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Tailored physical activity advice delivered through the Internet:

Evaluation of a computerised intervention for adults

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SAMENVATTING

Regelmatig bewegen heeft een positieve invloed op onze gezondheid. Onderzoek toont aan dat indien men minstens 30 minuten fysiek actief is aan een matige intensiteit gedurende 5 dagen van de week, het risico op het ontwikkelen van cardiovasculaire aandoeningen, zwaarlijvigheid, diabetes, bepaalde soorten kankers, osteoporose en mentale problemen verkleint. Meer dan 50% van de Vlaamse bevolking beweegt echter onvoldoende. Het is dan ook belangrijk om effectieve interventies ter promotie van fysieke activiteit te ontwikkelen, waarmee we een grote groep mensen kunnen bereiken.

Het doel van dit doctoraatsonderzoek is het evalueren van een computergestuurde en geïndividualiseerde interventie via het Internet ter promotie van fysieke activiteit bij volwassenen. Deze interventie houdt in dat deelnemers een computergestuurde vragenlijst over beweging invullen, waarna onmiddellijk een bewegingsadvies op maat op het scherm verschijnt. Een gelijkaardige interventie op CD-ROM was reeds eerder door onze vakgroep ontwikkeld en bleek effectief te zijn onder gecontroleerde condities: Volwassenen die in de computerklas van de universiteit een geïndividualiseerd advies ontvingen, bleken na 6 maanden meer te bewegen in vergelijking met een groep volwassenen die geen advies hadden gekregen. Voor het huidige project werd het bewegingsadvies op maat via het Internet beschikbaar gemaakt. In een eerste interventiestudie werd het effect van advies op maat vergeleken met een online standaardadvies. Hieruit bleek dat deelnemers het advies op maat positiever beoordeelden dan het standaardadvies maar dat er geen verschil was op vlak van beweging. In een volgende fase werd een nieuwe website ontwikkeld, met centraal een bewegingadvies op maat. Door middel van gebruikerstesten met zowel ervaren als onervaren Internetgebruikers, werd de website gebruiksvriendelijk gemaakt. Een volgende studie toonde aan dat het verspreiden van folders met het adres van deze website niet voldoende was om volwassenen de site te laten bezoeken. Een kort persoonlijk contact vooraf, bleek veel effectiever te zijn. Tenslotte werd in een tweede interventiestudie de effectiviteit van de website nagegaan. Deelnemers die de interventie op één welbepaald tijdstip of gedurende langere tijd kregen, bleken na een half jaar meer te zijn gaan bewegen dan deelnemers die geen interventie kregen. Een bijkomende studie ging na wat de karakteristieken waren van mensen die al dan niet geïnteresseerd waren in een bewegingsadvies via het Internet, en het computerprogramma ook hadden doorlopen. Resultaten toonden aan dat er geen verschillen waren wat betreft leeftijd of mate van beweging. Wel toonden er meer vrouwen dan mannen, en meer mensen met een gemiddeld of hogere socio-economisch status (SES) dan met een lagere SES, interesse in een bewegingsadvies op maat. Uit de resultaten van deze onderzoeken kunnen we besluiten dat een website met bewegingsadvies op maat effectief kan zijn om fysieke activiteit te promoten bij een groot deel van de Vlaamse volwassen populatie.

CHAPTER 1

GENERAL INTRODUCTION

1. Introduction

Lack of physical activity has a negative impact on health and life expectancy. Not being regularly physically active is associated with a higher risk of premature mortality, coronary heart disease, cardiovascular diseases, colon cancer, diabetes mellitus, obesity, osteoporosis and low back pain.[1,2] Like in other Western countries, many Belgian adults suffer from these chronic diseases. Because changes in physical activity behaviour can help in preventing these diseases, it is important, from both an individual and public health perspective, to disseminate effective intervention strategies promoting regular physical activity in the adult population.

Following the model of Planned Health Education[3] it is necessary to execute 5 steps before an intervention strategy could be disseminated (see Figure 1). The first phase in the process of Planned Health Education is *analysing the health problem*. The second step is *analysing the risk behaviour* (physical inactivity), followed by *an analysis of behavioural determinants*. After determinants of physical activity have been identified, an intervention could be *developed*. Next the intervention has to be *implemented and evaluated* for its efficacy. If the intervention is found to be effective, it can be *disseminated* on a larger scale.

In this thesis an intervention strategy aimed to increase physical activity levels in adults is evaluated. The following chapters discuss the last two phases of the model. This introductory chapter focuses on the first three steps of the model, followed by a description of the intervention and methods used to evaluate the intervention.

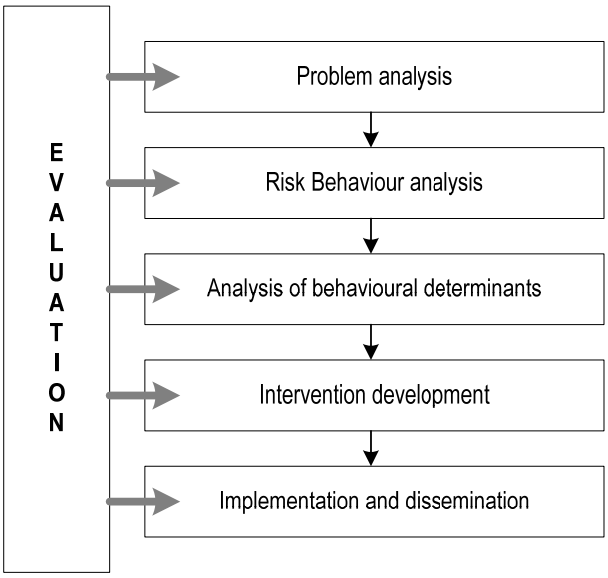

Figure 1. Model of Planned Health Education. From Kok *et al.*, 2000[3]

2. Problem analysis

Cardiovascular diseases (CVDs) are, together with cancers, the most common chronic diseases and the most important causes of death in Europe. CVDs can take many forms, such as high blood pressure, coronary artery disease, valvular heart disease, stroke, or rheumatic heart disease. In the Europe Union (EU), CVDs account for approximately 40% of deaths in both male and female population and within this group coronary heart disease is a major cause of death.[4] All types of cancer currently account for 28.5% of male deaths and 22.0% of female deaths in the Europe Union. Colorectal cancer is the most common type of cancer among all persons in the EU.

In Flanders, similar mortality rates attributable to CVDs and cancers are found. CVDs accounted for 33% of total mortality in the male population and for 40% in female population in 2004; cancers accounted for 31% and 23% respectively.[5]

Next to the burden of disease and mortality, CVD and cancer are also associated with disability and loss of quality of life and since clinical care in these diseases are costly and prolonged it is also a major economic burden.[6,7] The good news is that physical activity, like other life style factors, plays an important role in prevention of these diseases and thus much can be gained by increasing physical activity levels in the adult population.

3. Risk behaviour analysis

From physical activity to physical inactivity

In prehistoric times, physical activity was a major part of daily life. For thousands of years our ancestors lead a nomadic lifestyle in which being physically active was essential to survive.[8]

About 5000 years ago, people settled down and lost their nomadic lifestyle, however they still needed to be physically active to survive.[9] Levels of physical activity did not dramatically change until industrialisation and mechanisation began about a hundred years ago. In the developed countries a lot of efforts were made in the past five decades to create environments which are as comfortable to us as possible and accessible to people of all socio-economic backgrounds.

Nowadays, the majority of people pass the day without doing any physical activity at all. It has come so far that being physically active in today's society is no longer a necessity, but a choice.[8] Unfortunately in the past few decades, it became clear, through a lot of research, that lack of physical activity has a strong negative impact on health and life expectancy.[10,11]

Health benefits of physical activity in adults

The first evidence of the health benefits of a physically active lifestyle was shown by the research of Morris and colleagues in 1953.[12] They observed that ticket collectors on buses in London, who had to run up and down the double-decker busses all day long and thus had a job that involved a lot of physical activity, had a lower incidence of heart attack than their colleague bus drivers with a sitting job. Since this study, much epidemiological evidence has been collected to verify the numerous health benefits of physical activity.

Longitudinal studies have confirmed that a physical active lifestyle is associated with a lower risk of all-cause mortality and from cardiovascular disease in particular, among both men and women.[13-16] Studies have shown that people who are physically active or fit have 20%-50% reduction in relative risk of premature death compared with inactive persons.[17-20] The relative risk of physical inactivity is similar to that of other lifestyle factors such as smoking, hypertension, hypercholesterolemia and obesity. Moreover, studies indicate that people who have one or more of these risk factors but are physically fit, might be at lower risk of premature death than people who have no other risk factors but are sedentary.[15, 21, 22]

Further, the importance of regular physical activity has been demonstrated for the primary prevention of non-insulin dependent diabetes mellitus [23, 24] and different types of cancer, in particular colon and breast cancer.[25] An active lifestyle also plays an important role in both the prevention and treatment of obesity,[26] of which the prevalence has increased dramatically in developed countries over the few last decades.[27, 28] Regular physical activity combined with a healthy diet seems the most successful method to achieve initial weight loss when compared to diet alone or exercise alone[29, 30] and is also important for preventing weight regain.[31]

Musculoskeletal health is improved by regular physical activity: weight-bearing exercise can increase bone mineral density which is important in the prevention of osteoporosis.[32, 33] Moreover, there is also evidence to suggest that people who suffer from osteoarthritis can benefit from physical activity.[34]

Finally, research shows that regular physical activity has positive effects on mental health and well-being, such as by reducing anxiety and depressive symptoms.[35, 36]

Recommended levels of physical activity in adults

To attain the health benefits described above, people are advised to participate in sufficient amounts of physical activity. But how much physical activity is enough?

For a long time scientists believed that an increase in physical fitness level was necessary to obtain health benefits. As a consequence, health organisations recommended people a minimum of 20 minutes of continuous, vigorous-intensity activity at least three times a week.[37] However, in the following decades, a large number of studies have shown that many health benefits can be experienced through lower levels of physical activity. As a result, a new international consensus statement was developed and disseminated. Since 1995 adults have been advised to accumulate at least 30 minutes of moderate-intensity physical activity on most, preferably all, days of the week.[38] Additional health benefits can be gained through greater amounts of physical activity but the amount of health benefits depends on initial physical activity level (see figure 2).[38] Sedentary people who become sufficiently physically active (A) will have the most health benefits, whereas those who are already physically active (B, C) will obtain smaller additional health and fitness benefits by increasing their physical activity level.

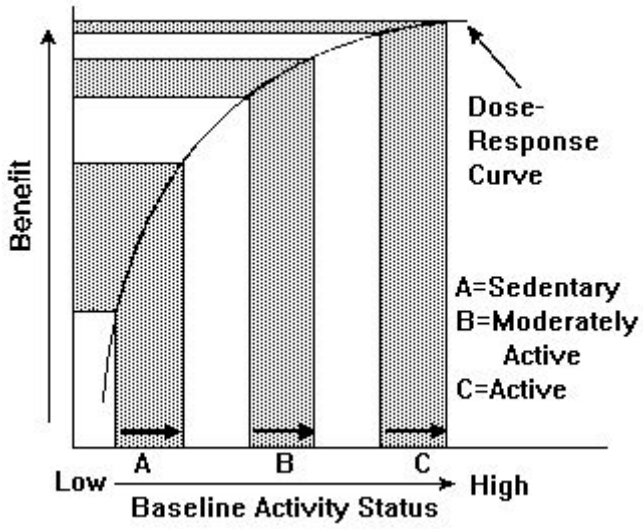

Figure 2. The dose-response curve: relationship between physical activity and health benefits. The lower the baseline physical activity status, the greater will be the health benefits associated with a given increase in physical activity (arrows A, B and C). From Pate *et al.*, 1995 [38]

In 2001, the new physical activity recommendation was adopted by the Belgian "Health Enhancing Physical Activity (HEPA) group".[39] However, as there are indications that 30 minutes is not sufficient in weight management[40] other organisations, such as

Institute of Medicine[41] and Eurodiet,[42] promote a minimum dose of 60 minutes physical activity per day.

The main objective of the developed intervention evaluated in the present dissertation was to prevent all kind of chronic diseases related to physical inactivity. Therefore the focus was on promoting health-enhancing physical activity by participating in moderate-intensity activities and accumulating at least 30 minutes but ideally 60 minutes physical activity per day, to gain additional health benefits.

Definitions

Before describing the prevalence of the risk behaviour, i.e. "not being regularly physically active", it is required to define the term "physical activity" here.

"Physical activity" can be defined as "any body movement produced by the skeletal muscles that results in a substantial increase over the resting energy expenditure".[40] Physical activity includes a number of behaviours such as walking to the bus station, gardening, swimming or building a brick wall. Therefore, "total physical activity" includes all activities from different behaviour categories, such as active transportation, household activities, leisure time physical activities and occupational physical activities, and can be performed at different intensities (light, moderate or vigorous).

"Moderate-intensity physical activity" is "any activity that refers to a level of effort at which a person should experience some increase in breathing or heart rate". The person should be able to carry on a conversation comfortably during the activity. It is equivalent to an energy expenditure of 3.5 to 7 calories per minute (Kcal/min), for example brisk walking.[43]

"Vigorous-intensity physical activity" is "any activity that is intense enough to represent a substantial challenge to an individual and results in a significant increase in heart and breathing rate." It is equivalent to any activity that burns more than 7 kcal/min, for example jogging.[43]

Prevalence of physical inactivity in adults

Despite the numbers of health benefits that are associated with an active lifestyle, the majority of adults in Western countries do not participate in regular physical activities. In the U.S., 55% of the population do not meet the recent guidelines of 30 minutes of moderate-intensity physical activity per day on most, preferably all, days of the week.[44] In Europe, similar prevalence rates are reported.[45] Comparable physical activity levels have been reported between European countries, however in Belgium, lower levels of

physical activity are found. The most recent population survey carried out in Belgium, showed that 66% of Belgian adults do not comply with the recent recommendation.[46] As a consequence, a large proportion of the population are at risk of developing chronic diseases such as cardiovascular diseases, non-insulin dependent diabetes mellitus, some forms of cancer, obesity, and biomechanical complaints.

Further, the high prevalence of physical inactivity in the population also has a large impact on the health care costs associated with physical inactivity. In Belgium there are no data available on this issue, however the annual burden of physical inactivity is estimated to be 1.4 billion euros in Canada;[47] 18.8 billion euros [48] in U.S. and 660 million euros in the Netherlands.[49] It has been estimated that physical inactivity contributes to more than 8000 deaths in Australia each year, and that for every 1% of the Australian population who become sufficiently physically active some 4.3 million euros in health care costs could be saved.[50]

The high prevalence of physical inactivity and its negative impact on health status (both at the individual and population level) indicates that effective physical activity interventions, which can reach large population groups at low costs, are needed urgently.[51] To be effective, interventions need to influence the causal factors that determine physical activity levels (also called determinants of physical activity).[52] Thus, it is important to investigate and know these determinants before developing interventions. The following paragraphs will describe the most important factors and some theoretical concepts related to physical activity.

4. Analysis of behavioural determinants

A large number of studies have analysed potential determinants of physical activity in adults and comprehensive reviews distinguish several types of determinants.[52-56] Firstly, demographic and biologic factors such as age, gender and socio-economic status (SES) may impact on physical activity behaviour. Older persons, women, and those with low SES are less likely to participate in regular physical activity. Secondly, many psychological, cognitive and emotional factors are reported. For example perceiving many barriers to physical activity leads to lower levels of physical activity. Behavioural attitudes and skills may also influence participation in physical activity, such as one's activity history during adulthood. Further, social and cultural factors are also important, for example the more social support from family or friends, the more likely it is that someone participates in physical activities. Finally, in recent years more research has

been conducted concerning physical environment factors, for example perceived access to sport facilities is positively associated with physical activity.

According to Sallis and Owen,[56] the following psychological determinants have the strongest and most significant influence on physical activity behaviour: *self-efficacy* (i.e. a person's confidence in his or her abilities to do physical activities in specific circumstances), *intentions* to be active or not, a*ttitudes* towards physical activity, and *benefits and barriers* of physical activity. Compared to other determinants, such as SES or cultural factors, psychological and social determinants are most likely to be modifiable by means of health education interventions. The focus of the intervention evaluated in this thesis is thus on influencing socio-psychological determinants.

The health promotion literature recommends developing theory-driven interventions as they tend to be more effective to increase physical activity.[57,58] To date, most interventions apply a combination of several different theories.[59] In this thesis, the evaluated intervention was based on two socio-cognitive models, the Transtheoretical model of Prochaska[60] and the Theory of Planned Behaviour[61]. The models' determinants and theoretical concepts that are used in the evaluated intervention are described below.

A first concept is the *stages of change* derived from Prochaska's *Transtheoretical model*. The stages of change concept suggests that changing health behaviour such as switching from a sedentary lifestyle to an active lifestyle, does not occur suddenly: people have to progress through five separate stages towards long-term behaviour change. People may be categorised into one of five stages: the *precontemplation stage* (not considering to become more physically active); the *contemplation stage* (considering becoming active); the *preparation stage* (actually planning to do more physical activity), the *action stage* (doing more physical activity) or the *maintenance stage* (having been regularly physically active for at least 6 months). During the process of behavioural change, relapse into the old behaviour may occur and people can regress to an earlier stage. Although the Transtheoretical Model is currently under debate[62], the stage concept has proven usefulness in physical activity interventions tailored to the individual.[63]

Another theoretical framework that was considered is the *Theory of Planned Behaviour*, which is an extension of the Theory of Reasoned Action.[64] The Theory of Reasoned Action is based on the assumption that health behaviour is entirely subject to someone's will and can predicted directly by *intention*, this is, the tendency of a person to demonstrate a certain behaviour. Intention in turn is predicted by *attitude* toward the behaviour and *subjective norm.* Attitude is a person's positive or negative evaluation of performing physical activity and can be expressed as perceived benefits minus perceived

barriers. Subjective norm is produced by the motivation to comply with the perceived normative expectations of significant others. The more recent Theory of Planned Behaviour adds a third factor to the Theory of Reasoned Action which acknowledges the facts that behaviours are not entirely subject to one's own will; *perceived behaviour control* (the subjective control a person perceives in being physically active or not). This factor has a direct influence on both intention and behaviour (see figure 3). The more positive the attitude and subjective norm and the greater the perceived control, the more positive the intention towards physical activity will be and hence, the greater the likelihood of participating in physical activity.

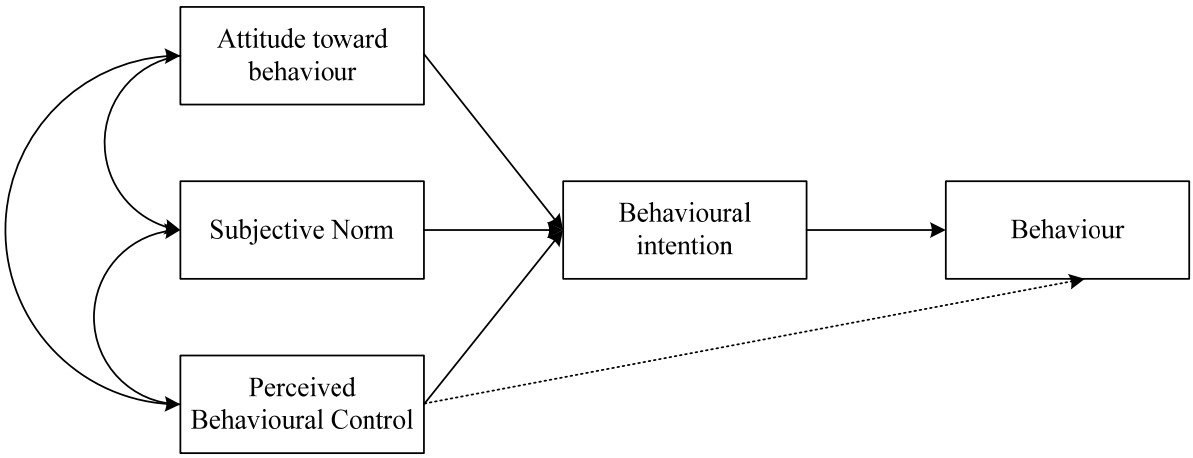

Figure 3. Theory of planned behaviour. From Ajzen, 1985. [61]

5. Intervention development

When the influence of determinants on physical activity is known, interventions to promote physical activity can be developed. Over time, many different types of physical activity interventions have been developed and evaluated.

Frequently used physical activity interventions at the population level are the mass-media campaigns which have the capacity to reach a large population at once, with minimum costs per person. Although, most people tend to remember the messages of the mass-media campaigns, which often result in an improvement in knowledge or attitudes toward physical activity, only a limited number of studies have reported changes in physical activity behaviour.[65]

Another strategy to promote physical activity are interventions that target one specific population group such as employers, women, church-attendees, and are implemented in corresponding settings such as workplaces, all-women organisations or

church settings. The results of these kinds of interventions are mixed and often depending on the methods applied within the intervention: leaflets, counselling, telephone, …These methods will determine the level of individualisation. The higher the level of individualisation the more likely an intervention is effective in producing physical activity changes.[57]

The most often used strategy to deliver individual-centred interventions is the person-to-person counselling, in which individuals learn specific behaviour skills to help them to change their behaviour. The counselling may be delivered via face-to-face contacts, but also through telephone, personal print or e-mail contacts. These kind of mediated interventions seem to be very effective,[66] but the disadvantage is that they are very time-consuming, with high costs per person and they only reach a small proportion of the population.

Thus, new types of interventions that are effective and have the potential to reach large population segments are needed. Computer-tailored interventions, in which individuals receive personalised feedback advice after completing a diagnostic questionnaire, might be a good solution: They combine the individual approach of person-to-person counselling with the wide-scale reach of mass-media through the use of computer technology.

Computer-tailored interventions

The term tailoring is defined as "*Any combination of information or change strategies intended to reach one specific person, based on characteristics that are unique to that person, related to the outcome of interest, and have been derived from an individual assessment*."[67]

The first generation tailored interventions that used computerised expert systems to deliver personal feedback were developed in the eighties and nineties of the past century. Researchers entered in participants' answers from a paper and pencil questionnaire into a computer program. After a few weeks participants received a personalised advice, generated by the computer expert system and printed in a letter format. The tailored advice was made up by a number of messages that were selected from a database. This database contains hundreds of text messages, of which only a very limited but personally relevant selection is presented to each participant. The answers provided by the participants are linked to the correct messages using special software that operates by means of a set of algorithms. These algorithms define who gets which messages under which circumstances (see figure 4).[67, 68]

Nowadays, the second generation tailoring interventions are interactive. By use of CD-ROMs, Intra- or Internet connections, people receive personalised feedback on their screen immediately after completing the computer questionnaire.

