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INTERNETIZED OBESITY TREATMENT – FROM RECRUITMENT TO PRACTICE

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Stockholm 2012

Published by Karolinska Institutet. Printed by Larserics Digital Print AB.

 ISBN 978-91-7457-830-0

A travel around the world,
a travel around oneself,
a travel to the future,
and a travel which just has started.
~ *MS*

To My Family

ABSTRACT

Background: The prevalence of obesity is reaching alarming altitudes worldwide, and the current healthcare systems face challenges to treat everyone. Thus, new strategies are of high priority. The Internet, for instance, has the potential to reach individuals irrespective of geographical location. Consequently, the overall aim of this thesis was to gain further understanding of the Internet's applicability in obesity treatment, targeting lifestyle-related health aspects.

Methods: This thesis has been built on four studies (I, II, III & IV). Study I used a *prospective cohort* design, examining members' program performance in an Internet-based weight loss club during six months of participation (n=23,233, 20% males), focusing on "active members" (n= 4,440, 18% males). Study II characterized a *randomized intervention study* (n= 3,876, 67% males) in which the participants received either Internet-based counseling (personalized automated health feedback) with or without added telephone counseling, compared with no counseling, on health behavior improvements. Study III was a *validation study* evaluating the ability of our newly designed Internet-based virtual food plate (with pictures of food items) to assess food intake (lunch meal). We compared the results with participants' (n=55, 100% males) composed meal of real food items on a real food plate. Lastly, study IV was a *descriptive study* of the effects of reminders (e-mails, flyers, oral presentations etc.) on overall participation in study II.

Results: The findings from study I suggest that older members (≥ 65 years) performed equally well or better than younger members (< 65 years). They logged-in and recorded their health more frequently, and reported a higher total weight loss (women: 5.6kg, 6.8%; men: 6.4kg, 6.8%). The results from study II indicate an overall health improvement from the intervention per se, rather than for specific interventions. However, those participants who received personalized automated feedback enhanced their motivation to change health habits at follow-up. Study III supports the validity of our Internet-based virtual food plate, with Spearman and concordance correlations ranging between 0.58-0.70 and 0.59-0.81 for energy intake and nutritional components, respectively. A slight overestimation using our virtual food plate was found (+310kJ), but less among overweight participants (+147 kJ). Finally, study IV completes this thesis concluding that a high number of reminders were effective on response rate, predominantly for those with high Internet availability. The participants' characteristics (age, BMI, motivation etc.), nonetheless, did not influence *when* they participated.

Conclusions: The Internet possesses unique potentials in obesity treatment. This thesis presents valuable effects on health improvements primarily on middle-aged or older, overweight men – a subgroup known to be challenging to include in health promoting activities. This work is only one of the building blocks in the investigation of the Internet's applicability in medicine. Future research is urged to continue searching the needs and preferences of Internet-based strategies targeting obesity.

LIST OF ORIGINAL PAPERS

I. van der Mark M., Jonasson J., **Svensson M**., Linné Y., Rössner S. & Trolle Lagerros Y. Older members perform better in an Internet-based behavioral weight loss program compared to younger members. Obesity Facts. 2009;2(2):74-9.

II. **Svensson M**., Pasquali E., Bellocco R., Bakkman L. & Trolle Lagerros Y. The effects of a randomized workplace lifestyle intervention – using web-based feedback and telephone counseling. (2012). *Submitted manuscript.*

III. **Svensson M**., Bellocco R., Bakkman L. & Trolle Lagerros Y. An interactive Internet-based food plate provides promising results in food assessments – a validation study. (2012). *Submitted manuscript.*

IV. **Svensson M**., Svensson T., Hansen AW. & Trolle Lagerros Y. The effect of reminders in a web-based intervention study. European Journal of Epidemiology. 2012;27(5):333-340.

List of selected additional publications

I. **Svensson M**., Lagerros YT. Motivational technologies to promote weight loss – from Internet to gadgets. Patient Education and Counseling. 2010;79(3):356-60.

