Planner** Includes: a) Agenda, b) Goals (weekly goals for fruit and snack consumption with advice according to the Dutch recommendations) and c) Results of achievements.
- Settings** General settings regarding the username, email, sounds, push messages, privacy settings and help.

**Fig. 2.** Final design including descriptions of each functionality (four sub screens are shown above). *Note.* The app is in Dutch because of the Dutch target group.

A spark is a trigger that creates motivation, a facilitator triggers behaviour by making it easier to perform, and a signal simply reminds people to perform the task [11]. Feedback and progress of friends serve as a spark, creating motivation. The mirror, in which users can see the negative or positive consequences of their behaviour, also serves as a spark. The alarm mainly functions as a signal, as users are reminded of eating fruit by this functionality. The agenda, point system and entering fruit and snack consumption all serve as facilitators. These functionalities make the behaviour easier to perform, as they provide a point of reference and make users aware of their consumption.

The final application was design for an iPhone. The app has been called the Krachtvoer app (in English: Powerfood app), as it connects to an existing offline program (called *Krachtvoer*) with a similar goal and target group. Consequently, the app can be promoted via a multiple channel strategy and the brand name is already familiar among pupils.

## 6 Evaluation

An evaluation of the mobile application has been performed to provide support for the persuasive power of the Powerfood app. A usability test was performed to detect final usability issues. The design was evaluated by questioning participants about the attractiveness of the application and their perceived ease of use of the system. Finally, the effects on the ASE model were tested with a similar diary study and post interviews. The constructs information quality and openness to influence, adopted from a study by Nass, Fogg and Moon [14], were added to the final interview. Results were analyzed using qualitative data analysis. The interviews were fully transcribed and subsequently translated into a data matrix.

To rule out an interview bias, an additional online questionnaire was performed. The questionnaire was based on the technology acceptance model (TAM) [15]. TAM suggests that users are influenced by their perception of usefulness and ease of use when they are presented a new information system. Although this model originally does not measure behaviour change, the model does measure the intention to use the application and to what degree users perceive the app to be beneficial. A total of seven participants completed all three phases of the evaluation.

### 6.1 Results

The results showed that some tasks could not be completed properly as the intention of buttons was unclear or clickable items did not stand out enough. An improved version of the app have already been made based on this feedback (as presented in Figure 2). Participants often tried several buttons before reaching their destination. They said they were exploring the app, indicating the app engages them in a playful manner.

Results also indicated that participants expect a positive change in attitude when using the app in the long run. Confrontation with negative consequences and positive social influence especially contribute to this predicted shift in attitude. One participant said that “Attitude will probably change for snacks, because you are confronted by the consequences, especially by the mirror”. Two participants were not sure to what degree their attitude will change by the app.

Participants feel that the app makes the behaviour easier to perform because they are reminded by the alarm in the app. One of the participants described this improved efficacy by saying “Normally you don’t think about it and this helps reminding to eat fruit, for instance by the alarm”. Two other participants stated that many children are constantly busy with their mobile phones, indicating the potential persistency of the app. Majority of the participants thought that social influences would help them to change their unhealthy behaviour. One participant stated that “Because of the point system you know you’re not doing well and you can see that others perform better. You do not want to lose”. Another participant was unsure if social influences would work, and thinks it would only make a difference when many other people do not approve his behaviour.

Information quality and design were appreciated by participants. According to participants, all information and buttons in the app are relevant and complete. The reminder, goal orientation and monitoring consumption especially contribute to the

perceived usefulness of the app. All participants find the appearance attractive and the interface easy to learn and easy to use. Participants indicated it would be beneficial if the app is distributed by school and therefore the connection with *Krachtvoer* is very useful. Finally, participants suggested that social media should be included in the app.

The items of the questionnaire could be answered on a scale from 1 to 5, ranging from strongly disagree (1) to strongly agree (5). Interestingly, all participants indicated they would download the app as soon as it becomes available (mean scale value 4.6). Four scales were two-sided, of which all participants opted for the maximally positive side of the scales (*good, wise, favourable* and *positive*), suggesting their positive attitude towards the app. Participants find the app easy to use (mean 4.3) and indicate that the app does what they want and they find the design clear. Nonetheless, two participants indicated it costs much mental effort when using it for the first time, which could be solved with a short tutorial for new users. Participants were divided in whether they think their behaviour would permanently change (and eating habit would not go back to the old routine) when using the app on daily basis and in long run (mean 3.6). A possible explanation is that participants cannot fully predict behaviour that would result after the actual use of the app over a longer period of time, which indicates that longitudinal research is necessary for more decisive evidence.

## 7 Discussion and Conclusion

This paper examines the motives for fruit and snack consumption of adolescents, and proposes a mobile persuasive application that targets these motives. As predicted by the ASE model, one's attitude predicts the intention to carry out a given behaviour. Hence, when an individual's attitude is influenced by the application, the intention and subsequent behaviour could also be influenced. One's perceived control over the behaviour (i.e. self-efficacy) might further influence the intention, as the app makes the behaviour easier to perform by providing a reminder at relevant moments. Finally, users are challenged by other users and thereby encouraged to eat more fruit and less snacks. Results of the evaluation shows that all concepts of the ASE model are targeted with the Powerfood app. Thus, it can be predicted that the mobile application positively influences the attitude and self-efficacy of users, which is further reinforced by social influences in the application.

Currently, users are in between the stages of pre-contemplation and contemplation of the theory of change. The Powerfood app guides users to the preparation phase as it creates awareness, knowledge and subsequently a shift in attitude. One major limitation is that, due to a number of constraints, the mobile application could not be fully developed, which made it difficult to run an independent comprehensive longitudinal study. Results from this study should only be taken as predictions and trends of a specific behaviour. These results do not fully show the actual change in behaviour. Consequently, the action stage of the theory of change could not be validated with this study. For future research it is recommended to examine whether the application causes an actual increase of fruit intake (to 2 pieces a day) and a decrease of snack intake (to less than 10% of the total energy consumption).



Another limitation regarding the evaluation is that the target group was too small for the questionnaire to obtain statistically significant results. Although, we were able to get quite rich qualitative data, the quantitative analysis requires bigger sample size. For future research we would like to use a larger sample, or a small sample that can be tested for weeks if not months. Furthermore, the period after use of the application has not been taken into account with this study. It is possible that users relapse into their old habits when they stop using the application. The aim of the Powerfood app is to create new strong habits, and therefore in future research we will examine these effects over time.

The study provides support for several existing frameworks, such as the ASE model, Fogg's behaviour model and the theory of change. Although these models were not fully validated in practice, the evaluation does indicate results that support the models. In addition, the models have been adjusted to frameworks for testing health interventions, which can be used for future research. Only few existing frameworks were found that evaluated health interventions, which is partly because each intervention requires tailor made and different evaluation methods. Nonetheless, future research could make an attempt in creating a general framework for evaluating persuasive mobile healthcare applications.

This study contributes to an increase of insight into the problems associated with the prevention of one of the greatest health problems, namely overweight. It provides handgrips for future research and supports existing research on overweight and health interventions. The application will additionally be of practical use when it is fully developed by the Dutch institution *Krachtvoer* or one of its partners. What the Powerfood app will eventually bring about for young adolescents remains to be proven in practice, but the hereby presented design and analysis create a strong foundation for an operational version of the Powerfood app.

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