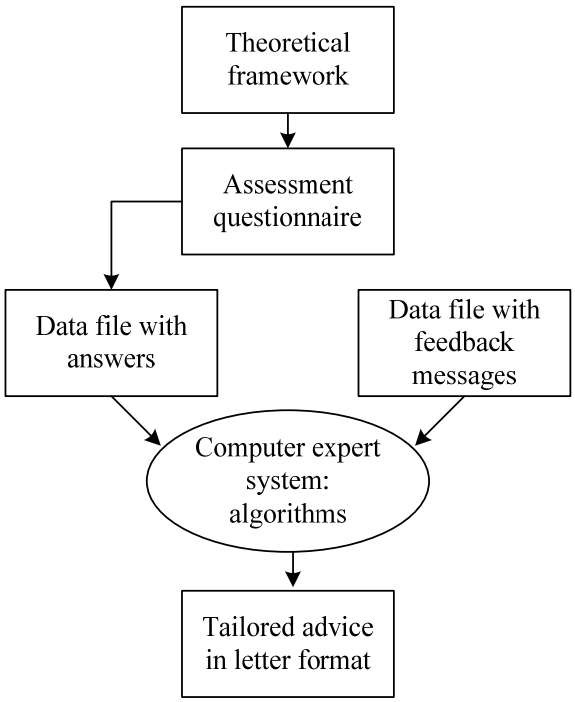

Figure 4. The process of computer tailoring. Adapted from Brug *et al.*, 1999. [69]

Based on the Elaboration likelihood model that states that people process information more thoroughly if they experience it as personally relevant,[70] it is hypothesised that interventions that are tailored to personal characteristics are more effective compared with interventions that do not take into account such individual factors. In tailored health messages, redundant non-personally relevant information is reduced and each person ideally receives only information that is personally relevant. Studies have shown that compared with standard information, computer-tailored information is indeed more read, remembered, saved and discussed with others, and perceived as personally relevant.[71, 72] Further, objective measurements have also shown that individuals pay more attention when reading individually tailored messages than in reading non-tailored messages.[73]

A number of studies have shown that computer-tailored interventions can induce significant improvements in smoking, diet and physical activity;[69,72,74,75] however a recent literature study showed that the evidence is strong for diet but mixed for physical activity.[76] Only three of the eleven studies found a significant effect in favour of

a tailored physical activity advice compared to no or generic information. In a study by Marcus *et al.*[75] both significant short- (one and three months) and medium-term (six months) effects were found in a sedentary population; Vandelanotte *et al.*[77] reported a medium-term and long-term effect[78] in a population not meeting the physical activity recommendations, and a study by Campbell *et al.*[79] resulted in a long-term effect (one year) in African-American church members. Two of the interventions that did result in significant increases in physical activity behaviour[75,77] seemed to be more intensive (more detailed survey and highly individualised feedback on determinants; or multiple feedback moments) than those that found no significant behaviour changes.

It is not clear what the optimal dose of a tailored intervention is. There are studies that have identified additional impact of a second[80] or third[81] computer-tailored letter on fat intake and quit-smoking intentions, respectively. However, other studies found no clear evidence on the superior effect of multiple tailored print messages compared with a single one.[82- 85]

Another issue that needs more investigation is the actual reach of computer-tailored interventions. A criticism often made in regard to health promoting interventions and also computer-tailored interventions is that they only tend to make the healthiest people healthier. It is often hypothesised that participants in these interventions are employed, highly educated and have more positive health behaviours compared with the general population.[77, 86, 87]

Computer-tailored interventions delivered through the Internet

With the rapid development of the Internet it is now possible to distribute computer-tailored interventions in a cost-effective manner and increase their reach drastically (no need for participants to go to a computer laboratory).

Worldwide there are currently more than one billion Internet users and this number is still increasing due to a drop in the cost of Internet connections and improved high-speed access. The biggest penetration rate (i.e. the percentage of the total population that uses the Internet) is found in North America (69.7%), followed by Oceania (54.1%) and Europe (38.6%).[88] In Belgium, 53% of the population was using the Internet regularly in the first quarter of 2005.[89] Further, Belgium has many Internet broadband subscribers and was having the highest rate of broadband connections in Europe in 2003.[90] Today the increase of Internet users is largest in underserved population groups like the elderly, those with lower education levels and women; consequently the gaps according to age, educational attainment and gender are narrowing.[89] Currently, many adults use the Internet to collect health related

information or advice for changing health-related behaviour. The reported numbers of adult Internet users in the U.S. who use the Internet for health information varies between 35 and 80%.[91-93] In an Australian study 35% of the participants preferred to receive advice for increasing their physical activity level by Internet and e-mail instead of other indirect strategies like book (14%), video (12%), mail (8%) or telephone (5%).[94]

Although much is published about the potential of the Internet for delivering health behaviour change interventions, very little evidence is available to date on the effectiveness of Internet-based computer-tailored interventions. In the physical activity domain there are only three tailoring studies using the Internet, each focusing on a specific subgroup of the population: diabetes patients,[95] older women[96] and students.[97] The first two found no superior effect of the tailored intervention compared to a standard intervention. The last study reported a significant effect (higher increase in the proportion of participants who met the physical activity recommendations) in favour of the tailored intervention group compared to a minimal contact group. There were also two studies that investigated an online physical activity intervention for healthy adults but they targeted the physical activity information to the stages of change and did not truly *tailor* to other behavioural constructs or determinants.[98, 99] To our knowledge, there are no published studies that evaluated a computer-tailored intervention to promote physical activity in a healthy adult population via the Internet.

Further, little is known about effective methods to stimulate adults to visit health-behaviour change websites. One study [100] has compared diverse online (e-mails, Internet banners, Internet buttons) and offline (print advertisements) recruitment strategies. The e-mail calls produced the highest number of participants and the print advertisements proved to be more cost-effective than the Internet banners.

Another related, but understudied issue, relates to who is more likely to participate in Internet-based interventions. Feil *et al.*[101] compared the characteristics of participants and non-participants in an Internet-based diabetes self-management support program. No differences were found in gender or computer familiarity between participants and non-participants but younger patients and those who had diabetes for a fewer number of years were more likely to participate. To date, no other studies have reported differences between participants and non-participants of Internet-based interventions.

6. Aims, methods and outline of this thesis

6.1. Aims

As described above, the majority of Belgian adults do not participate in regular physical activity which means that many are at increased risk for a various number of diseases. A small number of interventions have been conducted in Belgium (Flanders), they have mostly been focussing on increasing sport participation and were typically carried out by the Committee for Physical Education, Sport and Open Air Activities (Bestuur voor Lichamelijke Opvoeding, Sport en Openluchtleven, BLOSO). These interventions were not adjusted to personal characteristics and have not since been evaluated.

In a previous study carried out by the department of Movement and Sports Sciences (Ghent University), a computer-tailored program to promote physical activity in adults was developed using a CD-ROM. Pilot studies showed that the program was well accepted by both sexes, irrespective of age, educational level, and stage of change.[102] In an efficacy study of 771 volunteers, it was shown that participants who received a highly individualised physical activity advice once, increased their physical activity level significantly more than those in the no-intervention control group.[77] Even after two-year follow-up the intervention effects remained.[78]

A logical next step was to evaluate whether the tailored-program was also effective when delivered via the Internet. Therefore, the aim of this dissertation was to transform an existing computer-tailored program, which has been shown to be effective in laboratory settings,[77] into a website-delivered physical activity intervention for the general population and to evaluate its effectiveness in a real life setting. Further, the effect of additional e-mail messages and repeated tailored advice was investigated. A short overview of the different studies is presented below:

- In the first intervention study, an Internet application of the existing computer program on CD-ROM was developed and evaluated on its effectiveness in a real life setting. Participants between 25-55 years of age (N=526) were recruited from six different work site settings (2 governmental institutes, and 4 different commercial settings including an automobile, a metal, a food and an engineering company). The effect of tailored physical activity advice delivered via the Internet, with or without additional e-mail tip sheets, was compared with a general online advice. Paper and pencil formats of the International Physical Activity Questionnaire (IPAQ) and objective measurements were used to evaluate behaviour changes six months after the intervention. Results of this study are extensively reported and discussed in *Chapter 2*.

- As we had problems with the Internet delivered version of the CD-ROM intervention (problems to operate with different browsers; too much time needed to complete the questionnaire because only one question at the time could appear on the screen; loss of previous given answers when participants discontinued to complete the questionnaire) a completely new computer program, which was more suitable for the Internet and which solved the problems of the earlier version, was developed. Further, the new tailoring program was imbedded in a physical activity website with more elements to it. Usability and implementation tests were done for the pre-testing of the new website and the computer program. This is described in *Chapter 3.* Usability tests were done with six participants to improve the website. Next, an implementation test was performed with 200 visitors of a university hospital. The first objective of the latter study was to assess whether a face-to-face contact could enhance the number of visits to our tailored physical activity website and to determine the reasons for not visiting the website. The second objective was to test the physical activity website under real-life conditions, in a small study sample. Data to evaluate the website was collected using telephone interviews.

- The new website, with tailored advice as the key element, was evaluated in a second intervention study. 434 participants between 25-55 years of age were recruited from parents and staff of 14 primary and secondary schools. In this study, the first objective was to determine whether a physical activity website with tailored advice as the key element could enhance physical activity levels in adults, when compared with a no-intervention control group. The second objective was to examine if increased intervention intensity, by additional e-mail reminders and repeated exposure to the tailored advice, increases the effectiveness of the intervention. A computerised format of the IPAQ was used to evaluate the intervention after six months. The results of this study are reported and discussed in *Chapter 4.*

- In the study presented in *Chapter 5* the objective was to determine who participates in a tailored physical activity intervention delivered through the Internet. Characteristics of participants and non-participants were compared, using 1649 short questionnaires about parents' age, occupation and physical activity habits completed by their children, aged 10-18 years.

This thesis was part of a broader research project that was being conducted by the Policy Research Centre, *Sport, Physical activity and Health*. This is a consortium of researchers from 'Universiteit Gent', 'Katholieke Universiteit Leuven', and 'Vrije Universiteit Brussel', that was initiated in the year 2002 and funded by the Flemish government. One of the aims of the Policy Research Centre was to evaluate the effectiveness of a number of intervention programs promoting physical activity and sports in different populations groups.

6.2. Methods

The studies presented in Chapters 2 to 5 are manuscripts accepted by or submitted to peer-reviewed scientific journals. In these manuscripts, the evaluated intervention and measurements are reported concisely, as the number of words in these papers is limited. Therefore we will describe our intervention and methods in more detail in the following paragraphs.

A. Intervention

The tailored program used in the first intervention study (Chapter 2) was identical to the previously designed CD-ROM intervention and was made available online to participants in the intervention group by being issued a confidential username and password. An introduction page explained the nature and purpose of the intervention and after login, led the participants to the main component of the intervention - the '*Physical Activity Advice*' (see figure 5). In order to receive tailored physical activity advice, participants had to complete a computerised questionnaire consisting of 3 sections, namely demographics, physical activity behaviour (by use of the IPAQ) and psychosocial determinants (knowledge, social support, self-efficacy, attitudes, perceived benefits and barriers, intentions and environment). After completing the questionnaire, the tailored advice in letter format, appeared immediately on the participant's computer screen and could be printed out. The tailored advice started with a general introduction, followed by normative feedback which compared participants' physical activity level to current recommendations (expressed in minutes a day and illustrated by a graph); and ended with a number of tips and suggestions for increasing or maintaining physical activity levels.

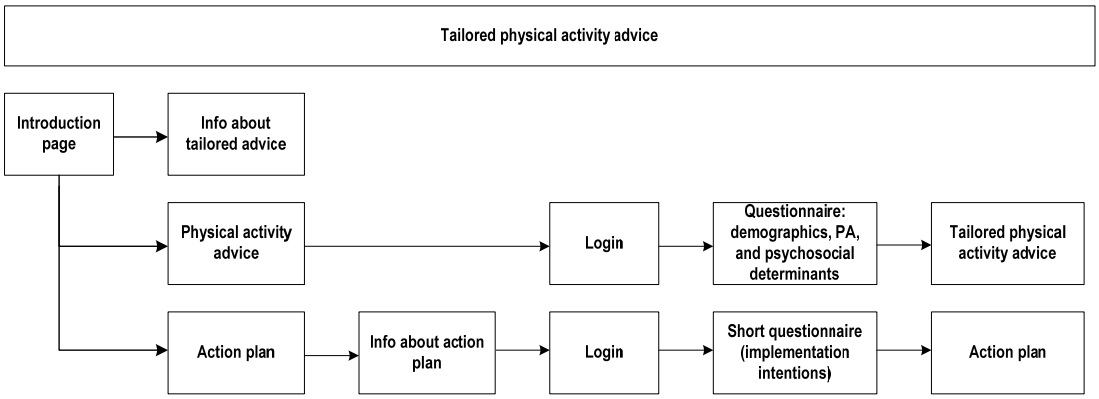

Figure 5. Site plan of the intervention program used in the first intervention study.

The physical activity advice was tailored to participants' stage of change,[60] and to the constructs of the Theory of Planned Behaviour.[61] Participants in different stages of change received different feedback which differed in terms of content and the way in which the participants were approached. *Precontemplators* were approached in an impersonal way (e.g. people could...) and received mainly general information and information about the benefits of physical activity. *Contemplators* were approached in a personal way (e.g. you could...) and received the same but not so extensive information as precontemplators. Further, it was mentioned that they might gain benefits from physical activity if they changed their behaviour. *Preparators* were approached in a more decisive way (e.g. you should...) and the emphasis of the messages was on changing their behaviour in order to comply with the recommendations. A supportive approach was used for people in the *action stage* (e.g. you do...) and the emphasis of the advice was on maintaining the newly adopted behaviour and relapse prevention. Finally, people in the *maintenance stage* were also approached in a supporting way (e.g. you do..) but their feedback was reduced, mentioning that they were doing well and that they should carry on their active lifestyle. Further, the Theory of Planned Behaviour was considered by giving the participants personally relevant feedback about the most important determinants of physical activity, namely intentions, attitudes, self-efficacy, knowledge, perceived benefits and perceived barriers.[56]

After receiving their tailored advice, participants who were not in the maintenance stage and were motivated to become more active, were also encouraged to complete the second part of the computer-program*:* the *'Action Plan'*. In the action plan module, people were asked what activity they would like to do, when, where, for how long and with whom. These questions were used to start a process of thought and to

assist people in putting their intentions into concrete actions (implementation intentions[103]). Similarly with the tailored advice, the Action Plan appeared on the screen immediately after completing the questionnaire and it could be printed out to remind participants of their physical activity intentions. In contrast with the advice, the Action Plan was an exact reproduction of the answers participants gave, with no new information presented.

For the second intervention study (Chapter 4), an entire website was developed with tailored advice as the key element (see siteplan page 54). The website (www.bewegingsadviesonline.be) was developed in such a way that the intervention study could be adapted to a real life situation as much as possible. All participants who were interested in the intervention could visit the site and read the introduction page with information about the intervention including the inclusion criteria. After completing an electronic informed consent form and a registration form, participants immediately received a unique username and password. After logging in they could browse through the entire website. The *tailored advice* was the key element of the website and based on the program used in the first interventions study (Chapter 2). The assessment questionnaire still consisted of 3 sections, but in contrast with the previous program it was possible now for participants to discontinue completing the questionnaire and continue at another place or time without loss of previously given answers. Apart from some small changes, the same message library and algorithms were used as in the original program. In the new tailored advice, hyperlinks that lead participants to other specific website sections were added.

The first additional website section was the *Weekly Activity Planner* which was an alternative to the Action Plan used in the first intervention study (Chapter 2). Participants who were not active enough were advised to make up their own weekly activity plan by filling in concrete activities that they plan to do in one specific week. Tips and suggestions and an electronic example were given to help participants make their own schedule online. Finally, they could print out their weekly plan to remember their good intentions.

Another section was *Goal-setting*. This section was added to motivate the participants by setting short-, medium- and long-term goals. An example was given and they could print out their own goal-setting form to complete offline.

Participants that preferred to do some exercises at home could download a *strengthening program* with 10 basic exercises for beginners (without equipment). The correct way to perform each exercise was described step-by-step and illustrated by photographs of a man/women corresponding with the target group (between 25-55

years of age and physically inactive). Participants were encouraged to print-out a self-monitoring form to keep up their progress.

There was also a section in which participants could download a *Stretching program*. The aim was to help participants increase or maintain their flexibility by 8 easy stretching exercises for beginners, also illustrated by photographs.

Participants who enjoyed more intensive exercise could download a *Start-to-run program*. This scientifically-based program guided beginners from 0 to 30 minutes of continuous running (jogging) over 3 months with 3 training sessions a week.

The website also contained a *Site plan* which gave a schematic overview of the website and led participants directly to a specific website section by means of intern hyperlinks.

Further in the *Links* section, participants could follow external hyperlinks to other relevant websites concerning physical activity in general and more specifically the most popular activities in Belgium that is, cycling and walking.

A *forum* was introduced to give participants the opportunity to get in contact with other website visitors and exchange information and experiences.

Finally the *contact* section gave participants information to contact the research team when they needed technical assistance or more information about the project.

In both intervention studies (Chapter 2 and 4) the effect of supplementary intervention materials were evaluated. In the first intervention study, these materials were reinforcement e-mails and a standard advice: in the second intervention study repeated feedback and additional e-mails were incorporated.

Stage-of-change targeted *e-mail tip sheets* were sent to participants in one study condition in the first intervention study (Chapter 2). For each e-mail, participants were first asked to click on one of five statements that best described their current stage of change and were then automatically transferred to a webpage with more personalised information corresponding with that stage of change. The type of information ranged from pros and cons of physical activity (precontemplation stage) to behaviour change suggestions for respondents in higher stages of change.

A s*tandard advice* was provided on the Internet for participants in the non-tailored comparison group in the first intervention study (Chapter 2). The webpage included information about the benefits of physical activity, current public health recommendations, the difference between moderate and vigorous intensity activities, and tips and suggestions to assist in becoming more physically active. This standard

advice was also based on information present in the computer-tailored program; however it was not tailored to the individual.

One intervention group in the second intervention study (Chapter 4) could obtain *repeated feedback*. This second tailored advice was based on the answers of a second assessment. As the same computer-program was used, the variation between first and second tailored advice depended on the variation in answers given on both assessments. If there was a lot of differences between these answers (which means that the participant did change his/her behaviour or determinants) the second tailored advice should also have been very different from the first one. However, if answers did not differ much (the participant did not change his behaviour or determinants) the second advice should have been quite similar to the first one.

The same group of participants who could receive a second advice also received *additional e-mails*. The e-mails did not contain tailored or stage-matched information. The aim was to stimulate participants to visit the website again. In every e-mail one specific website section was recommended and a hyperlink was given that led participants directly to that specific section.

B Measurements

IPAQ

To measure possible changes in physical activity behaviour, the long usual week version of the IPAQ was used in both intervention studies but in different formats. In the first intervention study (Chapter 2) participants completed an additional paper and pencil format of the IPAQ for evaluation purpose; in the second intervention study (Chapter 4) the computerised format of the IPAQ, also needed to generate the tailored feedback, was used.

IPAQ has shown to be a valid and reliable instrument at the population level[104] and has been used to evaluate physical activity interventions.[77,105] A reliability and validity testing of the specific Dutch computerised version, used in our tailored program, was also executed and the results were acceptable.[106] The questionnaire assessed the frequency (numbers of day) and duration (time per day) of physical activities at work (vigorous, moderate and walking), as transportation (cycling and walking), in and around the house (vigorous and moderate in garden, moderate inside home) and in leisure time (vigorous, moderate and walking). For walking and cycling an additional question on pace was added. In order to be reported, an activity should have lasted for at least ten minutes continuously. Sedentary behaviour was also measured by assessing daily sitting time (week day, weekend day).

CSA accelerometer

In the first intervention study (Chapter 2), objective physical measurements were also executed in a subgroup. Both frequency (min/day) and intensity (using Freedson's cut-off scores[107]) were measured by a CSA accelerometer (Computer Science Application, Inc, model 7164) that participants wore on the hip during seven consecutive days. Participants also reported when, how long and at which intensity they performed physical activities without wearing the accelerometer (for example during water-based activities) or when they forgot to wear the accelerometer.

Health-related measurements

In the same subgroup of participants who wore a CSA accelerometer, additional objective assessments of potentially relevant outcomes were carried out.

Height and *body weight* were assessed directly by a portable measuring rod and a digital balance scale respectively.

For measuring *body fatness*, bioelectric impedance analysis (BIA) was used. BIA is an indirect method to assess body composition and is based on the principle that the body's lean compartment (muscle, bone, water) which carries a lot of electrolytic water, conducts electricity far better than the body's fat compartment, which is very low in body water content.[108] The impedance value of the participants' body was measured with four surface electrodes placed on the right wrist and ankle and an electrical fixed current of 50 kHz was produced by a generator (Bodystat 1500) and applied to the skin using an adhesive electrode while the participants lying supine. The participants' body fat was calculated, by using the same regression equations as reported by Kyle.[109]

Systolic and *diastolic blood pressure* was measured by a mercury-manometer metre (Bauman), while participants were sitting.

Resting heart rate was monitored for one minute with a polar heart rate monitor (tempo) while participants were lying supine.

Usability testing

To ameliorate the newly developed website with the tailored advice, usability tests [110] were performed (Chapter 3). In the usability test, participants performed a list of tasks using the website, while observers watched and took notes. Participants were encouraged to say anything that came into their mind during the process and to try to solve possible problems by themselves. Five participant tests are considered to be an appropiate quantity to discover the most important errors and areas that need

improvement; as little can be gained by watching more people naviagate through the same design.[111]

Telephone interviews

Telephone interviews were carried out to make a qualitative evaluation of the website in a small study sample (Chapter 3). First, participants in the pilot study were asked whether they had visited the website and completed registration. Non-visitors were asked about their reason(s) for not visiting. Next, questions relating to the online questionnaire and the tailored advice followed for all registered participants. In the third part, participants were asked whether they had navigated to other sections of the website before or after receiving the tailored advice. If they had, all the specific website sections were evaluated in terms of the frequency of visits, level of usage, usefulness and problems or indistinctness. The participants were also asked to evaluate the entire website on features such as colour, structure, navigation, speed and hyperlinks. The last part of the interview contained questions relating to computer, e-mail and Internet access and usage.

Questionnaires completed by children

In the second intervention study (Chapter 4) primary and secondary schools were used to recruit participants. This strategy created the opportunity to collect information about the non-participating parents, through their children. To compare characteristics of participating and non-participating parents (Chapter 5), a large subgroup of pupils completed a short questionnaire in the classroom about their parents. After some general questions (name, age, occupation), more detailed information was collected on their parent's physical activity habits relating to transportation, sports activities, gardening, walking and cycling during leisure time. Reliability of the questionnaire was assessed using a test-retest design.

6.3. Outline

This thesis is primarily a collection of articles in press, under editorial review or submitted for publication. All articles were written to stand alone, and each deals with a specific research question (see 6.1 Aims).

- *Chapter 2* reports the results of the first intervention study.