List of selected published abstracts

I. **Svensson M**., Trolle Lagerros Y. Motivational technologies to promote weight loss – from Internet to gadgets. International Congress on Rehabilitation in Medicine, Nanjing, China. (2011).

II. **Svensson M**., Svensson T. & Trolle Lagerros Y. Strategies to encourage e-health – the effects of using different reminders to various extents on overall response patterns in a large randomized Internet-based intervention study. Medicine 2.0, 4th World's Congress. Stanford University, Palo Alto, CA, USA. (2011).

III. **Svensson M**., Van der Mark M., Trolle Lagerros Y. TFEQ-R18 on the Internet – results from a Swedish cohort of 22,800 participants. International Congress on Obesity, Stockholm, Sweden. (2010).

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LIST OF ABBREVIATIONS

BMI	Body Mass Index
CI	Confidence Interval
EI	Energy Intake
EN	English translation
kcal	Kilocalorie
kg	Kilogram
kJ	Kilojoules
MI	Motivational Interviewing
Mins	Minutes
OR	Odds Ratio
PAL	Physical Activity Level
SW	Swedish translation
WHO	World Health Organization

PREFACE

The Internet has become a strong building block in communication, storage of data, and convergence of diverse channels in society. Its rapidly expansion has been referred to as “the web of life” and its power has been compared with the industrial epoch’s electricity[1]. It may be suggested that an “Internetized” era has emerged, producing opportunities in the advancement of health and medicine.

To date, the Internet serves as an essential component of most individuals’ daily puzzle. Newspapers, e-mail conversations, calendars, cameras, virtual health coaches, and even the Global Positioning Services system, (GPS) are all features available in one piece of technological device. While the mode of delivering information continuously updates, the scientific knowledge remains rather constant. Yet, the high usage of the Internet among the public requires adjustments in the general healthcare, matching the needs and preferences of the patients.

In pace with modernization, however, the public health faces alarming lifestyle-related health conditions. The once bodily movements have been replaced by machines and automatic work forces, leading to an involuntarily low physical activity level. The public health has been conquered by obesity. There is a continuous strive for effective strategies to treat everyone.

The Internet may facilitate the administration of screening and health treatment, in a time and cost-effective way. It may promote healthcare irrespective of geographical location, allowing a larger number of individuals to receive care. The idea of healthcare independent of geography builds the skeleton of this thesis – partly because Internet-based health strategies may complement the conventional healthcare, and partly because it permits the public to engage in activities preventing the development of future diseases. Hence, the overall aim of this thesis was to study the applicability of the Internet in health promotion and overall screening of lifestyle-related health aspects.

The initiative of the present thesis originates from personal engagement between researchers at the Karolinska Institutet and the Swedish Transport Administration, Unit for Traffic and Railways (formerly known as Banverket), acknowledging railway employees at high risk of obesity and obesity-related health issues. An Internet-based approach was considered the most suitable method for a traveling target group such as this. Besides, there are invaluable advantages of Internet-based research. Consequently, the experiences and findings from this thesis are expected to be applicable in health promotions targeting the general healthcare, the public health, the occupational field, as well as the individual.

Hereafter, the term “Internet” will be used in the section for background discussing its general role in medicine. The synonymous term “the web” continues the description of the research making up this thesis, with reference by the CONSORT-EHEALTH[2] of suggested documentation of health and medical research conducted on the Internet. Finally, the concept of “medicine” encompasses both health and medical aspects.

1 BACKGROUND

1.1 OBESITY

1.1.1 Definition of obesity

Obesity is defined as an extreme fat accumulation that negatively impacts health. One of the most commonly used methods to define obesity is by calculating an individual's Body Mass Index (BMI). It is a measurement of an individual's bodyweight in kilograms, divided by his or her height in meters (kg/m^2)[3].