  Effectiveness of an online computer-tailored physical activity intervention in a real-life setting. Spittaels H, De Bourdeaudhuij I; Brug J, Vandelanotte C. *Health Education Research* Advance Access published on September 13, 2006; doi: 10.1093/her/cyl096

- *Chapter 3* describes the results of the usability tests and implementation test.

  Implementation of an online tailored physical activity intervention for adults in Belgium. Spittaels H, De Bourdeaudhuij I. *Health Promotion International*, Advance Access published on September 8, 2006; doi:10.1093/heapro/dal030

- *Chapter 4* reports the results of the second intervention study.

  Evaluation of a website-delivered computer-tailored intervention for increasing physical activity in the general population. Spittaels H, De Bourdeaudhuij I, Vandelanotte C. *Preventive Medicine*, Advance Access published on December 29, 2006, doi:10.1016/j.ypmed.2006.11.010

- *Chapter 5* describes the characteristics of participants and non-participants in the online tailored intervention.

  Who participates in a computer-tailored physical activity program delivered through the Internet? Spittaels H, De Bourdeaudhuij I. *The International Journal of Behavioral Nutrition and Physical Activity*, submitted

- Finally in *Chapter 6*, the most important findings and conclusions are summarised and discussed, followed by a formulation of the practical implications of the findings and recommendations for future research.

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CHAPTER 2

EFFECTIVENESS OF AN ONLINE COMPUTER-TAILORED PHYSICAL ACTIVITY INTERVENTION IN A REAL-LIFE SETTING

Abstract

The aim of this study was to evaluate the effectiveness of a computer-tailored physical activity intervention delivered through the Internet in a real-life setting. Healthy adults (N=526), recruited in six worksites, between 25 and 55 years of age were randomised to one of three conditions receiving respectively (i) online tailored physical activity advice + stage-based reinforcement e-mails; (ii) online tailored physical activity advice only; (iii) online non-tailored standard physical activity advice. At 6-months follow-up no differences in physical activity between study conditions were found; total physical activity, physical activity at moderate intensity and physical activity in leisure time significantly increased in all study conditions between baseline and follow-up. Further evaluation of the intervention materials showed that the tailored advice was more read, printed and discussed with others than the standard advice. Most of the respondents in the e-mail group indicated to be satisfied about the number, frequency and usefulness of the stage-based e-mails. In conclusion, although tailored advice was appreciated more than standard advice, no evidence was found that an online tailored physical activity intervention program outperformed online standard information.

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Introduction

Regular physical activity has an important influence on the health status and well-being of adults [1-3]. To take advantage of the health benefits of physical activity, adults are recommended to accumulate at least 30 minutes of physical activity at moderate-intensity on most, preferably all days of the week [4]. However, most adults in Western countries do not meet this guideline [5, 6]. Therefore effective interventions promoting an active lifestyle that can reach large population groups are needed.

Computer-tailored interventions have induced significant changes in smoking, diet and physical activity [7-10] and have the potential to provide individualized behaviour change information to many individuals at low costs [11]. Few computer-tailored programs evaluated to date are interactive [12]. This means that after completing a computer diagnostic questionnaire, participants immediately receive personally adapted advice [13]. The use of interactive computer programs makes tailored interventions more cost-effective and useful at the population level.

The Internet is now regarded as a promising channel for the distribution of interactive computer-tailored interventions [14]. It has the advantage of reaching a wide variety of people at once, at any time and location. In 2003, Belgium had the highest rate of broadband connections in Europe [15] and in the first quarter of 2005, 53 % of the Belgian population were using the Internet regularly [16]. Today the increase of Internet users is largest in underserved populations like the elderly, lower educated persons and women and consequently the gaps among age, educational attainment and gender are narrowing [16].

Although much is published about the potential of the Internet in health behaviour change, very little evidence is available to date on the effectiveness of Internet-based tailored interventions. We are aware of only one tailored Internet intervention study in the physical activity domain [17] specifically aimed at diabetes patients. Two other studies investigating intervention for healthy adults, targeted the physical activity information to the stages of change, but did not truly 'tailor' to other behavioural constructs or determinants [18, 19]. The present study is therefore the first to test an Internet-based computer-tailored intervention to promote physical activity in the general population.

The tailored intervention used in the present study was based on earlier work of our research group. An interactive computer program promoting physical activity was developed as a CD-ROM version. This program was evaluated on it's efficacy in a randomised controlled design in supervised laboratory conditions and appeared to be effective in increasing the level of physical activity after six months [20] as well as after a

follow-up at two years [21]. For the present intervention, this tailored physical activity program was transferred to an Internet version. Using the Internet meant that additional stage-based e-mail could be sent and evaluated. The aim of the present study was to investigate the effectiveness of the Internet version of the tailored physical activity advice, outside the laboratory. The effect of this online computer-tailored intervention was studied with and without additional stage-based e-mail reminder messages and compared with a standard intervention (online generic physical activity information). We hypothesized that the tailored intervention leads to a larger increase in physical activity than the standard intervention and that additional stage-based e-mail reminders will further improve the effects of the online tailored intervention.

Methods

Participants and Procedure

Participants were recruited by spreading e-mail messages, posters and internal newsletters in six worksites in the northern part of Belgium, including four commercial settings and two local governmental institutes (N=8000 employees). Inclusion criteria were: between 25 and 55 years of age, no history of cardiovascular disease, and Internet access (including e-mail access) either at home or at work. Individuals who were interested and met the inclusion criteria could react by e-mail, after which more detailed information about the study was sent. As an incentive for participation, respondents could win a gift coupon of 25 euros or two film tickets. Baseline questionnaires accompanied by an informed consent form were sent by regular mail to 570 persons who wanted to participate in the study (7% response rate). In total, 562 employees (92%) actually returned the baseline questionnaire with the informed consent form and were randomized individually into one of the three conditions. Group 1 (N=174) received computer-tailored physical activity advice supplemented with five stage-of-change targeted reminder e-mails during 8 weeks; Group 2 (N=175) received tailored physical activity advice without e-mails; and Group 3 (N=177) received standard advice (Fig. 1). Respondents in Group 3 who returned their 6 months post-baseline questionnaire were given the opportunity, as an incentive for their participation, to receive tailored advice online after completing and returning this questionnaire. The study was approved by the Ghent University Ethics Committee.

Tailored intervention

The tailored intervention was based on a previously designed intervention that was carefully developed and subjected to formative and efficacy evaluations in laboratory settings. This stepwise development process and the contents of the intervention have

been described in more detail elsewhere [20, 22]. In short, the tailored intervention consisted of 'physical activity advice' and an 'action plan'. In order to receive tailored physical activity advice, participants were required to log onto the website using a confidential username and password and complete both a physical activity and a psychosocial determinants questionnaire. The tailored advice appeared immediately on the computer screen and contained normative physical activity feedback as well

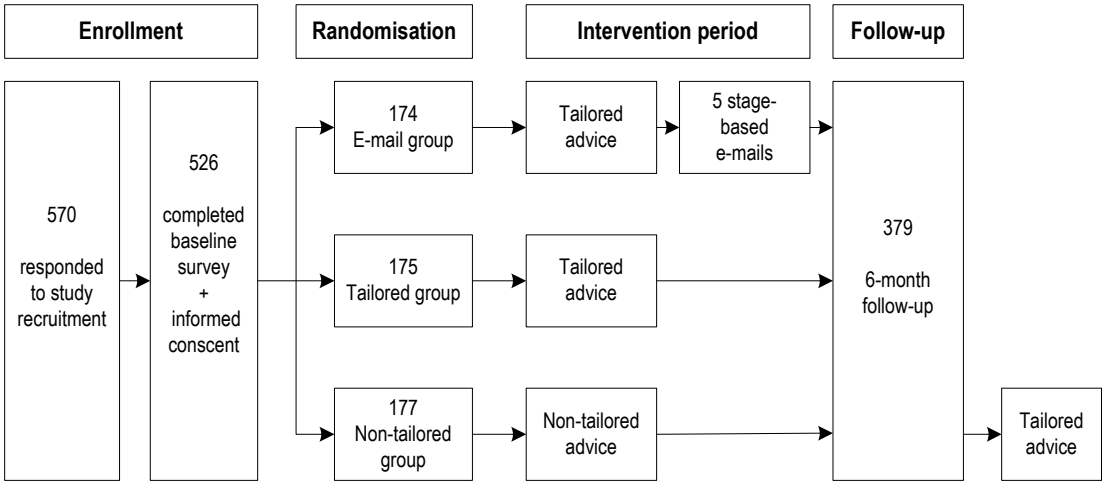

Fig. 1. Flow diagram of participants' progress through the phases of the randomized trial.

as tips and suggestions for increasing physical activity. The advice was tailored to participants' stage of changes [23], both by content and the way in which the participants were approached, and to the constructs of Theory of Planned Behavior [24] by giving the participants personal advice about intentions, attitudes, self-efficacy, social support, knowledge, benefits and barriers of physical activity. Participants with positive intentions to increase their level of physical activity were encouraged to make a personal Action Plan*;* that is, a specific plan to assist in putting their intentions into actions [25].

Reinforcement e-mails

After having received their tailored advice, participants in Group 1 were further encouraged to change their behaviour by five stage-of-change targeted e-mail tip sheets during a period of 8 weeks (Fig. 1). For each e-mail, participants were first asked to click-on one of five statements that best described their current stage of change and were then automatically transferred to the website for more personalised information corresponding with that stage of change. The type of information ranged from pros and cons of physical activity (precontemplation stage) to behaviour change suggestions for respondents in higher stages of change.

Standard advice

Participants in the non-tailored comparison group received a standard physical activity advice via the Internet. The webpage provided information about the benefits of physical activity, current public health recommendations, the difference between moderate- and vigorous-intensity activities, and tips and suggestions to assist in becoming more physically active. This standard advice was also based on information present in the computer-tailored program, however it was not tailored to the individual.

Measurements

All participants were asked to fill out a paper-and-pencil questionnaire at baseline and at 6-month follow-up. To assess physical activity, the long usual week version of the International Physical Activity Questionnaire (IPAQ) was used. IPAQ is a valid and reliable instrument to assess physical activity at population level [13, 26]. This questionnaire measures physical activity at work, as transportation, for household chores as well as during leisure time; it also assesses daily sitting time. Each reported physical activity was expressed in min week^{-1} by multiply frequency (day week^{-1}) and duration (min day^{-1}) of the activity. A 'total moderate-intensity and vigorous-intensity physical activity' index was computed by summing all reported physical activities executed at moderate and vigorous intensity. Participants were classified as complying with the American College of Sports Medicine recommendation when their score on this index was at least 210 min week^{-1} (average of 30 min day^{-1}).

At the 6-month follow-up, the questionnaire also included questions about exposure to and use of the advice respondents had received (i.e. whether participants remembered the advice; whether they read, printed or discussed it with others; and whether they thought the advice had had a positive impact on their physical activity behaviour and opinions). Respondents in Group 1 (reinforcement e-mails) received questions about the number of e-mails they received and read, and their opinion of the number, frequency, usefulness and effectiveness of the e-mail tip sheets.

In one of six worksites (an automobile company), participants were asked to participate in additional objective assessments of potentially relevant outcomes. Height, body weight, body fatness (bioelectric impedance with Bodystat 1500), blood pressure (Bauman metre), heart rate at rest (with polar heart rate monitor, tempo) and physical activity [Computer Science Application (CSA) accelerometer Inc., model 7164] worn on the hip during 7 consecutive days) were measured in volunteers at baseline (n=66) and at 6-month follow-up (n=57). Nine employees did not complete their measurements at follow-up due to work time constraints or sickness.

Statistics

Data were analysed for those having completed pre-post test data and also using an intention-to-treat analysis [27]. As no major differences were found, only the results of the complete cases analyses are presented. One-way analyses of variances (ANOVAs) were used to test for differences in baseline participant characteristics between the three intervention conditions. A drop-out analysis was executed using independent-samples *t*-tests for differences in level of physical activity, age, gender, Body Mass Index (BMI), education and stage of change at baseline. Repeated measure ANOVAs, with time (baseline and 6-month follow-up) as within subjects factor and intervention condition as between subjects factor, were conducted to evaluate the effects on physical activity. All analyses were performed using SPSS 11.0. Statistical significance was set at a level of 0.05.

Results

Participant characteristics

Of the initial sample, 379 (72%) persons responded to the post-tests after six months and were included in the analyses: 116 (66%) in the tailored intervention + e-mail group, 122 (69%) in the tailored intervention group and 141 (79%) in the standard intervention group (total drop-out = 28.9%). Drop-out analysis showed that younger participants, precontemplators and contemplators, and those who did not meet the guidelines at baseline were more likely to drop out. No significant differences were found for gender, education, BMI or total physical activity.

Baseline characteristics of the total study group are shown in Table I. Participants were predominantly male and had a mean age of 39.5 years. More than half had a higher education and were office workers. The mean total physical activity score measured by the IPAQ was 651 min week^{-1}. About 65% of the total sample met the minimal recommendation for physical activity. Gender specific analysis showed that 72.3% of men and 47% of women complied with the recommendation at baseline. Baseline measurements did not differ significantly between the three intervention groups.

Self-reported measurements

Changes in physical activity

Participants from all three study groups reported a significant increase in their level of physical activity at 6-month follow-up (Table II). Time effects were found for total physical activity, moderate- to vigorous-intensity physical activity, and physical activity in leisure time. There were also positive changes in amount of time spent sitting. Minutes sitting on both weekdays and weekend days significantly decreased for the total

study group at 6-month follow-up. However, no significant group × time interactions were found, indicating that there were no differences in effects between the three intervention groups.

Subgroup analyses (data not shown), focussing on participants meeting versus not meeting the physical activity recommendation of 30-min moderate and vigorous activity per day, showed similar time effects, but no interaction effects. In the group that did not meet the recommendation at baseline (n=129), time effects were found for the same variables as described above. Additional time effects were found for vigorous-intensity physical activity [F (1,131)= 12.826; $P < 0.001$] and household physical activity [F (1,131) = 6.161; $P < 0.05$].

Additional analyses, comparing physical activity increase of participants in the first four stages of change at baseline (precontemplation, contemplation, preparation and action) with those of participants in the maintenance stage, showed a greater increase in moderate- to vigorous-intensity physical activity for the participants in the first four stages [F (1,367) = 8.592; $P < 0.01$], irrespective of the intervention condition. No interaction effects were found for other physical activity variables.

Table I: *Baseline characteristics of total sample and three intervention groups (mean ± SD or %).*

	Total sample (n=379), mean ± SD	Tailored advice + e-mail (n=116), mean ± SD	Tailored advice (n =122), mean ± SD	Standard advice (n=141), mean ± SD
Demographics				
Men (%)	69.4 %	67.2 %	68.0 %	73.0 %
Women (%)	30.6 %	38.8 %	32.0 %	27.0 %
Age (year)	39.5 ± 8.5	39.7 ± 8.9	39.3 ± 8.7	40.9 ± 8.0
BMI (kg/m²)	24.4 ± 3.3	24.3 ± 3.0	24.4 ± 3.5	24.4 ± 3.1
College or university degree (%)	61.7 %	63.4 %	68.9 %	59.6 %
Work status:				
Factory workers (%)	21.9 %	22.4 %	21.3 %	22.0 %
Office workers (%)	54.1 %	60.3%	51.6 %	51.1 %
Managers (%)	24.0 %	17.2 %	27.0 %	27.0 %
Physical Activity (PA)				
Total PA (min week^{-1})	651 ± 465	696 ± 510	640 ± 422	622 ± 462
Moderate- and vigorous- intensity PA (min week^{-1})	390 ± 331	438 ± 373	362 ± 292	376 ± 325
30 min of PA on most days (%)	64.6 %	68.1 %	67.2 %	59.6%
Stages of change				
Precontemplation	8.5 %	6.9 %	7.6 %	10.7 %
Contemplation	15.2 %	13.8 %	13.4 %	17.9 %
Preparation	10.7 %	11.2 %	10.1 %	10.7 %
Action	12.8 %	12.9 %	16.0 %	10.0 %
Maintenance	52.3 %	55.2 %	52.9 %	49.3 %

Table II. *Mean physical activity(PA) scores (min week^{-1}) and time spent sitting (min day^{-1}) at baseline and at 6-month follow-up for all conditions and total group.*

	All Cases (=379)			Tailored advice + e-mail (n=116)	Tailored advice (n =122)	Standard advice (=141)	Time × group
	Mean ± SD	Change[a] (± SD)	*F* Time	Mean ± SD	Mean ± SD	Mean ± SD	*F*
Total PA (min week^{-1})							
Baseline	651 ± 465			696 ± 510	640 ± 422	622 ± 462	
6-month	720 ± 503	+69 (± 334)	10.951***	776 ± 540	682 ± 452	708 ± 514	0.935
Total moderate-to vigorous-intensity PA (min week^{-1})							
Baseline	390 ± 331			438 ± 373	362 ± 292	376 ± 325	
6-month	434 ± 356	+44 (± 236)	9.539*	479 ± 376	397 ± 310	428 ± 374	0.598
Total vigorous-intensity PA (min week^{-1})							
Baseline	136 ± 177			155 ± 200	134 ± 158	122 ± 174	
6-month	132 ± 161	-4 (±127)	0.064	161 ± 181	111 ± 140	128 ± 160	3.120
Transportation PA (min week^{-1})							
Baseline	108 ± 143			125 ± 173	108 ± 128	93 ± 126	
6-month	120 ± 150	+12 (± 115)	2.713	127 ±164	108 ± 125	125 ± 157	2.000
Household PA (min week^{-1})							
Baseline	251 ± 241			276 ± 279	249 ± 236	232 ± 208	
6-month	279 ± 264	+28 (± 223)	2.426	320 ± 289	262 ± 225	260 ± 272	1.138
Leisure-time PA (min week^{-1})							
Baseline	159 ± 164			174 ± 191	154 ± 150	151 ± 152	
6-month	194 ± 189	+35 (± 142)	26.554***	211 ± 220	190 ± 188	185 ± 161	0.044
Job-related PA(min week^{-1})							
Baseline	156 ± 303			176 ± 345	137 ± 244	157 ± 313	
6-month	159 ± 293	+3 (± 186)	0.103	166 ± 310	136 ± 239	175 ± 320	0.885
Sitting on weekday (min day^{-1})							
Baseline	481 ± 202			482 ± 183	492 ± 202	470 ± 217	
6-month	433 ± 174	-48 (± 165)	29.392***	443 ± 168	438 ± 172	419 ± 181	0.288
Sitting on weekend day (min day^{-1})							
Baseline	305 ± 168			308 ± 160	296 ± 160	309 ± 182	
6-month	272 ± 137	-33 (± 137)	10.733**	276 ± 131	268 ± 141	271 ± 139	0.143

[a]Changes are computed by subtracting baseline data form 6-month data. Plus and minus signs are shown to indicate the direction of change.
* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$ within group.

Receipt, use, appreciation and subjective impact of intervention materials

Process evaluation at 6-month follow-up showed positive results in favour of the tailored intervention materials (Table III). Almost twice as many participants from the tailored groups recalled having received their tailored advice in comparison with the non-tailored group. In the non-tailored group 41% could not remember the online standard advice, while the rest were aware of the non-tailored website but did not visit it because expectations of the site were not positive enough or because of lack of time, forgetfulness, and problems with PC or Internet.

Table III. *Process evaluation of the intervention materials*

Intervention materials	Tailored advice + e-mail		Tailored advice		Standard advice	
	Total (n =128)	Inactive[a] (n =45)	Total (n = 139)	Inactive [a] (n = 44)	Total (n = 156)	Inactive [a] (n = 64)
Tailored/general physical activity (PA) advice						
Received (%)	97	98	94	96	53	53
Read completely (%)	96	96	98	100	82	88
Printed out (%)	55	64	75	71	17	12
Discussed with others (%)	64	64	59	60	32	27
Find advice credible (%)	66	66	61	57	73	78
Changed opinions about PA (%)	49	52	37	43	29	31
Reported behavioural changes (%)	38	50	23	29	20	24
E-mails						
Received ≥ 3 e-mails (%)	92	95				
Read completely (%)	77	86				
Satisfied by number e-mails (%)	87	84				
Satisfied by frequency e-mails (%)	86	91				
Useful (%)	45	52				
Reported behavioural changes (%)	33	41				

[a]Participants not meeting the recommendations for PA at baseline.

Further, the process evaluation showed that the tailored advice was more likely to be read completely, printed out and discussed with others compared with the standard advice. For one item, the non-tailored information out-performed the tailored information: participants perceived it as more credible. Finally, more people in the tailored groups than in the non-tailored group reported to have changed their physical activity behaviour and opinions about physical activity after reading their physical activity advice.

Most participants of the e-mail group recalled at least three of the five reinforcement e-mails, read them completely, and were satisfied with the number and frequency of the e-mails. Further, half of the participants who were inactive at baseline

found the e-mail tip sheets to be useful and 41% reported that the e-mails helped them to become or remain physically active.

Objective measurements

Table IV shows the results of the health measurements taken at baseline and 6-month follow-up in one employee setting (n = 57). A significant decrease in BMI [F (1,42) = 5.340, P <0.05], fat percentage [F (1,42) = 9.402, P < 0.01] and diastolic blood pressure [F (1,42) = 7.335, P < 0.01] was found. A significant time × group interaction for percentage of body fat [F (2,41) = 3.641, P < 0.05) indicates a greater decline in percentage of body fat in the e-mail group in comparison with the other two groups.

Table IV. *Objective health measurements at baseline and 6-month follow-up.*

Health measurements	All cases (n=57)		Tailored advice+e-mail (n=14)	Tailored advice (n=22)	General advice (n=21)	Time*group
	Mean ± SD	F Time	Mean ±SD	Mean ± SD	Mean ± SD	F
Body mass index (kg m^{-2})						
Baseline	26.0 ± 3.4	5.340*	25.3 ± 3.7	26.1 ± 3.4	26.2 ± 3.4	0.842
6-month	25.8 ± 3.3		25.0 ± 3.6	26.1 ± 3.3	25.9 ± 3.4	
Difference	-0.2 ± 0.7		-0.3 ± 0.8	0.0 ± 0.6	-0.3 ± 0.6	
Body fat (%)						
Baseline	22.1 ± 6.0	9.402**	21.1 ± 6.8	21.8 ± 7.0	23.0 ± 4.3	3.641*
6-month	21.2 ± 5.9		19.0 ± 5.4	21.9 ± 6.5	22.1 ± 5.9	
Difference	-0.9 ± 2.5		-2.1 ± 3.8[a]	+ 0.1 ±1.6[b]	-0.9 ± 1.9[b]	
Systolic blood pressure (Hg cm)						
Baseline	12.5 ± 1.4	0.077	12.1 ± 1.5	12.5 ± 1.3	12.8 ± 1.5	3.217
6-month	12.4 ± 1.6		12.4 ± 1.4	11.9 ± 1.2	13.0 ± 2.0	
Difference	-0.1 ± 1.3		+ 0.3 ± 1.1	-0.6 ± 1.3	+0.2 ± 1.3	
Diastolic blood pressure (Hg cm)						
Baseline	8.4 ± 1.2	7.335**	7.9 ± 1.1	8.5 ± 1.2	8.6 ± 1.1	0.656
6-month	7.8 ± 1.5		7.6 ± 1.3	7.9 ± 1.2	7.8 ± 2.0	
Difference	-0.4 ± 1.4		- 0.3 ± 1.0	-0.6 ± 0.8	-0.8 ± 2.0	
Heart rate at rest (beats min^{-1})		1.115				
Baseline	64.1 ± 9.6		65.2 ± 11.3	63.6 ± 10.2	63.8 ± 8.3	0.013
6-month	62.8 ± 9.2		63.9 ± 10.6	62.1 ± 10.0	62.9 ± 7.8	
Difference	-1.3 ± 8.6		- 1.3 ± 9.5	-1.5± 8.2	-1.1 ± 8.9	

Differences are computed by subtracting baseline data form 6-month data. Plus and minus signs are shown to indicate the direction of change

[a;b]Means with different subscripts are significantly different from each other (Tuckey honestly significantly difference, P <0.05).

*P <0.05, **P <0.01

Due to technical errors or not wearing the accelerometer during for at least 5 days, complete pre-post data of CSA accelerometer measurements could be analysed for only 55 out of 66 participants in the subgroup. Participants spent an average of 326 ± 172

min week^{-1} at baseline and 338 ± 161 min week^{-1} at 6-month follow-up undertaking moderate- to vigorous-intensity physical activity. No statistically significant time or time × group interaction effects were found (data not shown).

Discussion

In the present study, there was no convincing evidence found that an online computer-tailored physical activity intervention outperformed online standard advice. However respondents in all three study groups reported increases in physical activity and decreases in sedentary behaviour. Further, the tailored physical activity advice was more positively evaluated than the non-tailored advice and participants were satisfied with the content and frequency of the reinforcement e-mails.

Cavill and Bauman [28] have argued that the evaluation of physical activity promotion campaigns should not only focus on behaviour change but also on antecedent variables (for example awareness, knowledge, saliency, beliefs etc). Our analyses of these variables found that more participants in the intervention groups discussed their tailored advice with others and changed their opinions about physical activity in comparison to participants in the standard advice group. This suggests that the tailored advice had a superior impact on participants, even though there were no between-group differences in behaviour change.

When considering the behavioural outcomes measured by the IPAQ in this study, it is promising to find increases in physical activity across the three study groups, because earlier studies reported no increases in physical activity levels in Belgian adults between 1997 and 2001 [6]. Nevertheless, these results should be interpreted with caution, since an overall increase in physical activity was not confirmed in the subgroup in which objective physical activity data were obtained.

A recent systematic review of the literature [12] concluded that the evidence for effectiveness of computer-tailored health education is convincing for nutrition education, but mixed for physical activity. Furthermore, the authors also mentioned that many of the studies reporting significant effects used no-intervention control groups and did not test Internet applications.

Different reasons might explain the lack of the superior effect on behaviour by the interactive computer-tailored intervention compared with online non-tailored intervention in the present study.

First, possibly ceiling effects might have occurred, as baseline physical activity levels were already high. More than 64% of participants met the recommendations at

baseline despite explicit recruitment of inactive participants. Belgian adults apparently associate physical activity with sports activities of vigorous intensity, based on national physical activity campaigns in the past which aimed to increase sports participation. Therefore, it is possible that employees who were not engaged in any sports activity but were indeed physically active at moderate intensity, enrolled in our study. More detailed analyses showed that especially the male participants in the present study already had high baseline physical activity scores in comparison with the general male population (72% vs. 57% meeting the recommendations), whereas female participants were more representative of the population (47% versus 48% meeting the recommendations) [6].

Second, it is possible that intervention effects were not found due to measurement effects. As was shown in a study by Van Sluijs *et al.* [29], participation in physical activity measurement itself can substantially influence physical activity behaviour in adults, making it harder to interpret the results.

Further, the standard deviations in the IPAQ data were very large, which makes it more difficult to find a significant interaction effect. A possible latent effect of the tailored advice may have resulted following the process evaluation, in which 50% of the initially inactive participants from the e-mail group mentioned that the advice stimulated them to make behavioural changes (Table III).

The results of the present study are comparable with earlier Internet-based intervention studies found in literature. Mostly only time effects for physical activity were found [17, 19, 30, 31] and only one study identified short and medium-term interaction effects on physical activity behaviour [18]. In the latter study, the participants in the intervention group who received stage-based physical activity feedback were more physically active at moderate intensity after 1 month compared to the control group. However, this effect disappeared after 3 months. The only effect that sustained over time was the increased amount of time spent in walking activity in favour of the intervention group.

The tailored physical activity advice used in the present study has been proven earlier to be effective in increasing physical activity [20], but failed to produce significant effects here. Several reasons could explain this. First, the original study was conducted under lab conditions, implying that all participants had come to the university computer class on a specific weekend day to obtain their tailored advice. This could have created a sample more motivated to make behavioural changes. The computer class also allowed for more control over respondents: researchers could check if each participant had completed all questions, and if the advice was printed out and handed over to the participant. Second, differences in sample characteristics could additionally account for some of the variations in outcomes. The participants in the previous study were less

physically active at baseline (56.8% met the physical activity recommendation) leaving more room for physical activity improvement. Moreover, participants were mainly female (64%) in contrast to the present study where the proportion of women was smaller (31%). The fact that males outnumbered females in the present study could be explained by males comprising the majority of employees in the two biggest worksites were recruitment was done (an automobile company and a company in the steel industry). Further research is needed to determine whether tailored interventions and more specifically, physical activity interventions, may be more effective among women than men.

Strengths and limitations

This study is one of the few to examine the effect of a physical activity tailored intervention delivered through the Internet and the first in a general healthy population setting. Using the Internet as a delivery channel enabled stage-based e-mails to be evaluated. Another strength was that the intervention was tested in 'real Internet conditions' and therefore, no personal contact was required. In comparison with other Internet-based intervention studies, a relatively large sample was studied using a randomised design. Further, intervention materials were based on behavioural change theories and physical activity advice was tailored to current behaviour, physical activity determinants and behavioural constructs. The tailored intervention was compared with online standard advice instead of a no-intervention control group, as seen in other studies.

There are several limitations to note, however. First, the estimated response rate was low. Only 7% of all employees were initially interested in participating in the study. Irvine *et al*. [32], who used the same recruitment strategies as the present study, also obtained a low response rate: 10% of the employees of two worksites participated in the Interactive Multimedia program to influence eating habits. In contrast, two physical activity promotion studies which used more intensive recruitment strategies like e-mails to all employees [19] or a combination of e-mails and telephone calls [33], found higher response rates (57 and 37%, respectively). However, the usefulness of the workplace as a recruitment setting in Internet intervention has been discussed in both studies. Demanding work tasks and receiving many electronic mailings every day could limit employees to react by e-mail and enrol in a study that has little to do with their job [19, 33]. In the present study we choose not to use an intensive recruitment strategy as we wanted to mimic the real-life implementation as much as possible. Nevertheless, the low response and participation rate may reduce the external validity of our results and should be taken into account when considering larger-scale implementation.

A second limitation is the fact that participants could take part voluntarily, causing self-selection bias. Other studies have shown that the majority of employees who participate in worksite physical activity interventions are already interested in physical activity or have been physically active in the past [34-39]. This is confirmed by high numbers of already sufficiently active participants at baseline in this study. These high levels of baseline activity, the fact that male participants outnumbered the female and that more participants had a university degree, indicates that the present sample is not representative of the Belgian population. A final limitation of the study is that physical activity findings are based on self-reported information, which could create a response bias.

Conclusion

No convincing evidence suggests that the present online tailored physical activity intervention was more effective than online standard advice. However, the computer-tailored intervention was better used and appreciated by participants. The present study also shows that implementation of an online tailored physical activity advice is possible. However, the results of our study showed that the Internet is a very specific communication channel and effects of the same tailoring program delivered in a different way could not be simply replicated. More research under real-life conditions should be executed to enhance our knowledge of how we can use the Internet effectively to promote physical activity. Future studies might investigate how we can reach our target group, attract them to visit the website and stay there long enough to complete the computer-program and read their tailored advice.

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CHAPTER 3

IMPLEMENTATION OF AN ONLINE TAILORED PHYSICAL ACTIVITY INTERVENTION FOR ADULTS IN BELGIUM

Abstract

It has been argued that the Internet is a promising channel for distribution of health promoting programs, because of its advantage to reach a wide variety of people at once, at any time and location. However, little research is done to study how we could prompt people to use these online health promoting programs. Therefore the main objective of the present study was to assess if a face-to-face contact stimulates adults to visit a recently developed tailored physical activity website to promote more physical activity in the general Belgian population. The second objective was to test the website under real-life conditions in a small sample. Therefore, 200 flyers, with a call for evaluating the new tailored physical activity website, were distributed to hospital visitors in two different ways. One group of visitors were personally approached by a research assistant and handed over a flyer. Another 100 visitors could simply take a flyer home, without initial personal contact. After two months, telephone interviews were done to make a qualitative evaluation of the website. The results showed that obviously more participants with an initial face-to-face contact (46%) registered on the website in comparison with the participants without personal contact (6%). The used strategy reaches participants of both sexes as well as regular and irregular Internet users. Secondly, the telephone interviews indicated that the website was accepted well, without major problems. We could conclude that distributing flyers combined with a short face-to-face contact, increased the number of visitors compared with distributed flyers without contact and that the tailored physical activity website could be used in real-life situations to promote an active lifestyle in Belgium. However, a controlled study with a larger sample size should be done to test the effectiveness of the tailored intervention in increasing physical activity.

Key words: physical activity, implementation strategies, Internet, tailored intervention

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Introduction

In 2000 the Internet was called a promising channel for distribution of health promoting programs, because of its advantage to reach a wide variety of people at once, at any time and location (Fotheringham *et al.*, 2000). Five years later, Internet use has expanded tremendously and usage is still increasing due to a drop in the cost of Internet connections and improved high speed access. Today there are more than one billion Internet users worldwide. The biggest penetration rate is found in North America (68.6%), followed by Oceania (52.6%) and Europe (36.1%) (Miniwatts International, 2006). At the moment the increase of Internet users is the largest in underserved populations like the elderly, lower educated persons and women; and consequently the gaps among age, educational attainment and gender are narrowing (Insites Consulting, 2005).

Currently, many adults use the Internet to receive health related information or advice for changing health-related behaviour. The reported numbers of adult Internet users in the US who ever searched the Internet for health information vary between 35 and 80% (Baker *et al.*, 2003; Harris Interactive, 2005; Fox, 2005). In an Australian study 35% of the participants preferred to receive advice for increasing their physical activity level by Internet and e-mail instead of other indirect strategies like book (14%), video (12%), postal mail (8%) or telephone (5%) (Marshall *et al.*, 2005).

As a consequence, researchers started to develop and evaluate online health advice on various topics such as smoking (Feil *et al.*, 2003; Lenert *et al.*, 2003), diet (Oenema *et al.*, 2001; Irvine *et al.*, 2004) and physical activity (Marshall *et al.*, 2003; Napolitano *et al.*, 2003). It has been proposed that qualitative behavioural change websites should be theory-based (Doshi *et al.*, 2003) and that the efficacy could be enhanced by adding tailored advice, i.e. personal feedback on the participants' risk behaviour and ways to change it (Kirsch and Lewis, 2004). However, very little is known on how to stimulate adults to visit health-behaviour change websites. In Switzerland, a single print advertisement for an online physical activity intervention resulted in absolute number of 947 visitors after a two week period, but corresponded only with a participation rate of 0.3% (Martin-Diener and Thüring, 2002). The same research group also compared print advertisements with diverse recruitment strategies as e-mails and Internet banners and buttons (Thüring *et al.*, 2003). The e-mail calls produced the highest number of participants, with a response rate of 36.8%. Further, the print advertisements proved to be more cost-effective than the Internet banners. In another study (Feil *et al.,* 2003) absolute numbers of recruited participants by search engines and user groups were higher in comparison with non-Internet recruitment

methods (newspaper, radio interview or distributed brochures). However, no response rates could be calculated for these strategies. No research is done to evaluate other strategies that could enhance the participation rate of health promoting Internet interventions, for example face-to-face contact.

Therefore, the first objective of the present study was to assess if personal contact could enhance the number of visits to our newly developed tailored physical activity website and determine the reasons for not visiting the website. Next, the second objective was to test the physical activity website under real-life conditions, in the general population.

Methods

Participants

Participants were recruited from visitors of a university hospital. The inclusion criteria were (1) between 20 and 55 years of age (2) no history of cardiovascular disease and (3) having Internet access.

Group 1 consisted of 100 visitors (50 women, 50 men) who were personally approached by a research assistant and asked to test a newly developed website aiming to promote physical activity in adults. People were asked to visit the website in a two month period, after which a research assistant would contact them by phone to interview them about their website experiences. They were told that the aim of the study was to improve the physical activity website. Individuals who wanted to participate received a flyer with a standard message and a unique flyer number. A researcher assistant noted their name and telephone number, so that they could be contacted afterwards.

Another 100 flyers were dispersed in various highly visible hospital locations, passed by many visitors. Group 2 consisted of these visitors who had taken voluntary a flyer with them, without personal contact.

Procedure

Both participants from Groups 1 and 2 could visit the site during a 2 month period, using the information on their flyer. Each flyer contained a standard message about the aim and time period of the study; how to navigate to the website; and a unique flyer number that was needed during registration. The flyer also mentioned that participants could receive a free tailored physical activity advice at the time they visited the website. More detailed information about the study and the registration procedure was mentioned on the introduction page of the website. During registration an electronic

informed consent was filled in and a confidential username and password was created. After login, participants had access to the entire website (see figure 1).

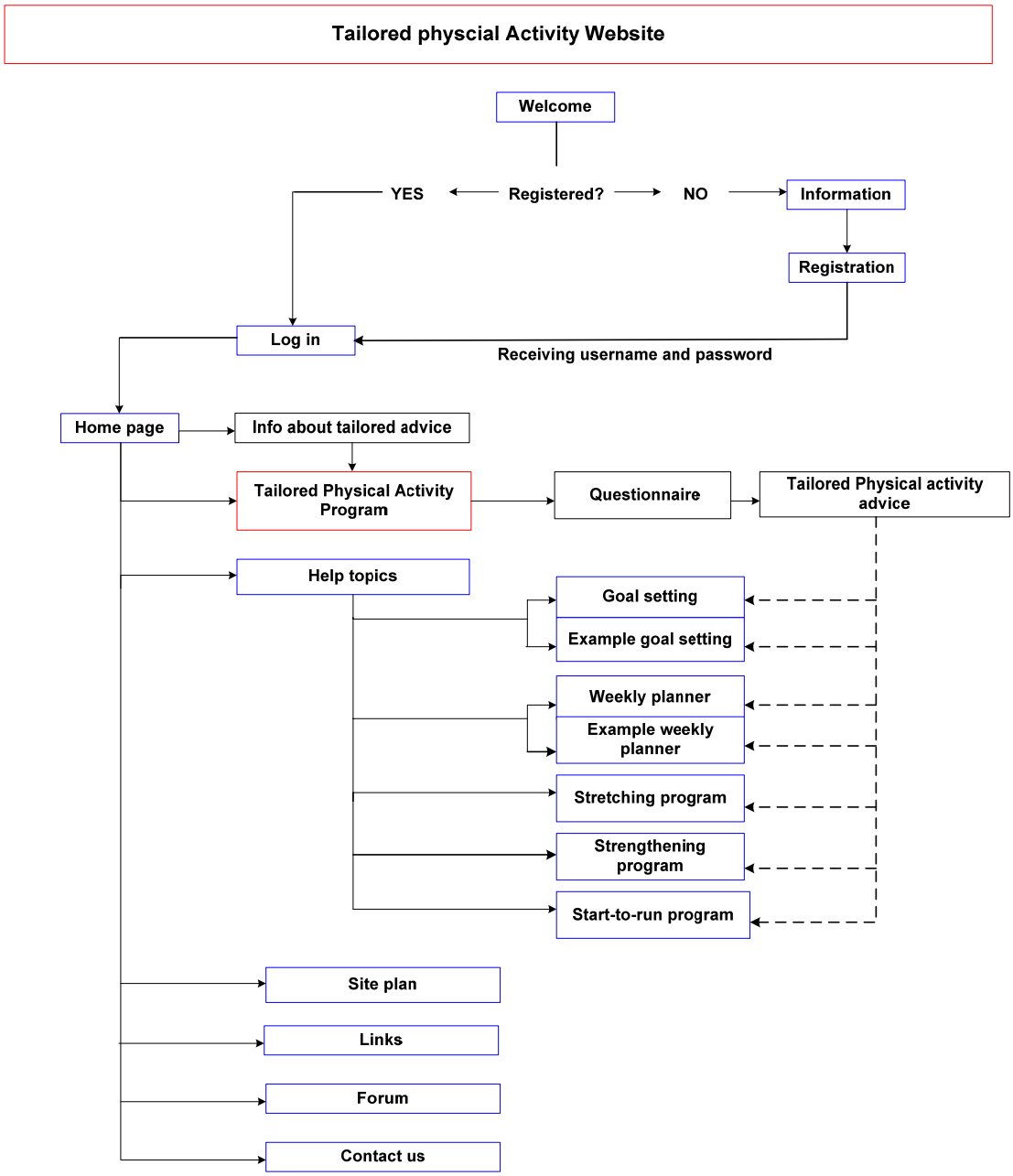

Fig. 1: Site plan of the tailored physical activity website

The main section of the website was an interactive tailored computer program that generated individualised physical activity advice after participants completed an assessment, containing questions on demographics, physical activity (Craig *et al.*, 2003) and psychosocial determinants. The advice contained information about participants' level of physical activity compared to American College of Sports Medicine (ACSM) recommendations (Pate *et al.*, 1995) and was tailored to participants' stage of change

(Prochaska, 1994), both by content and the way in which participants were approached, and constructs of Theory of Planned Behavior (Ajzen, 1985) by giving participants personal advice about intentions, attitudes, self-efficacy, social support, knowledge, benefits and barriers of physical activity. Participants could follow hyperlinks in their advice that lead to other specific website sections, namely goal setting, weekly plan, strength and flexibility exercises, start-to run program, forum, links and contact information. See table 1 for a description of each specific website section.

All participants of Group 1 were contacted by phone 2 months after the flyers were handed out and/or dispersed. Every person was tried to be reached by a minimum of 10 telephone calls on different days and times. In Group 2, only the participants that navigated to the site and filled in their telephone number during registration could be contacted.

Table 1: Description of specific website sections.

Website section	Description
Goal setting	Print-out form to fill in short, medium and long term goals and achieved goals; supplemented with an online example.
Weekly plan	Online form to fill in the planned physical activities for one week, with tips and suggestions and an example; This was included to transform physical activity intentions into concrete acts (implementation intentions) (Gollwitzer, 1999).
Stretching program	Eight stretching exercises for beginners. Illustrated with photographs.
Strength program	Ten easy strengthening exercises for beginners (without equipment), illustrated with photographs and supplemented with a self-monitoring form.
Start-to-run program	Exercise program for beginners: from 0 to 30 minutes running in 3 months
Site plan	See Figure 1, with hyperlinks directly to the specific website section
Links	Hyperlinks to other relevant websites concerning physical activity in general and more specific the most practiced activities in Belgium: cycling and walking
Forum	Forum to get in contact with other website visitors and exchange information and experiences.
Contact us	Contact information with e-mail address in case of help or more information needed

Development of the website

The content of the tailored computer program was based on a previously developed and evaluated computer program on CD-ROM that is described in more detail elsewhere (Vandelanotte and De Bourdeaudhuij, 2003; Vandelanotte *et al.*, 2005). New computer software, which was more suitable for the Internet medium (for example: operating with different browsers) was developed and other website sections beside the tailored advice (see Table 1), were added to assist people in becoming more physically active.

Usability testing

During the website development, usability testing (US Department of Health & Human Services, 2005) was done with six volunteer participants (all between 25 and 52 years old, 3/6 female, 4/6 with low confidence using Internet, 4/6 low educated). Five usability problems were detected and solved. Most of the changes executed, made it easier for the user to navigate through the entire website: For example, hyperlinks were made more visible and the print version of the tailored advice was made to open in a smaller (new) browser window, in order that closing the page not take the participants out of the website.

Measurements

The registration procedure, including the use of a unique flyer number, objectively assessed the number of participants in both groups that actually visited the website.

Interviews by phone

The telephone interviews were executed by the same researcher and contained a maximum of four parts. First, all participants in Group 1 were asked whether they had visited the website and completed registration. Non-visitors were asked about the reason for non-visiting.

Next, questions about the online questionnaire and the tailored advice followed for all registered participants in both groups: What problems did they experience? Could they remember the content of the advice and the current physical activity recommendations? Did they print, read and/or discuss the tailored advice? Did they make behavioural changes after reading the advice?

In the third part, participants were asked whether they had navigated to other sections of the website before or after receiving the tailored advice. If so, all the specific website sections were evaluated on frequency of visiting, on level of usage, on usefulness and on problems or indistinctness. Further the participants were asked to evaluate the entire website on features such as colour, structure, navigation speed, hyperlinks, etc. The last part of the interview contained questions about computer, e-mail and Internet access and usage. This was needed to study whether regular computer or Internet users could visit the site more easily compared with irregular users.

Statistical analyses

All data analyses were performed using SPSS 11.0. Descriptive analyses using means, standard deviations and distributions were used to describe participants' characteristics,

website use and qualitative website evaluation. χ^2-tests were used to detect relations between categorical variables. Statistical significance was set at a level of 0.05.

Results

Website registration

After two months, 46 of the 100 participants in Group 1 registered on the site and 41 received their tailored physical activity advice. In Group 1, 91 out of 100 participants could be contacted by phone. In Group 2, 11 of the 100 flyers were left in the hospital, 89 were taken home by visitors and 6 of them registered on the site. All six participants received their tailored physical activity advice and could be contacted by phone (see Figure 2).

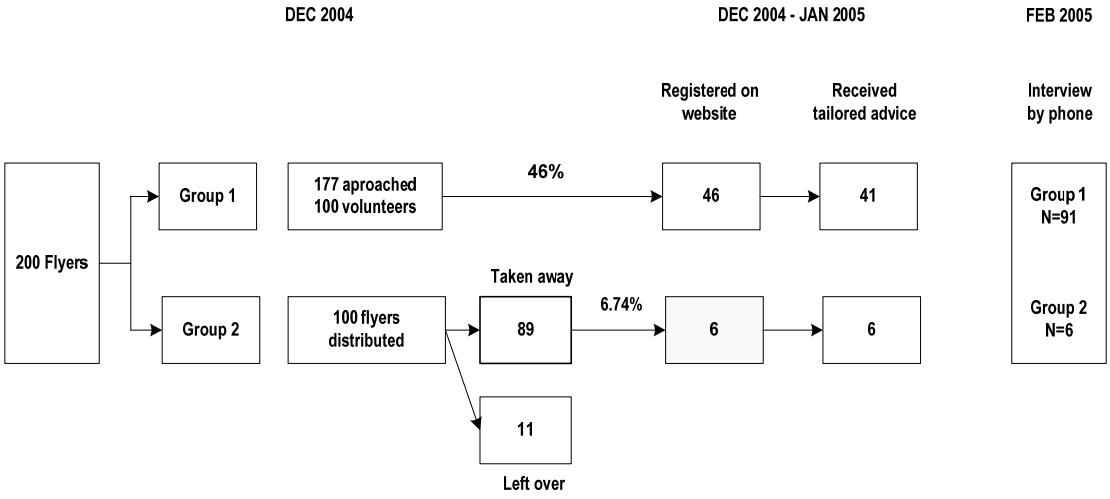

Fig. 2: Study design and number of participants during the different stages of the study.

Non – registrations

Figure 2 shows that 54 of the 100 persons in Group 1 did not register on the website; 49 of them were contacted by phone. Telephone interviews revealed that 42 persons of the 49 had indeed not visited the website, however 7 participants did navigate to the welcome-page (Figure1), but could not (n = 4) or were not willing to fulfil registration (n = 3). The most important reasons for not visiting the site were "lack of time" (n = 20/42), followed by "forgotten" (n = 17/42). Most of the people who simply forgot to navigate to the site (n = 17), would have preferred a reminder e-mail (n = 10), instead of a reminder telephone call (n = 4) or both e-mail and telephone call (n =3).

Participant characteristics

Characteristics of the participants are summarized in Table 2. Almost as many men as women received their tailored advice. Average age was 38 years and they were highly educated and employed and 40% did not meet the physical activity recommendation for adults. Most of the participants had Internet access both at home and at work, and a third of the participants used the Internet as an information source daily.

An equal number of irregular as regular (at least once a week) Internet users visited the website ($\chi^2 = 2.877$; df = 1, $P > 0.05$). There was also no association found between frequency of Internet use and problems experienced during website visit ($\chi^2=1.075$, df = 1, $P > 0.05$).

Table 2: Characteristics of participants who fulfilled assessment questionnaire and/or were reached by phone (Groups 1 + 2).

Characteristics of participants	*n*	Values in % or means ± SD
Demographic variables[a]		
Age (year)	47	38 ± 11
BMI (kg/m²)	47	24.4 ± 3.7
Male	23/47	48.9
Higher education	31/47	66
Employed	40/47	85.1
PA scores[a]		
Total PA (min/week)	47	611 ± 529
Total PA of moderate to vigorous intensity(min/week)	47	407 ± 369
Total PA at vigorous intensity (min/week)	47	118 ± 138
Sedentary behaviour[a]		
Sitting on a week day (min/day)	47	341 ± 177
Sitting on a weekend day (min/day)	47	272 ± 131
Recommendation[a]		
Minimal 30 minutes PA/day at moderate intensity	28/47	59.6 %
Stages of change[a]		
Precontemplation	6/47	12.8
Contemplation	6/47	12.8
Preparation	7/47	14.9
Action	5/47	10.6
Maintenance	23/47	48.9
Access and use of PC/e-mail/Internet[b]		
Internet access only at home	30/97	30.9
Internet access only at work	7/97	7.2
Internet access both at home and work	58/97	59.8
Daily PC-use	72/97	74.2
Daily e-mail use	62/97	63.9
Daily Internet use	33/97	34.0

PA = Physical activity.
[a] Data from online questionnaires (completed by 41 participants in Group 1 and 6 participants in Group 2).
[b] Data from telephone interviews (91 participants in Group 1 and 6 participants in Group 2 were reached).

Tailored physical activity advice evaluation

From the five persons in Group 1 who fulfilled registration but received no tailored physical activity advice, three participants scored positive on one of the screening questions [based on PAR-Q (Thomas *et al.*, 1992) and the SCORE system (De Backer *et al.*, 2003)] and were recommended to consult their general practitioner; and the other two participants did not answer the questionnaire completely, which was necessary to receive a tailored advice.

In total, 47 individuals (Groups 1 + 2) received a tailored physical activity advice, and 43 of them could be reached by phone. All the participants (n =43) except one, filled in the questionnaire without interruption. The reported mean time to complete the questionnaire was 15 minutes (± 12.1 min), which was acceptable for most of the participants (n =40/43). Almost all individuals could remember their physical activity level mentioned in the advice, but only six persons could recall the mentioned ACSM physical activity recommendation for adults. Only one of them had heard about the physical activity recommendation before participating in the study.

More than half (n =25/43) of the participants saved their tailored advice by printing it out (n = 23) or by saving it on PC (n = 2); 16 participants (37%) read their advice a second time and 24 individuals (56%) discussed it with others.

Most of the volunteers (n =32/43 or 74%) found the tailored advice stimulating, however only 10 persons (23%) did made behavioural changes immediately, while another 10 participants indicated they intended to make some changes. All participants who made behavioural changes (n = 10) mentioned they were interested in receiving a second tailored advice and were curious about the change in their physical activity score.

Website evaluation

The other parts of the website (supplementary to the tailored advice) were visited by 11 individuals out of 43 (22%). In general the website was evaluated positively (good structure, colour use, writing style, working links, and navigating speed) and everybody should recommend the website to others.

As given in Table 3, participants visited different sections of the website, dependent on their interests. The most visited section was the start-to-run program that was experienced as (very) helpful by everyone and actually executed by one person.

Table 3: Evaluation of specific website sections by participants who visited at least one website section beside the tailored advice (Groups 1 + 2).

	Strength program	Stretching-program	Start-to-run program	Weekly plan	Goal-setting	Links	Forum	Site plan
Visited? (*n*)								
1 X	6	5	8	3	3	3	1	2
>1X	0	1	1	0	0	1	0	0
Used? (*n*)	6	6	9	3	3	4	0	2
Printed	4	4	5	2	2			
Saved	2	2	3	1	1			
Executed	0	0	1	0				
Filled in form					0			
Followed hyperlinks						4		2
Evaluation? (*n*)								
Very helpful	5	6	6	2	2	3		2
Helpful	0	0	3	1	1	1		0
Not helpful	1	0	0	0	0	0		0
Not at all helpful	0	0	0	0	0	0		0

Discussion

The first finding of this study is that an initial face-to-face contact, even with a stranger, encouraged individuals to visit a physical activity website. A total of 46 of the 100 participants who were personally approached and handed over a flyer, registered on our physical activity website in comparison with only 6% of the participants who had simply taken a flyer home, without initial contact. Secondly, the telephone interviews indicated that the website was accepted well and no major problems were experienced.

Low response rates are a common problem in the recruitment of participants for Internet-based health promoting research (Im and Chee, 2004). A few studies have compared different strategies to motivate potential participants to visit their health-behaviour changing website. The measured response rates varied between 0.3% for print advertisements (Martin-Diener and Thüring, 2002) to 36.8% for e-mails-messages (Thüring *et al.*, 2003). In the study by Feil *et al.* (2003) the success of strategies such as Internet engines or Internet banners on absolute numbers of visitors was highlighted, however no calculation of response rates were possible. Therefore, the high number of website visitors caused by a short face-to-face contact in the present study is promising. Moreover, the hospital visitors were approached by an unknown person and we could hypothesise that the response rate should by even higher if the flyer was handed over by a familiar person, for example a family doctor. Another advantage of implementing the recruitment in already existed networks, for example general practice, is the decrease in additional costs of a face-to-face contact.

Further, it should also be mentioned that the most common reason for not visiting the study-website, was forgetfulness. The non-visitors indicated that a reminder e-mail could help them to remember it. Therefore, it should be recommended to combine the first strategy of an initial face-to-face contact with reminder e-mails.

Few problems were experienced using the website. Almost all participants (90%) who registered on the site received their tailored advice. This is much more than the 33% visitors who finished the physical activity module in the study of Martin-Diener and Thüring (2002). Further, participants in the present study completed the assessment questionnaire in about 15 minutes, which was twice as fast as the completion time of the CD-ROM version. Most of the participants found the tailored advice stimulating and 23% of them reported immediate behavioural changes. All of the latter were interested to receive a second tailored advice to see how their PA score had been increased.

It was clear that the tailored advice was the key element of the website, only 11 out of the 47 participants navigated to another section of the website. However, those 11 persons evaluated the visited website sections positively.

Another important finding of the telephone interviews was the poor knowledge about the physical activity guidelines for adults and the fact that reading it once was not enough to remember it. In Belgium, only few national physical activity campaigns have been done and almost all were aimed to increase sports participation (Vandelanotte, 2004). Therefore, large-scale repetitive interventions to increase the knowledge about current physical activity recommendations seem necessary in Belgium.

The results showed that our recruitment strategies prompted both regular as well as irregular Internet users to our website. This was similar with the results of Feil *et al.* (2000), who found no relation between Internet use and participating in an Internet-based diabetes self-support program. We could also attract an equal number of men and women to our website, which corresponds with the finding that online exercise and fitness information is a popular health topic for both sexes (Fox, 2005).

Limitations of this study

A first limitation of this study is the small sample size. Nevertheless, the sample was diverse with an equal number of men and women and both regular as irregular Internet users. Second, with the exception of the numbers of flyers and registrations, all measurements were self-reported data. It would be of interest to know how many people in Group 2 saw and read the flyers, but did not take the flyer away. Objective data of website visit (when and how long each visit lasted) could also have been informative. A third limitation is that no more than two recruitment strategies were compared.

Conclusion

We could conclude that the used strategy of distributing flyers combined with short face-to-face contact, could increase the number of visitors of a tailored physical activity website compared with distributed flyers without contact and that this strategy reached both men and women as well as regular and irregular Internet users. The second strategy, distributing flyers without personal contact, resulted in very few website visits and therefore appears to be an ineffective strategy on it's own for prompting people to visit a health-related website. Further, the tailored physical activity website could be used under real-life situations and was evaluated well.

Future research should study how such a face-to-face contact could be implemented in already existing contacts and what the effect is of additional reminder e-mails to prompt adults to visit a health–behavioural change website. Finally, the effectiveness of the website in increasing physical activity in the general population should be investigated.

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CHAPTER 4

EVALUATION OF A WEBSITE-DELIVERED COMPUTER-TAILORED INTERVENTION FOR INCREASING PHYSICAL ACTIVITY IN THE GENERAL POPULATION

Abstract

Objective. To examine if a website-delivered physical activity intervention, that provides participants with computer-tailored feedback, can improve physical activity in the general population.

Methods. Healthy adults (n=434), recruited from parents and staff of 14 primary and secondary schools in Belgium in the spring of 2005, were allocated into one of two intervention groups (receiving intervention with or without repeated feedback) or a no-intervention control group. Physical activity levels were self-reported at baseline and at 6-months (n=285), using a computerized long version of the International Physical Activity Questionnaire online. Repeated measures analysis of co-variances were used to examine differences between the three groups.

Results. Intent-to-treat analysis showed significant time by group interaction effects in favor of both intervention groups compared with the control group. Significant increases were found for active transportation (+20, +24, +11 min/week respectively) and leisure-time physical activity (+26, +19, -4 min/week respectively); a significant decrease for minutes sitting on weekdays (-22, -34, +4 min/day respectively). No significant differences were found between both intervention groups.

Conclusion. A website-delivered intervention, including computer-tailoring, was able to increase physical activity when compared to a no-intervention control group. High drop-out rate and the low number of participants who received repeated feedback indicated that engagement and retention are important challenges in e-health studies.

Keywords: Intervention study; Internet; Health behavior; Adult; Primary prevention

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Introduction

Regular moderate-intensity physical activity (PA) has an important influence on health and well-being (Paffenbarger et al., 1986; Morris et al., 1990; Dishman, 1992). Health authorities recommend to participate in at least 30 minutes of moderate-intensity PA on most, preferably all days of the week (Pate et al., 1995; CDC, 2001). More health benefits could be achieved by participating in at least 20 minutes of continuous vigorous-intensity PA, 3 times a week (ACSM, 1978). However, more than half of the adult population in Western countries does not meet these PA recommendations (Caspersen et al., 2000; Buziarsist et al., 2001). Therefore, effective PA interventions, that can reach large population groups at low costs, are needed.

Today they are more than one billion Internet users worldwide (Miniwatts International, 2006) and many of them use this new communication channel for searching for health information (Fox, 2005). The Internet has created a new opportunity to distribute interventions in a cost-effective manner. Therefore, health providers have started to disseminate behavioral interventions through the Internet, including computer-tailored interventions (Etter, 2005; Oenema et al., 2001; Irvine et al., 2004; Bernhardt, 2001). Although computer-tailored interventions, that provide participants with personal relevant feedback produced by a computerised expert system, have induced significant changes in smoking, diet, and PA (Brug et al., 1999; Skinner et al., 1999; Strecher, 1999; Kreuter et al., 2000); little evidence is available on the effectiveness of website-delivered tailored interventions. In the PA domain, some newly developed websites have been tested for their usability and feasibility (Sciamanna et al., 2002; Leslie et al., 2005; McCoy et al., 2005; Anhoj and Holm Jensen, 2004; Thüring et al., 2003). However few studies have investigated the effectiveness of website-delivered computer-tailored interventions, and have focused mainly on specific population groups such as diabetes patients (McKay et al., 2001) and the elderly (Hageman et al., 2005). Others have targeted PA information to the different stages of change (for example goal setting, activity planning, self-monitoring, rewards, using cues) but did not tailor to other behavioral constructs or determinants at an individual level (Napolitano et al., 2003; Marshall et al., 2003).

Therefore the aim of the current study was to build an existing computer-tailored program, which has been shown to be effective in laboratory settings (Vandelanotte et al., 2005b), into a website-delivered PA intervention for the general population and to evaluate its effectiveness in a real life setting. To our knowledge, the present study is the first to do so. Further, in contrast with other computer-tailored interventions studies which used mostly single feedback moments (Kroeze et al., 2006), we wanted to

examine if increased intervention intensity, by additional e-mail reminders and repeated exposure to the tailored advice, increase the effectiveness of the intervention.

Methods

Participants and study design

Participants were recruited by distributing brochures to parents of children and school staff of 14 primary and secondary schools, located in three different regions in Belgium. Eligible participants were between 20 and 55 years of age, had no history of cardiovascular diseases, and had access to the Internet. Individuals who were interested and met the eligibility criteria had to return a reply card with their contact information. Potential participants were allocated to one of three study groups, using the school region as a unit of randomization to avoid potential "contamination" between groups.

All participants were invited via e-mail to complete the questionnaire on the intervention website, both at baseline and 6 months later, using a confidential username and password. Reminder messages by email (2) and phone (1) were provided to participants who did not respond to the first invitation. Participants in group 1 and 2 received the tailored PA advice on their computer screen immediately following their baseline assessment and could also visit other website sections. In addition participants in group 1 also received during the intervention period seven non-tailored e-mails to invite them to visit a specific website section by following a hyperlink. One e-mail, 3 months post-baseline, invited participants to fill in a second assessment, to receive new tailored advice. Group 3 was a waiting-list control group and had no access to the website and the computer-tailored feedback until they completed the follow-up questionnaire at 6 months. Gift coupons were raffled among all participants both at baseline and at follow-up. Baseline assessment took place during spring, while follow-up was done during fall (Fig. 1). The study was approved by the Ghent University Ethics Committee and an electronic informed consent statement was obtained from each participant at the start of the study.

Intervention website

The main section of the website included an interactive computer-tailored program that generated individualized PA advice after completing an assessment questionnaire. The content of this computer-tailored program was based on a previously developed and evaluated computer program on CD-ROM (Vandelanotte and De Bourdeaudhuij, 2003, Vandelanotte et al., 2005a).

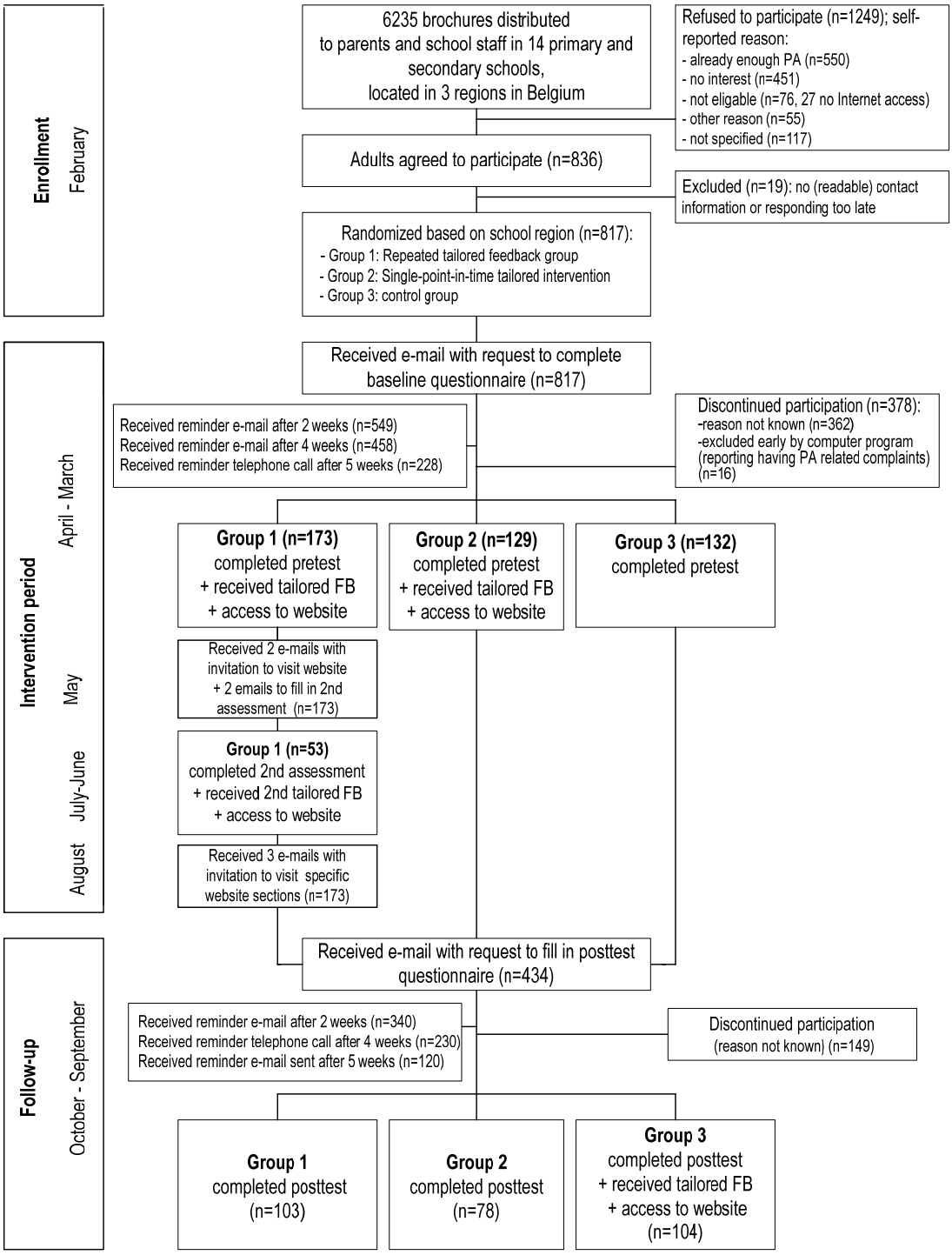

Fig. 1. Flow diagram of the study.

Note: Study conducted in Belgium in 2005; PA=physical activity; FB = feedback

The assessment questionnaire contained questions on demographics, PA and psychosocial determinants of PA and was designed to provide feedback to participants on their PA level, together with tips and suggestions to improve their behavior. The advice was tailored on stages of changes (Prochaska, 1994), both by content and the way in which the participants were approached (a more distant way for precontemplators to

avoid resistance, a more personal way for contemplators, a decisive way for preparators and a supporting way for participants in action or maintenance stage). Further also the constructs of the Theory of Planned Behavior (Ajzen, 1985) were considered by giving the participants personal advice about intentions, attitudes, self-efficacy, social support, knowledge, benefits and barriers of PA. Examples of tailoring messages are shown in Table 1.

For the website-delivered version of the tailored advice used in this study hyperlinks, that lead participants to additional website sections (goal setting, weekly plan, strength and flexibility exercises, start-to-run program, forum, links and contact information) were added to the original CD-ROM based intervention.

Table 1. Example messages of which the tailored advice is build of

	Example message
Introduction (message for a contemplator)	You are planning to increase your activity within the next 6 months. This is a very good idea, because at the moment you are not active enough! The following tips might help you fulfilling your good intentions.
Leisure time (message for a preparator)	You reported doing 80 minutes of sport and physical activities per week in your leisure time. This is very good, go on! Doing more sport and physical activities in your leisure time is just one of the possibilities that you have when planning to become more active. Find out more about this when we address 'the weekly activity plan'.
Barrier (message for a precontemplator)	Lack of interest is an important barrier for you to be active. Maybe you are not well informed about the advantages of an active lifestyle; we hope that this letter can help to change this. Or maybe you think that being active is unpleasant. Are you sure about that? As pointed out in the 'weekly activity plan' there are plenty options to choose from. If you make a small effort you must surely find an activity that suits you well and that you find enjoyable.

Study conducted in Belgium in 2005

Measurements

Outcomes measures

The long usual week version of the International Physical Activity Questionnaire (IPAQ) was used to assess PA levels at baseline and follow-up as well as to provide participants feedback on their PA level. IPAQ showed to be a valid and reliable instrument at population level (Craig et al., 2003) and has been used to evaluate PA interventions (Vandelanotte et al., 2005b; Vandelanotte et al., in press). It assesses the frequency and duration of physical activities at work, as transportation, in household and in leisure time; it also assesses daily sitting time. PA scores for each domain and a 'total moderate- to vigorous-intensity physical activity score' (MVPA) (complying with the recent PA recommendation) were calculated and expressed in minutes/week.

Process measures

The assessment questionnaires, 3-months (group 1) and 6-months (group 1 and 2) post-baseline, contained questions to evaluate both the tailored advice (i.e. whether participants read, printed or discussed their first/second advice with others; and whether they thought the first/second advice had a positive impact on their PA behavior) as well as the intervention website (i.e. whether participants visited particular sections; and whether they used it and found it helpful).

Statistical analyses

Due to positive skewness of all PA variables (indicated by a significant Shapiro-Wilk test), analyses were executed using logtransformed (Keene, 1995; Napolitano et al., 2003) PA data. Drop-out analyses were executed using independent-samples *T*-Tests for numeric variables and Mann-Whitney *U* test for categorical data. To evaluate the effects on PA behavior, repeated measure ANCOVAs with time (within) and intervention condition (between) as factors, and age and Body Mass Index (BMI) as covariates, were conducted using both an intent-to-treat analysis (n=434) (assuming no change from baseline for drop-outs) and a retained sample analysis (without drop-outs) (n=285). All analyses were performed using SPSS 12.0.

Results

Participation

At baseline 434 respondents participated in the study of which 285 (66%) completed the 6-month follow-up (see Fig. 1). Drop-out analysis showed that men (χ^2=4.146, p<0.05, two-tailed), participants with higher BMI (t=-2.163, p<0.05, two-tailed) and those in intervention groups (χ^2=14.511, p<0.01, two-tailed) were more likely to drop out. No significant differences were found for baseline PA levels. Total sample characteristics at baseline are shown in Table 2. Compared with the general Belgian population (Table 2) the study sample was similar in age and BMI, but higher educated, more employed and slightly more physically active (more compliance with PA recommendations).

Table 2. Baseline characteristics (% or mean ± S.D.) of total sample and three study groups, compared with the general Belgian population.

	Study sample (*n*=434)	Group 1 (*n*=173)	Group 2 (*n*=129)	Group 3 (*n*=132)	General Belgian population
	%	%	%	%	%
Gender (female)	66.1	65.3	66.7	66.7	51.1[b]
Higher education	66.8	61.9	67.4	72.7	30.0[b]
Employed	86.1	86.2	84.5	87.8	64.3[b]
Compliance with PA recommendations	43.5	47.4	44.2%	37.9	34[a]
Stages of change					
Precontemplation	5.1	3.5	6.2	6.1	
Contemplation	14.1	8.7	15.5	19.8	
Preparation	37.4	40.5	34.1	36.6	
Action	10.9	11.6	12.4	8.4	
Maintenance	32.6	35.8	31.8	29.0	
	Mean (S.D.)	Mean (S.D.)	Mean (S.D.)	Mean (S.D.)	Mean
Age in years	41.4 (5.6)	43.3 (5.7)	39.6 (5.0)	40.7 (5.3)	40.2[b]
BMI in kg/m²	24.6 (3.6)	25.0 (3.7)	24.6 (3.6)	24.1 (3.5)	24.8[a]
PA at moderate intensity in min/day	37.5 (40.0)	40.9 (40.5)	39.5 (42.3)	30.9 (36.4)	53.4[a]

Study conducted in Belgium in 2005; PA = Physical Activity; PA recommendations = accumulating at least 30 minutes of moderate-intensity physical activity on most, preferably all days of the week OR doing at least 20 minutes of continuous activity at vigorous intensity, at least three times a week; BMI= Body Mass Index. Group 1= tailored intervention with additional contacts and repeated feedback possibility; group 2= single-point-in time tailored intervention; group 3=control group

a: Source: Belgian Health Inquiry (Bayingana et al., 2004), only compliance with health recommendation (Pate et al., 1995)

b: Source: National Institute for Statistics, Population Stats (2005).

Changes in physical activity

Participants in both intervention groups reported a significant increase in PA level and decrease in time spent sitting at 6-month follow-up compared with the control group (Table 3a). Significant time by group effects were found for active transportation, PA in leisure time and time spent sitting on a weekday. Pair-wise comparison showed no significant differences between the two intervention groups.

Subgroup analyses, focusing on participants not meeting the PA recommendations at baseline (doing less than 210 minutes moderate-to-vigorous intensity activities a week and less than 20 minutes continuous activities at vigorous intensity, three times a week), showed similar effects in favor of the intervention groups: increases in total MVPA and active transportation (only for completers), and an increase in household activities and a decrease in time spent sitting on weekdays (for total sample) (Table 3b). Again, no significant differences were found between intervention groups.

Table 3a. Mean physical activity scores (min/week) and time spent sitting (min/day) at baseline and at 6-month follow-up for all conditions using intent-to-treat analysis and retained sample analysis

	Intent-to-treat (n=434)				Completers (n=285)			
	Group 1 (n=173)	Group 2 (n=129)	Group 3 (n=132)	Time × group	Group 1 (n=103)	Group 2 (n=78)	Group 3 (n=104)	Time × group
	Mean (S.D.)	Mean (S.D.)	Mean (S.D.)	F^a	Mean (S.D.)	Mean (S.D.)	Mean (S.D.)	F^a
Total MVPA[b]								
Baseline	286 (284)	277 (296)	216 (255)	0.879	292 (285)	290 (319)	201 (254)	1.548
6 month	363 (323)	314 (324)	241 (269)		420 (337)	352 (357)	233 (273)	
Difference	+ 77	+ 37	+ 25		+ 128	+ 62	+ 32	
Transportation PA								
Baseline	56 (90)	51 (86)	45 (83)	2.926*	61 (93)	46 (84)	42 (65)	5.250**
6 month	76 (102)	75 (117)	56 (91)		95 (108)	86 (130)	55 (78)	
Difference	+ 20	+ 24	+ 11		+ 34	+ 40	+ 13	
Household PA								
Baseline	210 (240)	159 (175)	200 (207)	1.204	232 (249)	181 (190)	209 (216)	1.892
6 month	234 (248)	199 (243)	196 (183)		271 (257)	246 (281)	203 (187)	
Difference	+ 24	+ 40	- 4		+ 39	+ 65	- 6	
Leisure-time PA								
Baseline	89 (109)	77 (103)	81 (92)	2.322*	99 (108)	79 (114)	74 (86)	3.139*
6 month	115 (129)	96 (108)	85 (120)		143 (134)	112 (118)	80 (123)	
Difference	+ 26	+ 19	+ 4		+ 44	+ 33	- 6	
Job-related PA								
Baseline	215 (334)	218 (336)	128 (258)	0.0249	187 (308)	243 (370)	121 (261)	0.268
6-month	228 (341)	200 (348)	130 (263)		210 (322)	213 (389)	124 (268)	
Difference	+ 13	- 18	+ 2		+ 23	- 30	+ 3	
Weekday sitting time (min/day)								
Baseline	350 (212)	351 (225)	385 (213)	3.105*	344 (196)	329 (221)	384 (209)	
6 month	328 (214)	317 (210)	389 (209)		307 (197)	273 (185)	388 (205)	3.713*
Difference	- 22	- 34	+ 4		- 37	- 56	+ 4	
Weekend sitting time								
Baseline	265 (151)	260 (146)	224 (113)	0.189	265 (142)	257 (141)	223 (104)	0.254
6 month	252 (143)	248 (156)	214 (128)		242 (125)	237 (157)	210 (114)	
Difference	-13	- 12	- 10		- 23	- 20	+ 23	

* $p<0.05$; ** $p<0.01$;*** $p<0.001$ within group (one-tailed).

[a:] Repeated Measures ANCOVA's on logtransformed data (untransformed data are presented in the table); with age and BMI as covariates; [b]: representing PA complying with recent guideline (accumulating at least 30 minutes of moderate-intensity physical activity on most, preferably all days of the week)

Study conducted in Belgium in 2005; PA = Physical Activity; MVPA= Moderate-to vigorous-intensity physical activity; group 1= tailored intervention with additional contacts and repeated feedback possibility; group 2= single-point-in time tailored intervention; group 3=control group

Table 3b. Mean physical activity scores (min/week) and time spent sitting (min/day) at baseline and at 6-month follow-up for participants not meeting PA recommendations at baseline using intent-to-treat analysis and retained sample analysis

	Participants not meeting PA recommendations at baseline, intent-to-treat (n=245)				Participants not meeting PA recommendation at baseline, completers (n=162)			
	Group 1 *n*=91	Group 2 *n*=72	Group 3 *n*=82	Time × group	Group 1 *n*=51	Group 2 *n*=42	Group 3 *n*=69	Time × group
	Mean (S.D.)	Mean (S.D.)	Mean (S.D.)	F^a	Mean (S.D.)	Mean (S.D.)	Mean (S.D.)	F^a
Total MVPA[b]								
Baseline	89 (63)	83 (60)	72 (57)	1.018	88 (65)	77 (61)	72 (57)	2.982*
6-month	190 (232)	153 (145)	124 (151)		270 (282)	197(172)	134 (161)	
Difference	+ 101	+ 70	+ 52		+ 182	+ 120	+ 62	
Transportation PA								
Baseline	42 (55)	32 (65)	37 (62)	1.688	40 (52)	28 (70)	39 (62)	4.187**
6-month	69 (88)	44 (56)	47 (73)		87 (103)	48 (55)	51 (75)	
Difference	+ 27	+ 12	+ 10		+ 47	+ 20	+ 12	
Household PA								
Baseline	145 (156)	138 (155)	159 (159)	2.538 *	168 (181)	149 (166)	172 (167)	4.126**
6-month	180 (203)	190 (214)	160 (151)		229 (242)	238 (245)	173 (158)	
Difference	+ 35	+ 52	+ 1		+ 61	+ 89	+1	
Leisure-time PA								
Baseline	48 (48)	44 (54)	44 (52)	0.912	52 (52)	47 (62)	44 (51)	1.855 (*)
6-month	75 (87)	75 (101)	54 (79)		99 (104)	100 (122)	56 (82)	
Difference	+ 27	+ 31	+ 10		+ 47	+ 53	+ 12	
Job-related PA								
Baseline	56 (122)	39 (80)	22 (65)	0.232	43 (100)	26 (59)	24 (70)	0.580
6-month	100 (206)	55 (98)	38 (109)		121 (242)	53 (97)	43 (118)	
Difference	+ 44	+ 16	+ 16		+ 78	+ 27	+ 19	
Weekday sitting time (min/day)								
Baseline	415 (223)	416 (232)	427 (206)	1.861(*)	415 (209)	392 (243)	414 (198)	
6-month	392 (226)	365 (209)	420 (218)		376 (214)	305 (184)	405 (213)	2.601*
Difference	- 23	- 51	- 7		- 36	- 87	- 9	
Weekend sitting time								
Baseline	290 (160)	278 (154)	231 (117)	0.360	298 (150)	291 (160)	225 (99)	0.052
6-month	271 (149)	261(166)	217 (135)		263 (128)	262 (180)	208 (122)	
Difference	- 19	- 17	- 14		- 35	- 29	- 17	

(*) p <0.1; * p<0.05; ** p<0.01; *** p<0.001 within group (one-tailed)

[a]: Repeated Measures ANCOVA's on logtransformed data (untransformed data are presented in the table); with age and BMI as covariates; [b]: representing PA complying with recent guideline (accumulating at least 30 minutes of moderate-intensity physical activity on most, preferably all days of the week) Note: PA = Physical Activity; not meeting PA recommendations = less than 210 minutes moderate-to-vigorous intensity activities at week and less than 20 minutes continuous activity at vigorous intensity, three times a week; MVPA= Moderate-to vigorous-intensity physical activity; Group 1= tailored intervention with additional contacts and repeated feedback possibility; Group 2= single-point-in time tailored intervention; Group 3=control group

Fig. 2 illustrates the impact of the intervention on the percentages of participants who met the PA recommendations at 6 months. When all participants (N=434) were included in the analysis (Fig. 2A), the intervention resulted in a significant increase of 10% of participants that met the recommendations in the first intervention group, compared with non-significant increases of 5% (group 2) and 4% (group 3). Fig. 2B shows that 23% (group 1) 25% (group 2) and 20% (group 3) of participants who were insufficiently active at baseline (N= 245), did met the PA recommendations after 6 months.

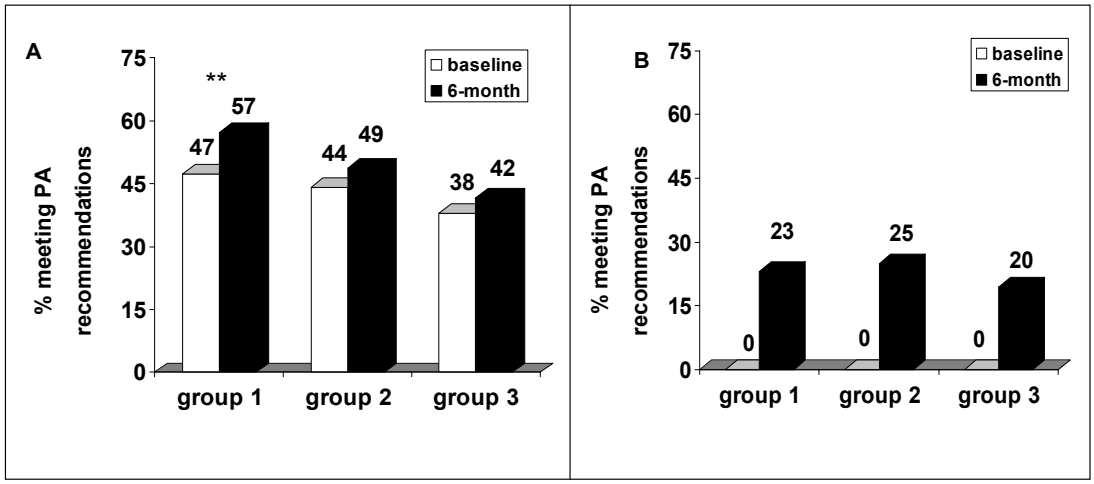

Fig. 2. Percentages of all (n=434) participants (A) and insufficiently active participants (N=245) at baseline (B) meeting the physical activity recommendations at baseline and at 6-month follow-up across the different conditions.

** Significant increase: Z=-4.131, p<0.001 (one-tailed)
Note: PA recommendations = accumulating at least 30 minutes of moderate-intensity physical activity on most, preferably all days of the week OR doing at least 20 minutes of continuous activity at vigorous intensity, at least three times a week; group 1= tailored intervention with additional contacts and repeated feedback possibility; group 2= single-point-in time tailored intervention; group 3= control group

Use, appreciation and subjective impact of intervention materials

Fifty-three out of 173 (30.6%) participants in group 1 obtained a second tailored advice 3 months after their first advice (see Fig. 1). In both intervention groups, 94% of the participants read the advice and over 50% of participants printed, discussed or saved it (see Table 4). Further, about half of the participants reported that they had made changes in PA after reading their first advice. In group 1, 9 out of 34 participants (26.5%) indicated change after reading their second advice.

Table 4. Use and subjective impact of the tailored advice in both intervention groups

	Received tailored advice twice (part of group 1)				Received tailored advice once (part of group 1 + group 2) (n = 140)	
	First advice (n = 53)		Second advice (n = 34)			
	n	%	n	%	n	%
Read completely	50	94.3	32	94.1	132	94.3
Printed out	28	52.8	16	47.1	67	47.9
Discussed with others	27	50.9	12	35.3	42	30.0
Saved advice	28	52.8	18	52.9	68	48.6
Made behavioral changes	30	56.6	9	26.5	67	47.8
Planned behavioral changes	6	11.3	8	23.5	31	22.1

Study conducted in Belgium in 2005; group 1= tailored intervention with additional contacts and repeated feedback possibility; group 2= single-point-in time tailored intervention.

Discussion

Effects on behavior

The results of this study show that a computer-tailored PA intervention delivered through the Internet could enhance PA levels in healthy volunteers and decrease sitting behavior in comparison with a no-intervention group. Although the effect on MVPA was only significant in a subsample (completers who were insufficiently active), significant changes for total sample were found for active transportation and leisure-time PA. PA behaviour is most easily changed in those two activity domains, as they are the more volitional in nature. Our findings extend those of an earlier efficacy study in which the computer-tailored intervention was delivered through a CD-ROM under more controlled laboratory conditions (Vandelanotte et al., 2005b). In light of a recent systematic review of the literature showing convincing evidence for the effectiveness of computer-tailored nutrition interventions, but mixed for PA (Kroeze et al., 2006), this study also adds new evidence on the potential for website-delivered interventions to facilitate PA behavior change. Except for the study by Napolitano (2003), other Internet-based studies with (McKay et al., 2001) or without computer-tailored feedback (Marshall et al., 2003; Tate et al., 2001; Harvey-Berino et al., 2002) found only time effects on PA behavior and no superior effects in favor of the tailored/targeted intervention groups.

Frequency of tailored feedback

No significant differences in PA behavior were found between the group with repeated tailored feedback and the group with single feedback. Nevertheless this should be interpreted with caution, since a minority of participants in the first group actually received a second advice. In the literature, there are studies who found also no clear

evidence of the superior effect of multiple tailored print messages compared with a single one (Velicer et al., 1999; Heimendinger et al., 2005; Marcus et al., 2005; Strecher et al., 2005). However, other studies did identify additional impact of a second (Brug et al., 1998) or third (Dijkstra et al., 1998) computer-tailored letter on respectively fat intake and quit-smoking intention.

Process Evaluation

The process evaluation was positive; indicating that most participants used the advice and were stimulated afterwards to make or plan PA changes. Some participants who received repeated feedback also reported to have taken profit of their second advice, which shows that some individuals need additional time or stimuli before making behavioral changes. However, only a small number of participants reacted on the e-mail prompts to obtain a second advice; perhaps the time period was too short (4 weeks) or inconvenient (summer holiday). Nevertheless, Wang and Etter (Wang and Etter, 2004) reported an even smaller number (19.6%) of visitors who returned to the stop-tabac.ch website to achieve a second or third computer-tailored smoking cessation letter.

Strengths and limitations

This study is one of the few to examine the effectiveness of a computer-tailored PA intervention delivered through the Internet and the first to do so among a general healthy population setting. A second strength is that the intervention was fully automated and therefore, no face-to-face contact was required, mimicking a real-life implementation as much as possible. Thirdly, as 56.5% of participants did not meet the PA recommendation at baseline we succeeded in reaching our target group. Further, the preponderance of women in the sample (69.5%), showed that women with interest in PA information, do not drop-out when the information can only be obtained online. This is in line with the recent findings that Internet use is no longer dominated among youth and men, and that the largest growth in Internet use in Belgium is found among women and older adults (Insites Consulting, 2005). Finally, another strength is the stepwise approach used in intervention development and evaluation (from acceptability, feasibility and efficacy testing of the CD-ROM version in laboratory settings to usability tests, an implementation study and finally an effectiveness study of the website version in field settings) as recommended by the literature (Campbell et al., 2000; Kroeze et al., 2006).

This study has several limitations. First, participants were motivated volunteers who were not totally representative of the general population. Second, no individual

website usage patterns were monitored. Third, previously it has been shown that the self-report measure used to assess PA (IPAQ), has a tendency towards overreporting (Rzewnicki et al., 2003). Fourth, the intervention was conducted during spring and summer and may not translate to other periods of the year. Fifth, although Internet access is still increasing, to date the Internet is not able to reach representative or disadvantaged populations. Finally, a major limitation is the high drop-out rate (34%); this drop-out was twice as high in intervention groups (40%) when compared to the control group (21%). This difference could be explained by the fact that participants in the intervention groups received their tailored feedback immediately after baseline assessment and therefore had, in contrast with the control group, less motivation to stay in the study until post-test. High drop-out rates have also been reported in other Internet trials (44% by Feil et al., 2003 and 65% by Etter, 2005) and is mentioned as a typical and natural feature of Internet self-help application (Eysenbach, 2005) because of its easiness to discontinue participation, especially in interventions focusing on non-life-threatening behaviors. The combination of reminder e-mails with reminder telephone calls could be a useful strategy in retaining participants in Internet trials as it prevented even higher drop-out rates in the present study.

Conclusion

The interactive website, with tailored physical advice was able to increase PA in motivated volunteer participants in comparison with a no-intervention control group. These results indicate that website delivered PA interventions can be effectively and feasibly implemented in real-life situations. More research is needed on optimal intervening intensity as no significant differences were found between both intervention groups. Comparable with previous Internet trials, attrition was high; more in depth research on this typical feature of e-health research is needed. Interventions, such as the one evaluated in the present study, can be disseminated and promoted as a stand-alone-intervention (for example by a general practitioner recommending the website to a sedentary patient), or can be implemented as part of a more comprehensive (community) trial, using tailored advice as a trigger for behavior change combined with other effective strategies to increase and sustain PA levels over time.

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CHAPTER 5

WHO PARTICIPATES IN A COMPUTER-TAILORED PHYSICAL ACTIVITY PROGRAM DELIVERED THROUGH THE INTERNET?

Abstract

Background: Today, more and more health professionals use the Internet to deliver behavioral change interventions, because of its advantage to reach a wide variety of people at low costs. However, little is known about who is interested in and actually participates in such website-delivered programs. Therefore, the purpose of this manuscript was to examine the characteristics of participants and non-participants (parents recruited through schools) in a computer-tailored physical activity intervention delivered through the Internet.

Methods: 1730 pupils (between 10-18 years of age) from 12 primary and secondary schools in Belgium completed a short questionnaire concerning their parents' age, occupation and physical activity habits. Chi-square analysis and binary logistic regressions were used to compare characteristics of those parents who enrolled (i.e. agreed to participate; n=338) or actually participated (i.e. completed online assessment, n=171) in a website-delivered physical activity intervention with the characteristics of those parents who did not enroll (n=2894) or did not participate (n=3061).

Results: Mothers were more likely to enroll (Odds Ratio (OR)=1.68, $p<0.001$) and participate (OR=2.27, $p<0.005$) in the program than fathers. High socioeconomic status (SES) (OR=3.42, $p<0.001$) and being employed (OR=3.03, $p<0.001$) were also significant predictors for enrollment but not for participation. Age and physical activity level did neither predict enrollment nor participation.

***Conclusion*:** Website-delivered interventions seem to attract different kind of people: younger and older as well as physically inactive and physically active adults participated in an online computer-tailored physical activity intervention when recruitment was done through schools. However, other health-education programs are still needed to reach all segments of the population equally.

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Background

Epidemiological evidence shows that physical inactivity is an independent risk factor for developing coronary heart disease, cardiovascular disease and all-cause mortality [1-4]. Further, research also demonstrated that physical inactivity increases the risk for other chronic diseases as diabetes mellitus type 2 [5,6], anxiety and depression [7-8], different types of cancer [9], and osteoporosis [10-11]. Since the majority of the adults in Western countries does not participate in regular physical activities [12-13] many are at risk and therefore, effective interventions promoting an active lifestyle that can reach large population groups at low costs are of great importance [14].

Face-to-face counseling, as used in primary care, seemed to be an effective method for delivering physical activity interventions [15-16], but it is very time-consuming, and only a small proportion of the population can be reached [17]. An alternative strategy is computer-tailoring, which seems to be effective in changing smoking, diet or physical activity behavior [18-21]. Interactive computer-tailored interventions can be used to mimic face-to-face counseling [17], by giving participants immediate personally adapted advice after completing an electronic diagnostic questionnaire. With the rapid development of the Internet, a new opportunity is created to distribute computer-tailored interventions in a cost-effective manner.

Today there are more than one billion Internet users worldwide [22] and this number is still increasing due to a drop in the cost of Internet connections and improved high speed access. The biggest penetration rate is found in North America (68.6%), followed by Oceania (52.6%) and Europe (36.4%) [22]. At the moment the increase of Internet users is the largest in underserved populations, such as the elderly, lower educated persons and women; and consequently the gaps among age, educational attainment and gender are narrowing [23]. Consequently Internet interventions could reach a wide variety of people at once, at any time and location. In the last years, more and more health professionals have started to use the Internet to deliver behavioral change interventions on various topics such as smoking [24-25], diet [26] and physical activity [27-28]. The former studies mainly focussed on the acceptability, feasibility and efficacy of health promotion programs via the Internet, but little is known about the actual reach of these programs, more specific: who participates in interactive Internet interventions and who does not?

A critique often heard with regard to health promoting interventions and also to computer-tailored interventions is that it only makes the healthiest people healthier. It is often hypothesised that participants in these interventions are employed, high educated and have more positive health behaviors compared with the general population [29],

[30-31]. Further, it seems that more women than men participate in health promoting interventions through the Internet [32-35].

A study by McClure [36] showed that characteristics of visitors to a smoking cessation website (Project Quit) differed by the recruitment strategy that was used. Participants recruited by newsletters were more likely to be female, Caucasian and older compared to participants who were recruited by a proactive invitation letter. However, the total sample was similar to participants who enrolled in phone counseling smoking cessation programs: participants were middle-aged and moderate-to heavy smokers with a history of numerous quit attempts. Further, Cobb and Graham [37] determined the characteristics of adults who search the Internet for smoking cessation information. They reported that the majority of visitors of the leading smoking cessation website (Quitnet) were female smokers between the ages of 26-44; intended to quit in the next 30 days, and made 5.1 quit attempts during the past year. In a study by Feil *et al*. [38] characteristics of participants and non-participants in an Internet-based diabetes self-management support program were compared. There were no differences found in gender or computer familiarity between participants and non-participants but younger patients and those who had diabetes a fewer number of years were more likely to participate. To our knowledge, no studies reported differences between participants and non-participants of website-delivered physical activity promotion programs.

Therefore in this paper we examined who participated, and conversely who did not participate in a computer-tailored physical activity intervention delivered through the Internet. The first aim of the current study was to investigate if enrollment (i.e. agreement to participate) and actually participation (i.e. completing online assessment at least once) could be predicted by means of individual characteristics such as age, gender, socioeconomic status (SES), employment and physical activity level. The second aim was to report the most common reasons for non-participation.

We hypothesized that younger people, women, employees, those with higher SES, and those who are already regular physically active would be more likely to enroll and participate in the computer-tailored intervention.

Methods

Study sample and procedure

This study was carried out in the context of a randomized control trial that tested the effectiveness of computer-tailored physical activity intervention program delivered through the Internet. More information about the intervention trial itself and its effectiveness is described in more detail elsewhere [39]. In short, the recruitment for

the intervention trial was done as follows: brochures with a call to participate in a physical activity program, with as key element a website-delivered tailored physical activity advice, were distributed to parents and school staff of the 14 primary and secondary schools in Belgium, that agreed to participate. People who were interested to receive a tailored physical activity advice through the Internet and fulfilled the inclusion criteria (between 20-55 years old, no history of cardiovascular diseases, access to the Internet at home, work, school or public places) could return a reply card mentioning that they wanted to participate. Individuals who not wanted to participate were also asked to return the reply card mentioning the reason for refusal. At the start of the intervention all individuals who subscribed were invited via e-mail to register on the website, to complete an electronic informed consent statement, and to fill in the diagnostic questionnaire. Participants who were randomised in the intervention groups received their tailored advice on their screen immediately after completing the diagnostic questionnaire; participants in the control waiting group received their advice after they complete the follow-up questionnaire at six months.

For the current study a sub sample of pupils (between 10-18 years of age) from 12 out of 14 intervention schools, completed in the classroom a short questionnaire concerning their parents' age, occupation and physical activity habits. The advantage of this method was that also information could be collected about the parents who did not respond at all to the intervention invitation.

Two of the 14 participating schools in the intervention study, refused to let pupils fill in the short questionnaire needed for the current study. The most important reason for refusal was that those schools already participated in a number of studies in the same school year, which caused an excess of questionnaires that had to be completed by their pupils. In the primary schools that participated in the current study, all pupils of 5th and 6th class filled in the questionnaire in the classroom under supervision of their class teacher. In the secondary intervention schools, a number of classes were chosen randomly (those that received a study hour in one specific week, caused by sickness of a teacher) to complete the questionnaires in the class room under supervision of an employee of the school. The study was approved by the Ghent University Ethics Committee.

In total, 2000 short questionnaires were distributed in the intervention schools, of which 1740 (87%) were completed by pupils. 1730 questionnaires were suitable for further analysis and were checked on doubles. Eighty-one siblings, reporting on the characteristics of the same couple of parents, were detected and only one questionnaire of them was (ad random) included in the analysis. This resulted in 1649 questionnaires

of which characteristics of 3232 parents were computed (1637 mothers and 1595 fathers).

The 3232 names on the questionnaires filled in by the pupils were matched with the names of the participants in the intervention and with those who did not participate but filled in the reply card (agreement to participate or reason for refusal). Based on the level of participation in the intervention, five groups of parents of which their children completed a questionnaire were identified, and were subject to further analyses in the current study. Group 1 consists of the parents who logged in to the website and completed the diagnostic questionnaire both at baseline and at follow-up (n=109); subjects in group 2 are the parents who logged in to the website and completed the diagnostic questionnaire at baseline but did not return to the website at follow-up (n=62); group 3 contains the responders who agreed to participate in the intervention but did not start (did not visit the website to complete diagnostic questionnaire at baseline) (n=167); group 4 consists of the parents who did not want to participate in the intervention because they were already sufficiently physically active (n=246); and group 5 includes the remaining individuals (n=2648): they declined for other reasons or did not respond to the intervention invitation. See figure 1 for an overview of the study sample.

For binary logistic regression analyses these five groups were dichotomized into "participants" (groups 1-2) and "non-participants" (groups 3-5) and also into "enrolled parents" (groups 1-3) and "not-enrolled parents" (groups 4-5).

Measurements

Questionnaires completed by the children

The questionnaire existed of two identical parts: one about the mother and one about the father. First, general information (name, age and occupation of mother/father) was asked. Next, questions relating to transportation followed: whether and how mother/father usually goes to her/his work or to the grocery/shops (no transport; car or public transport; by bike; walking). Further, it was asked whether mother/father participates in sports activities, gardening, walking or cycling during leisure time (never; irregular; regular). If appropriate, more details were asked about frequency (days/week) and duration (min/day) of active transportation to work, and about type and frequency (days/week) of sports activities.

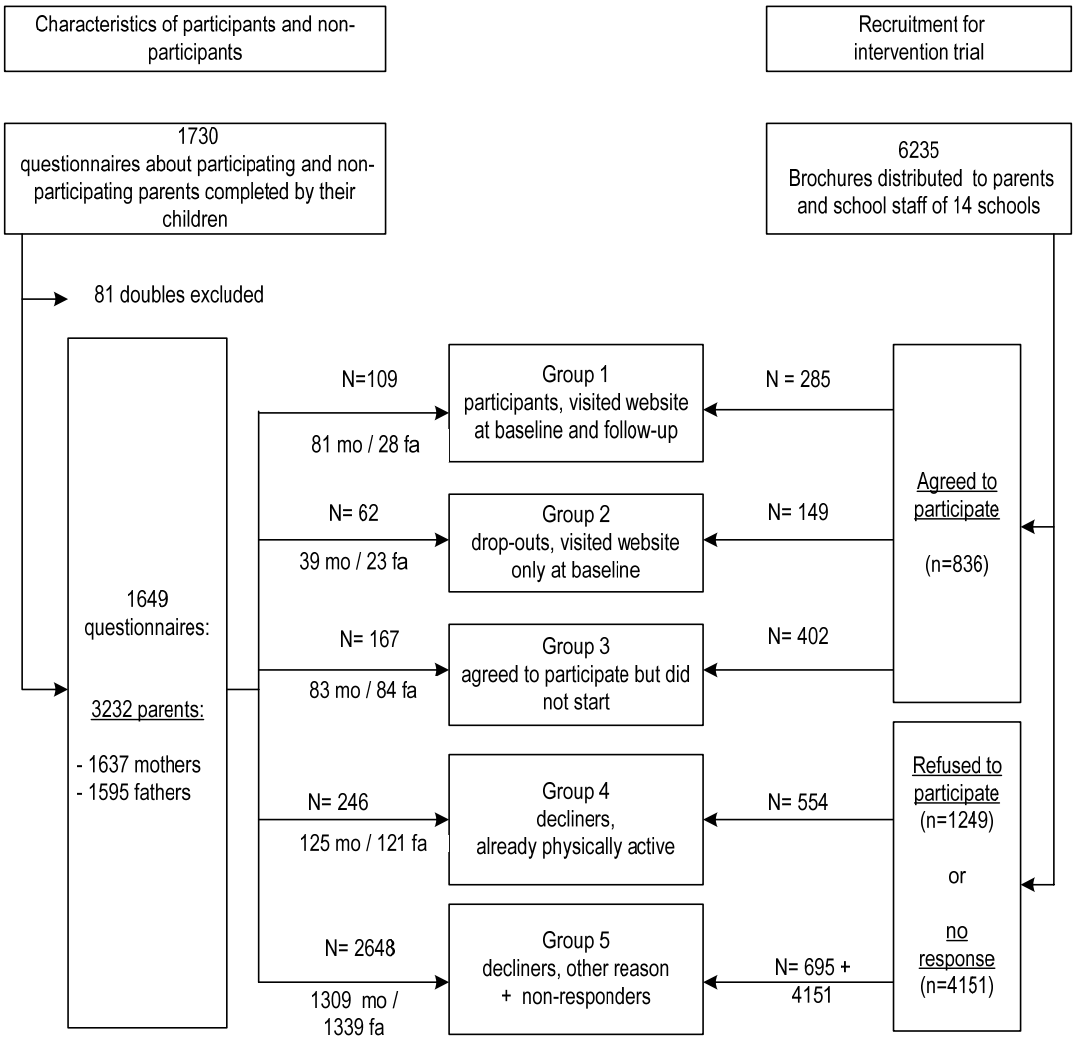

Figure 1. Schematic overview of the study sample. Study groups based on the levels of participation in (or responding to) the intervention. Note: mo = mothers; fa = fathers

A *transport index* was calculated by multiply frequency and duration of active transportation and a *sports index* was calculated by taking into account the frequency of sport activities of ≥ 3 MET values (multiples of resting metabolic rate [40]).Further a *total physical activity index* was calculated by counting up each answer corresponding with participation in a physical activity. Finally, each subject was classified into one of 4 categories based on these 3 indices. Category a: a sedentary job and almost no active transportation or physical activities in leisure time; category b: irregular or too less physical activities; category c: more then 150 minutes active transportation to work, or regularly participating in physical activities; category d: more then 3 times a week participating in sports activities of ≥ 3 METs. These categories were dichotomized (for binary logistic regression analyses) into a "not regularly active group" (categories a-b) and a "regularly active group" (categories c-d).

Parental occupation was used to derive SES by coding the job description according to the classification of the Central Bureau for Statistics of the Netherlands [41]. This classification is based on the level of skills needed to execute a job: low level (e.g. truck drivers); medium level (e.g. nurse); or high level (e.g. dentist). Job descriptions as 'housewife', 'student', 'job-seeker' and 'retired' were classified as 'economically inactive'.

Test-retest stability [42] of the questionnaire was evaluated in a different study (data not shown) with 82 pupils between 11 and 13 years of age who completed the questionnaire twice, with a one week interval under supervision of a teacher. The reliability results were good: ICC values of the three physical activity indices ranged from 0.78 to 0.82 for mothers and from 0.70 to 0.82 for fathers; kappa values of the categorical answers all exceeded 0.70 (mothers) and 0.60 (fathers); calculating the proportion of agreement indicated that 91% of the mothers and 80% of the fathers were classified in the same physical activity category, and 97% (mothers) and 91.3% (fathers) were classified in the same SES category.

Reply cards of parents and school staff

Information collected during the recruitment process of the intervention study [39] was also used in the current study. Basic information was collected from all parents and school staff that responded (n=2085) to the invitation by means of a reply card in the brochure: name and family name of the adult; relation to the school where the brochure was distributed; and (in case of a parent) name and grade of their child(ren). Further, individuals who were interested in the intervention (enrollers) filled in contact information and those who did not want to participate mentioned the reason for refusal (not fulfilling the inclusion criteria; already sufficiently physically active; no interest; other reason).

Statistical analyses

Chi² analysis was used to determine possible differences in physical activity level between the five groups of parents (based on level of participation). Binary logistic regression was used to detect if *enrollment* into the intervention could be predicted by age, gender, SES, employment or baseline physical activity level. As there were lots of good intenders but few completers, binary logistic regression was also done to detect which variables could predict *participation*.

All statistical analyses were performed using SPSS software (version 12.0) and statistical significance was set at a level of 0.05.

Results

Physical activity levels

Table 1 shows the parents' physical activity levels, reported by their children, in the five groups. Only a small proportion of them (25%) met the physical activity recommendations for adults (at least 30 minutes of moderate-intensity physical activity on most, preferably all days of the week; or participating in at least 20 minutes of continuous vigorous-intensity physical activity 3 times a week [12, 43]) and Chi² analysis showed that this proportion significantly differed between groups (χ^2=17.02, p<0.01). Subgroup analyses focusing on who enrolled in the intervention (groups 1-3) and those who did not participate in the intervention (groups 3-5) showed different results for mothers and fathers. Mothers in group 3 are tended to be less physically active then mothers in group 1 and 2; no significant differences were found between those groups who did not participate. On the contrary fathers in group 4 are the most active of the non-participants; and no significant differences were found between fathers in the three groups who enrolled in the study.

Table 1. Children-reported physical activity characteristics of their parents in both participant and non-participants groups

	Compliance with physical activity recommendations					
	Mothers		Fathers		Total sample	
	n	%	*n*	%	*n*	%
Group 1	26/81	32.1	5/28	17.9	31/109	28.4
Group 2	12/39	30.8	7/23	30.4	19/62	30.6
Group 3	17/83	20.5	25/84	29.8	42/167	25.1
Group 4	35/125	28.0	52/121	43.0	87/246	35.4
Group 5	291/1309	22.2	345/1339	25.8	636/2648	24.0
Total	381/1637	23.3	434/1595	27.2	815/3232	25.2
	χ^2	*P*	χ^2	*P*	χ^2	*P*
Groups 1-5(all)	7.48	0.11	18.23	0.00**	17.02	0.00**
Groups 1-3 (enrolled)	3.11	0.05(*)	0.62	0.28	0.71	0.24
Groups 3-5 (not participated)	2.40	0.30	16.81	0.00***	15.46	0.00***

Note: Group 1= participated, group 2 = participated but dropped-out before follow-up, group 3=enrolled, but did not start, group 4=decliners, already physically active enough, group 5= decliners for other reason and non-responders.
(*)*P*<0.1; *P<0.01; *** *P*<0.001

Predicting enrollment and participation

Results of binary logistic regression analysis predicting parents' enrollment and participation are shown in table 2.

Two models were tested: In the first model 'gender' (male-female), 'SES' (low-medium-high) and 'physical activity level' (not active-active) were included as predictors; in the second model, 'SES' was replaced by 'employed' (no-yes) to include also the economically inactive parents (n=339). Age could not predict enrollment or participation on its own and was therefore eliminated from both models. In 256 out of 3232 questionnaires the job occupation of the parent was missing or to vague to code the job. This resulted in 2637 parents that were included in model 1 and 2976 parents in model 2.

Gender could predict both enrollment and participation in the intervention in both models: mothers were consistently more likely to enroll and participate in the intervention than fathers. SES was also a significant predictor: parents of medium or high SES were more likely to enroll than parents of low SES. However when we only take into account the parents who agreed to participate (group 1, 2 and 3), those in the medium SES group were more likely to complete the diagnostic questionnaires compared to persons in the low and high SES groups. In the second model, 'employed' predicted enrollment (those with a job were more likely to enroll then those without a job) but when persons were enrolled, this variable could no longer predict further participation. Finally, baseline physical activity level did not predict enrollment nor participation in any of the models.

Reply cards

The right part of figure 1 shows that 2085 individuals returned the reply card, mentioning whether they wanted to participate in the intervention or not. Most of the responders were parents (52.8% mothers, 39.6% fathers) and only a small number were members of school staff (4.2%).

Reasons for refusal are shown in table 3. The most important reasons were: "do already a lot of physically activities" (44%) and "having no interest" (36%). Almost nobody (2%) mentioned "not having PC or Internet access" as a reason for not enrolling.

Table 2. Results of binary logistic regression predicting parent's enrollment and participation

MODEL 1	Enrollment [a] (all groups, *n*=2637)					Participation [b] (enrollers, *n*=300)				
	n	*n* enrolled (%)	adjusted OR	95% CI	*P*	*n*	*n* participated (%)	adjusted OR	95% CI	*P*
Gender										
Male	1427	128 (9.0)	1.00[c]			128	48 (37.5)	1.00[c]		
Female	1210	172 (14.2)	1.68	1.31-2.16	**<0.001**	172	101 (58.7)	2.27	1.39-3.70	**0.001**
SES										
Low	879	47 (5.3)	1.00[c]			47	14 (29.8)	1.00[c]		
Medium	1489	213 (14.3)	2.87	2.07-3.99	**<0.001**	213	121 (56.8)	3.17	1.58-6.34	**0.001**
High	269	40 (14.9)	3.42	2.18-5.37	**<0.001**	40	14 (35.0)	1.65	0.65-4.19	0.293
PA										
Not-active	1908	216 (11.3)	1.00[c]			216	106 (49.1)	1.00[c]		
Active	729	84 (11.5)	0.93	0.71–1.22	0.584	84	43 (51.2)	0.92	0.54-1.57	0.766

MODEL 2	Enrollment [a] (all groups, *n*=2976)					Participation [b] (enrollers, *n*=317)				
	n	*n* enrolled (%)	adjusted OR	95% CI	*P*	*n*	*n* participated (%)	adjusted OR	95% CI	*P*
Gender										
Male	1452	128 (8.8)	1.00[c]			128	48 (37.5)	1.00[c]		
Female	1524	189 (12.4)	1.70	1.34-2.17	**<0.001**	189	112 (59.3)	2.38	1.49-3.80	**<0.001**
Employed										
No	339	17 (5.0)	1.00[c]			17	11 (64.7)	1.00[c]	0.53-1.46	0.626
Yes	2637	300 (11.4)	3.03	1.81-5.06	**<0.001**	300	149 (49.7)	0.88		
PA										
Not-active	2204	229 (10.4)	1.00[c]			229	114 (49.8)	1.00[c]		
Active	772	88 (11.4)	0.94	0.72-1.22	0.630	88	46 (52.3)	0.77	0.27-2.19	0.619

Note: [a] including group 1, 2, 3, 4, 5
[b] excluding group 4&5
[c] Reference group
CI=confidence interval; PA=Physical activity, SES=Socio-economic status (based on occupation) adjusted OR = odds ratio adjusted for gender, SES / employment, physical activity; CI=confidence interval; PA=Physical activity

Table 3. Reasons for refusal (*n*=1249)

	n	Percentage (%)
Already physically active	550	44
No interest	451	36
Not eligable	49	4
No PC or Internet access	27	2
Not specified	117	9
Others:		
No time or too busy	40	3.2
Already enrolled via other child	8	0.6
Health concerns	6	0.5
Not specified	1	0.1

Discussion

This study is one of the few that compare participants and non-participants, recruited through schools, of an interactive computer program delivered through the Internet. A main finding of the study is that there are important gender differences in enrollment and participation: mothers were more likely to enroll and to participate than fathers. Other studies also found a greater proportion of women participating in website-delivered health promoting programs [32-35], but the results for participation in physical activity promoting programs are mixed [27, 44]. The latter is in accordance with the finding that *despite the fact* that women are more likely to search for health information through the Internet than men, both women and men are equally interested in online information related to exercise and fitness [45]. However, it has to be mentioned that, similar with the current study, most website-delivered intervention studies recruited their participants by advertisements and did not recruit proactive. Therefore it is not sure that in the mentioned studies an equally proportion of men and woman have been reached. In our study it is possible that more women received and read the brochure with the invitation to receive a tailored advice, because mothers are often more involved in child care (for example: 285 (18%) children reported in the questionnaire that their mother was a "housewife", in contrast with only 7 (0.4%) children who described their fathers occupation as "househusband").

A second finding is that the higher the level of SES the more likely the parents will enroll in the intervention. This is similar with the results of non-Internet based studies [29,46] who consistently found lower rates of participation in work-site wellness programs in low SES groups than those in higher SES groups. However, in the current study only medium SES could predict both enrollment and participation, while high SES could only predict enrollment. This could be explained by the fact that people of higher SES (e.g. a bank manager) are indeed interested in the intervention material,

but their busy time schedule (inherent to their profession) prevents them to actually participate.

A similar predictor was employment: people who are economically inactive are often classified in the low SES group [47] and therefore it is not surprising that in this study employed parents were more likely to enroll than job-seekers, housewives and students; however employment was not a significant predictor for participation. It seems that enrolled people who are economically inactive, are motivated enough to visit the intervention website and complete the assessment questionnaires.

In general, it is stated that individuals who are more committed to a healthy lifestyle are more likely to enroll in health promoting programs [29, 46]. However, in our study no differences were found between regular physically active and non-physically active parents in predicting enrollment or participation: mothers or fathers who were regular physically active were not more likely to enroll or to participate in the intervention then irregular physically active parents. However, the physical activity level of mothers differed between those who agreed to participate and those who actually participated: mothers who enrolled but did not participate were less regularly active compared with those who did participate. This was not the case for the fathers.

It is important to note some limitations and strengths of this study. The first limitation is that parent's characteristics such as occupation and physical activity level were reported by the children and not by the parents themselves. However, studies showed that children of 11 years and older are able to provide valid data about parents' occupation in a survey setting [47, 48] and test-retest stability of the questionnaire used in the current study showed good results. But, while there are important benefits to let children report about their parents' physical activity behavior, such as collecting data from precontemplators (which is difficult to get as they are not willing to complete physical activity assessments), there is still a possibility that this short questionnaire filled in by an intermediary underreport the actual parents' physical activity behavior [49].

A second limitation of the study is the reactive recruitment method that was used by distributing brochures to parents and school staff. This may be created a coverage error: As already mentioned we could not know how many pupils handed out the brochure to their parents and whether both parents read it. As a consequence no response and participation rates could be measured exactly. However, the used recruitment method also had several advantages.

The first strength is that by recruiting participants via an offline method, we could also reach irregular Internet users. Second, by using the school as setting to recruit we could offer parents without Internet access a computer session on the school site. However, similar with the literature [50] we found that Internet access in this population is very high: no computer sessions were organised by lack of interest and almost nobody mentioned lack of Internet access as reason for not-participating. Third, using the school setting also created the possibility of collecting data of non-participants via their children and fourth, the way the intervention program was offered to the participants mimicked a real-life implementation as good as possible.

Conclusion

Interventions to promote physical activity should reach a wide variety of people at once, at any time and location. This study reported that young and older as well as physically inactive and physically active adults could be reached by an interactive computer-tailored physical activity intervention when brochures were distributed in schools. However, more women then men and more adults of medium SES then adults of low SES participated. Further more employees than economically inactive people enrolled in the intervention program. Most reported reasons for non-participation were (1) being already sufficiently physical active and (2) not interested.

More research is needed to investigate if irregular active women also should drop-out early when the website was recommended by a well-known health professional (for example their general practitioner). Future research should focus on how we could reach physical inactive men and people of low SES to participate in a website-delivered physical activity intervention.

A computer-tailored physical activity intervention delivered through the Internet seemed to reach different kind of people. It is not so that especially the most actives or the most inactive persons will participate in the intervention: both physically active parents and sedentary parents enrolled and participated. Further, both younger and older adults are equally likely to participate. However, the program did not succeed in reaching all underserved populations, for example those parents of low SES. Other health-education programs and/or other recruiting methods are needed to reach all segments of the adult population, especially those high at risk.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

HS participated in the design of the study, collected and analysed the data, and led the writing of the paper. ID participated in the design of the study and provided substantive feedback on the manuscript. Both authors have read and approved the final manuscript.

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CHAPTER 6

GENERAL DISCUSSION

GENERAL DISCUSSION

The present thesis investigated the effectiveness and implementation possibilities of a computer-tailored physical activity intervention delivered through the Internet. This final chapter begins with a summary of the main findings of the studies that are presented in Chapters 2 to 5. Next, some chapter-overarching issues will be discussed and corresponding conclusions drawn. Further methodological issues and limitations will be formulated followed by practical implications and recommendations for future research.

1. Main findings

First intervention study

In the first intervention study (Chapter 2), the effectiveness of an Internet-based version of the earlier developed tailored physical activity program that was delivered through CD-ROM[1], with or without additional e-mail tip sheets, was compared with online standard physical activity information. The results of this study show that participants in both groups, those who received tailored advice and those who received standard information, increased their physical activity levels after six months. In contrast with the hypothesis, the tailored advice did not outperform the standard advice. However, the tailored advice was more often read, printed out and discussed with others than the standard advice. No additional effects were found in the study group who received additional stage-based e-mails. Most of the participants in this group indicated that they were satisfied with the number, frequency and usefulness of the stage-based e-mails. Despite this, physical activity increase was not significantly different when compared to the group without stage-based e-mails.

Implementation study

In the study described in Chapter 3, two recruitment strategies for stimulating adults to visit the newly developed tailored physical activity website were compared. The results showed that distributing flyers combined with a short face-to-face contact, increased the number of visitors compared with flyers without interpersonal contact. It was also promising that the first strategy reached participants of both sexes as well as regular and irregular Internet users. Further, the non-visitors indicated that the most important reason for not visiting the website was forgetfulness. Finally, the website was well-accepted, without major problems.

Second intervention study

In the second intervention study (Chapter 4) the effectiveness of the new tailored physical activity program developed specifically for the Internet, was compared with a no-intervention control group. The second objective of this study was to determine if increased intervention intensity, by additional e-mail reminders and repeated exposure to the tailored advice, could increase the effectiveness of the intervention.

The results of this study indicated that the website, with tailored physical activity advice was able to increase physical activity in motivated volunteers in comparison with a no-intervention control group. Significant increases were found for active transportation and leisure time physical activity and a significant decrease for minutes sitting on weekdays. Secondly, physical activity levels of participants in the intervention group who received additional e-mail reminders and repeated feedback did not significantly differ from the intervention group who received single feedback.

Who participates?

The study presented in Chapter 5 was carried out in the context of the second intervention study (Chapter 4). The main objective was to examine differences in characteristics (such as age, gender, socioeconomic status (SES), employment and physical activity level) of participants and non-participants in the tailored physical activity intervention. The second aim was to report the most common reasons for non-participation.

Significant differences between participants and non-participants, who were recruited from parents and school staff, were found. Firstly, there were important gender differences: women were more likely to enrol (i.e. agree to participate) and to participate (i.e. visit the website and complete online assessment questionnaire at least once) in the intervention program than men. Secondly, the higher the level of SES the more likely the adults were to enrol in the program, however SES did not in itself predict participation. Next, employed individuals were more likely to enrol in the program than job-seekers, housewives and students however employment was not a significant predictor of participation. Further, age and physical activity level did not predict enrolment or participation: young and older as well as physically inactive and active adults were as equally likely to enrol and participate in the intervention program.
Finally, the most reported reasons for non-participation were (1) being already sufficiently physical active and (2) being not interested.

2. General discussion and final conclusions

2.1. Is tailored physical activity advice delivered through the Internet effective?

The results of both intervention studies (Chapter 2 and 4) that evaluated the effect of Internet-delivered tailored advice were mixed. Although the first intervention study (Chapter 2) indicated that tailored advice was better appreciated than standard advice, no evidence was found to suggest that tailored advice was more effective in increasing physical activity levels when compared with online standard advice. However, the results of the second intervention study (Chapter 4) suggest that the tailored website was effective in increasing physical activity when compared with no intervention.

There are several reasons that might explain the discrepancy between the two studies. A first explanation is that the effect of tailored advice was compared with a standard advice in the first intervention study whereas in the second intervention study the comparison group was a no intervention-control group. It might be that an online standard advice in itself is already sufficient for improving physical activity, however it has to be mentioned that 47% of the participants in the control group reported that they did not read a standard advice (or did not remember that they did). Six percent of them even reported that they did not visit the webpage consciously, because they preferred receiving personalised advice.

Secondly, the sample characteristics of both studies varied. The participants in the first intervention study were more physically active at baseline compared with the second intervention study (64% versus 43.5% met the physical activity recommendation). This could have resulted in a ceiling effect (less room for improvement) in the first study. It is possible that differences in baseline levels between the studies were caused by differences in recruitment settings. In the first study, participants were employees of six different worksites, including two factories; whereas in the second intervention study parents and staff of 14 primary and secondary schools were recruited. Analysis showed that male participants in the first intervention study (factory workers) contributed the most to the high baseline physical activity level of the study sample (72% of the males met the physical activity recommendation). In the second study a more mixed sample was recruited (employees and non-employees, physically active and physically inactive). In the same line, the proportion of participating men and women (69.4% males in the first intervention versus 33.9% males in the second) might have contributed to the differences in baseline levels of physical activity level and also to the differences in effectiveness between the studies. Intervention effects in the second study did not differ between women and men,

however the sample sizes were possibly too small (number of male participants in three study conditions were respectively 60, 43 and 44) to find gender effects. Further research is needed to investigate whether computer-tailoring maybe more effective among women than men.

A third possible explanation is the time of year that the interventions were conducted. The pre- and post-test measurements of both studies were conducted in less extreme seasons of the year (autumn-spring in study one versus spring-autumn in study two). The first study included winter for changes in physical activity behaviour to occur whereas the second study included summer. It could be hypothesised that weather conditions and seasonal influences (more daylight) in the second study were therefore more helpful to maintain a more physically active lifestyle compared with the seasonal conditions in the first study.

Finally, small differences in the tailored intervention programs used in both studies might explain the variance in the results. In the first study, the intervention mainly consisted of the tailored advice supplemented with an action plan, whereas in the second study a complete website was developed with the tailored advice as key element. However the tailored advice itself was in both studies, apart from some small adaptations, based on the same assessment questionnaire, message library and algorithms.

At the time, both intervention studies were the first of their kind to be conducted and no comparisons could therefore be made with similar Internet-based tailored physical activity interventions in a healthy adult population. A few studies have evaluated website-delivered tailored interventions focussing on other health-related behaviours, and have shown positive results [2-4] as well as no effects on behaviour.[5] The results of the second intervention study (Chapter 4) showed that a computer-tailored intervention may increase physical activity levels in motivated volunteers, however intervention effects were small compared with the effects earlier found in the efficacy study with the tailored intervention on CD-ROM[1]. It is not clear whether these differences could be attributed to the Internet as delivering channel or to the study design (other recruitment method, less controlled conditions, etc.). Further, in the second intervention study the effects on total moderate-to-vigorous intensity physical activity levels (which were needed to gain general health benefits) were only significant in one subgroup (completers, not meeting PA recommendation at baseline). As the use of the Internet communication channel to deliver health promoting interventions continues to emerge, concurrent research is needed to evaluate the effectiveness of computer-tailored physical activity intervention delivered through the Internet.

The results of our two intervention studies suggest that it is possible to promote physical activity using Internet-based tailored advice in healthy volunteers, resulting in direct (behaviour) or indirect effects (opinions); it is however uncertain if Internet-based tailored advice is superior to Internet-based generic advice.

2.2. What is the optimal intervention intensity?

In both intervention studies, an extra intervention condition was created to evaluate the effect of adding intervention material to accompany the tailored advice. In study one, stage-based e-mails were added, whereas in the second intervention study reminder e-mails and repeated feedback were added. Although the additional intervention materials were well appreciated, there was no significant additional impact on physical activity behaviour.

Previous studies of website interventions that have incorporated additional e-mails, found positive effects on health behaviour. In a study by Lenert *et al.*, individually timed educational e-mail messages enhanced early success of an Internet smoking cessation intervention.[6] Other studies showed that the frequency of reminders such as telephone calls or e-mails seemed to be more important than the actual content of the calls or e-mails in supporting ex-obese adults to maintain their healthy diet and active lifestyle.[7] In our second intervention study, the e-mails did not contain new information; only a link to a specific website section was included to stimulate people to be physically active and generate repeated exposure to the intervention materials. In contrast with our hypothesis, no additional effect of the supplementary reminder e-mails and repeated feedback was found in the second intervention study. However, it should be mentioned that only a minority of participants in the repeated feedback group did actually receive a second advice.

It is not clear to what extent the Internet as a delivery mode may influence the effect of repeated feedback. Studies that investigated the superior effect of multiple tailored print messages compared with a single one have found mixed results; some found no clear evidence[8-11] whereas other studies did identify additional impact of a second[12] or third[13] computer-tailored letter on respectively fat intake and quit-smoking intention.

There is no conclusive evidence to suggest that increased intervention intensity can significantly increase intervention effectiveness.

2.3. Who could be reached by an Internet-delivered physical activity promotion program?

Chapters 2-5 seem to indicate that the characteristics of participants who take part in Internet-delivered physical activity promotion programs highly depend on the recruitment strategy and setting. In the first intervention study (Chapter 2) when participants were recruited in worksite settings, more men than women and more physically active than sedentary individuals participated, whereas in intervention study 2 (Chapter 4), recruitment through schools resulted in more participation by women and less active individuals. Results of the implementation study (Chapter 3) also suggested that face-to-face contact is important in increasing the number of visitors to the website and that people with less Internet experience could be reached by an offline recruitment method. The superior effect of proactive recruitment was confirmed by a recent study of a smoking-cessation campaign; an individual-level recruitment strategy (sending invitation letters by mail to likely smokers) was more effective in prompting adults to visit their stop-smoking website compared with reactive population-based recruitment strategies (advertisements in newsletters and websites).[14]

Chapter 5, indicated that both younger and older adults as well as physically active and physically inactive individuals could be reached by an indirect proactive recruitment method. However, underserved populations such as adults of low SES and unemployed people were less likely to enrol.

Depending on the chosen recruitment strategy a significant proportion of the adult population, but not all, could be reached and approached to participate in an Internet-delivered physical activity intervention program; special attention needs to be given to underserved population groups.

2.4 Awareness of one's own physical activity level and the current physical activity recommendation

Awareness seems to be an important determinant of health behaviour change. If someone is not aware that his/her behaviour is unhealthy, the intention to change this behaviour will be low.[15] This has been shown in studies of complex behaviours such as nutrition behaviours where a large number of people underestimate their fruit, vegetable and dietary fat intake.[16-18]

Adults might have problems estimating their own physical activity level, as physical activity behaviour can consist out of a large number of specific activities (such as cycling to work, walking in leisure time or gardening) which is often spread out over the day and over several days of the week. In the Netherlands it has been shown that 61.1% of inactive adults overestimated their level of physical activity,[19] however based

on the results of the intervention studies in Chapter 2 and 4 it seems that in Belgium the opposite is true. In the first intervention study 36.8% of the participants did not accurately estimate their own physical activity level at baseline: 31.7% underestimated, and 5.1% overestimated it. In the second intervention study 19.5% underestimated and 2.5% overestimated their own physical activity level. It is possible that this discrepancy in estimates of physical activity in the Netherlands and Belgium's population is caused by differences in measurement methods [a short physical activity questionnaire versus long version of the International Physical Activity Questionnaire (IPAQ) or by using a less representative Belgian study sample (especially in our first intervention study)]. Another explanation, however, is that the recent recommendation of 30 minutes moderate physical activity a day is not well-known to Belgians. In the implementation study (Chapter 3) and the second intervention study (Chapter 4) only 2.3% and 6.5% of the participants respectively, reported that they knew of the recent physical activity guidelines. Therefore, it could be hypothesised that many adults in Belgium still believe that they have to do intensive sport activities to gain health benefits (as recommended in previous campaigns), and therefore underestimate, instead of overestimate, their own physical activity level.

Estimates of one's own physical activity level among Belgian adults are quite good but awareness of the current recommendation for physical activity is very low.

3. Limitations

In this section, the most important limitations and methodological issues of both intervention studies (Chapter 2 and 4) are discussed. More specific issues of these and the other studies (Chapter 3 and 5) have already been discussed in the discussion sections of the relevant chapters.

A first important methodological issue to consider when evaluating a physical activity intervention is the measurement method used to assess physical activity. In both intervention studies presented in this thesis, a Dutch (paper and pencil or computerised) version of the International Physical Activity Questionnaire (IPAQ) was used. This questionnaire has been showed to be reliable and valid in measuring physical activity in Belgian adults,[20] however as with other self-report questionnaires, the IPAQ can be subject to response bias. It has been shown that the IPAQ has a tendency towards overreporting.[21] This issue was handled in both studies by using cut-offs for each reported physical activity in the paper-and-pencil version and limiting the possible

answers in the computerised version. Ideally, objective measurements, such as accelerometers, should be used to assess physical activity. However, in intervention studies with a large number of participants, it is often not feasible to use them: they account for additional costs and time investment and increase the burden for participants. Moreover, when testing an Internet-based intervention that aims to mimic real-life implementation (as in our second intervention study) the incorporation of additional objective measurements would undo the advantages of the Internet as a delivery channel (i.e. receiving intervention at any time or place).

A second limitation of both intervention studies relates to recruiting people that voluntarily participate, causing self-selection bias: In these studies, participants were characterised by being already motivated to increase their physical activity and therefore are not totally representative of the general population. Further, a significant proportion of the participants were already sufficiently physically active. However, we chose not to exclude them at the start of the intervention for several reasons: Firstly, due to the fact that a part of the population does not accurately estimate their own physical activity level, participants were not excluded on the basis of their answer to one single question about their own level of physical activity. Secondly, if we added an additional physical activity measurement that excluded regularly physically active individuals, the burden of measurement for the included participants would have increased, elevating the risk of early drop-out. Further, we wanted to mimic real-life implementation as closely as possible without redundant measurements. Thirdly, participants who just met the physical activity recommendations of 30 minutes of physical activity a day, also received an advice to stimulate them to continue their physically active lifestyle and even *increase* their level to 60 minutes of physical activity a day.

A more representative study sample could have been attained by recruiting a random sample of participants. In recent years, probability samples were in many cases obtained by means of random digit dialling of home phone numbers. However, this technique does no longer guarantee a probability sample as the existence of broadband Internet access and cellular phones has resulted in suspending the classical (home) phone line in many households.[22] As the prevalence of Internet connections continues to increase, it maybe possible in the future to recruit representative study samples through the Internet.[23] However, this will not solve the problem of self-selection bias via volunteer participation due to the unethical nature of trying to force people to participate in an intervention. On the contrary, in an earlier pilot study conducted by colleagues at our department (data not reported) where tailored fat-reduction advice was generated through a CD-ROM, the supervisor of a company insisted that all his employees participated in the study. The results of this study however, showed that the

intervention had no positive effect at all and that there was high resistance to the intervention materials among a substantial proportion of the sample.

Another limitation is that the computer-tailored physical activity advice evaluated in this thesis was developed as a primary prevention program. The program focused on increasing physical activity in apparently healthy people, and not among those that have medical conditions (e.g. cardiovascular diseases or diabetes). For those people it is maybe even more important to adopt a physical active lifestyle, but our study was aimed at primary prevention.

A fourth limitation of both intervention studies was the high drop-out rate. After 6 months, 29% of the participants in the first intervention study and 34% of the participants in the second intervention study did not fill in their post-test questionnaire. In both studies the drop-out rates were higher in the intervention groups compared to the control group. In the first study, drop-out in the intervention groups was 32% compared to 20% in the standard advice group; in the second study the drop-out rate in the groups with tailored advice (40%) was twice as high compared to the group who received no advice at all (21%). This difference could be explained by the fact that participants in the intervention groups received their tailored feedback immediately after baseline assessment and had therefore lost motivation to stay in the study; whereas participants in the waiting-list control groups did not receive a tailored advice until they completed the post-test questionnaire and might be more motivated to continue their participation. High drop-out rates have also been reported in other Internet trials[24,25] and seem therefore to be a typical feature, maybe inherent to the Internet medium.[26] A number of suggestions have been made to reduce the drop-out rates in Internet trials for example by using respondent-friendly website designs and repeated online and offline reminders.[27,28] In both our intervention studies reminder e-mails were sent to participants who did not complete questionnaires immediately and in the second study participants were also reminded through telephone calls to return their data. These strategies did increase the number of completed questionnaires however the total drop-out rates in both studies were still high.

4. Practical implications

Today, more than half of the Belgian population is not physically active enough to gain health benefits. In the past, only a limited number of campaigns and interventions to promote an active lifestyle have been carried out among the Belgian adult population and the results of the studies in Chapter 3 and 4 indicate that a considerable number of adults are not aware of the current guidelines for physical activity. Thus, interventions

to increase awareness of the physical activity guidelines and help people to adopt a physically active lifestyle are needed. The computer-tailored program evaluated in this thesis is an intervention that can be suitably implemented in Flanders, Belgium. The results presented in this thesis showed that the intervention could be feasibly implemented in real-life conditions and can be effective in increasing physical activity levels in motivated volunteers. It is not clear how we could increase the intervention effects. As the intervention materials were evaluated well, there are no indications about which intervention component may need changes.

Our 'ready-to-use' intervention can be disseminated as a stand-alone-intervention, but it is recommended to implement it as part of a more comprehensive (community) intervention. When used as a stand-alone intervention however an accompanying, well-planned promotion strategy is needed to reach a significant proportion of the population. As outlined in Chapter 3, simply distributing brochures that mention the URL of the website will not result in a significant number of website visitors. The Flemish Institute for Health Promotion (Vlaams Instituut voor Gezondheidspromotie, VIG) and the Local Health Initiatives (LOkaal GezondheidsOverleg, LOGO) could play an important role in promoting and implementing the computer-tailored program in the general population. These bodies could successfully guide and educate people in local and national organisations on how to use and promote the intervention. For example, they could introduce the website to general practitioners who could then recommend sedentary patients to visit the website. Moreover they could also help organisations to plan comprehensive physical activity or health promotion campaigns that include the website-delivered tailored advice. As part of a more comprehensive intervention, the advice could be a trigger for behaviour change in combination with other effective strategies to increase and sustain physical activity levels over time. However, more research on these topics is needed (see future research).

As outlined in Chapter 4, an adapted recruitment strategy would allow our website-delivered intervention to reach a wide variety of people including physically active and sedentary, as well as younger and older adults. However, the program might not have the potential to reach all underserved populations, for example adults of low SES. To produce a significant effect on quality of life, mortality and health care costs, other physical activity interventions are still needed to reach all segments of the population, especially those at high risk, and they should focus on the long term perspective. In order to increase physical activity levels in the overall population, interventions need to be as diverse as possible, targeting both individuals and communities; affect policy as well as creating an environment that provides

opportunities to be active, and focussing on adopting as well as maintaining a physical active lifestyle.

5. Future research

Although much is published about the potential of the Internet as a channel to deliver health behaviour interventions, there is little research to support this claim. This thesis is one of the first that provides some initial insight into the effectiveness and implementation possibilities of a computer-tailored physical activity intervention delivered through the Internet. Inherent to scientific research, some new questions have been raised and other questions remain unanswered. Recommendations for future research concerning computer-tailored advice through the Internet are formulated here.

Firstly, it is necessary to replicate the results of this thesis in a larger, more diverse population trial and examining the long-term effects of the intervention on physical activity behaviour. Secondly, the results of this thesis did not allow for conclusions to be drawn about optimal intervention intensity; thus more research is needed to determine the optimal dose of computer-tailoring required to bring about changes in physical activity behaviour. Next to the optimal frequency of tailored feedback, it is also worthwhile to examine the optimal length of one feedback letter, as it is suggested that an overload of information (i.e. too much information to process) could decrease the effectiveness of the tailored advice. Other issues that also deserve attention include how additional e-mails, repeated feedback and iterative feedback (i.e. feedback tailored to changes in intentions and behaviour that participants make after initial feedback) increase the effect of a single-point-in-time intervention and what the most cost-effective strategies to prompt people to return to the website for repeated feedback are. As previously mentioned, high attrition in e-health trials is a common dilemma and it is suggested that this issue be addressed in more detail in future studies.[26]

Chapter 4 showed that interpersonal contact is important in attracting individuals to visit the tailored website for the first time; however this strategy involves additional costs. It is therefore worthwhile to investigate how face-to-face contact could be achieved through existing real-life contacts, such as those made in general practice. The general practitioner is for most adults a preferred source for information and advice about lifestyle issues such as physical activity.[29,30] However lack of time and knowledge about physical activity prevents many physicians from discussing physical activity with their patients.[31,32] Therefore computer-tailored advice could be used to complement their counselling activities. Research is needed to evaluate if the general practice setting

would be a feasible and effective avenue and whether a more diverse population could be reached.

More research is required on how to reach certain population subgroups (inactive men, adults of low SES) that are less likely to participate in our website-delivered intervention. Could they be reached by another strategy or would it be more cost-effective to engage subgroup participants in other kinds of interventions?

Finally, as suggested in the computer-tailored literature, little is known about the specific working mechanisms that might explain why tailored health communications are (sometimes) more effective than those that are non-tailored. One of the possible explanations could be found in the "elaboration likelihood model,"[33] which suggests that people are more likely to process information thoughtfully if they perceive it to be personally relevant. Another explanation hypothesised by Dijkstra[34] is the "self-referent encoding" of information. From this perspective, a deeper and richer processing of information will initiate if individuals identify a stimulus as being relevant for or referring to the self.[35] Both theoretical explanations are confirmed by the process evaluation in the first intervention study, whereby the tailored advice was more often read (or remembered to be read), printed out, and discussed with others relative to the standard advice. However, the tailored advice did not outperform the standard advice in terms of behavior change, measured by the IPAQ.

More research about the mentioned models and related issues is needed to gain deeper insight into the working mechanisms of computer-tailored health education which may (hopefully) lead to more effective tailored interventions.

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