According to the World Health Organization (WHO), an index $\geq 25kg/m^2$ is classified as overweight and $\geq 30kg/m^2$ as obesity (aka pre-obesity) among adults. There are sub-classifications of obesity in relation to BMI as well, using the following three degrees of adult-obesity: *grade I*: 30.0-34.9kg/m^2, g*rade II*: 35.0-39.9kg/m^2 and *grade III*: $\geq 40kg/m^2$. It has been suggested that individuals who are overweight are likely to develop obesity during their lifespan[4].

However, BMI does not take an individual's age, sex, muscle mass or ethnicity into account, therefore, it should merely be considered a rough estimate of defining obesity, or used in population-based studies[3]. There are many anthropometric techniques to complement the BMI. One example is by measuring waist circumference to estimate an individual's abdominal fat (central adiposity)[5]. Prior research claims an importance of a healthy waist circumference to prevent the development of health consequences associated with obesity, particularly those metabolically related[6].

A waist circumference < 102cm for men, or < 88cm for women, has been recommended to prevent the health risks of excess abdominal fat in Caucasians. The cut-offs differ between ethnicities. More narrow cut-offs have been set for Asians (< 90cm for men; < 80cm for women)[7].

1.1.2 Consequences of obesity

The health risks of obesity are upsetting. It has been associated with a cluster of severe health conditions including cardiovascular diseases, arteriosclerosis, diabetes type II, musculoskeletal conditions, asthma, some types of cancers, and overall metabolic changes (when combined is known as the metabolic syndrome), as well as premature death. In 2008, cardiovascular diseases topped the list of leading causes of deaths worldwide[3]. The metabolic syndrome has found to increase the risk for cardiovascular diseases by 200%[8]. As a result, the WHO has declared obesity a "disease"[3 4]. Thus, by preventing obesity, the development and prevalence of many related health conditions would decline as well.

Obesity also puts an increased economic burden to the general healthcare and state economy[9]. It has been estimated to account for 1.9% of the Swedish national healthcare expenditure, according to a study conducted in 2008[10]. The current literature also supports a relationship between greater degrees of obesity and increased risks for work-related sick-leave (longer than one week), which in turn adds stress to the national economy[11].

1.1.3 Prevalence of obesity

The prevalence of obesity strikes alarming altitudes. More than 65% of the population worldwide represents countries where overweight and obesity are associated with more deaths than the condition of underweight. About 10% of the world's population was obese in 2008[3]. Other statistics speaks for its dramatic increases as well. According to Finucane et al, the overall BMI has increased by 0.4 - 0.5kg/m² every ten years between 1980 and 2008. The region of Oceania reported the highest increase of almost 2.0kg/m² [12].

In Sweden, about one out of ten is obese: every other man and every third woman are currently overweight. Obesity is primarily mounting among blue color workers (foremost males), those who already are overweight, and those living outside of the Swedish metropolitan areas[13].

1.1.4 Obesity in the railway industry

One of the subgroups identified at high risk for obesity is employees in the railway industry. Train drivers, for instance, spend a majority of their workday sedentarily. The possibilities of developing obesity and co-morbidities are therefore high. A study conducted in 2007, by our research team[14] among 1241 safety employees in the railway industry (Banverket, SJ AB, and Green Cargo), indicates that employees responsible for the safety of others were unhealthier than other occupational groups at the companies.

According to our data, more than 60% of all track technicians were overweight, 70% had an unhealthy diet, and almost 50% had high cholesterol levels at the study point. The data also showed creeping health problems including diabetes, hypertension, and asthma. These statistics demonstrate a need for improvement. A healthy condition is critical for safety personnel. Having all or some of the warning signals threatens both the drivers' safety and the approximately 500 passengers of any train. This background of employees' health in the railway industry clarifies the rational for study II, and builds the foundation for study III and IV.

1.1.5 Management of obesity

The ultimate road to take in the management of obesity is prevention. However, because the disease already has conquered the public health, finding effective treatment strategies is of high priority[4 15 16]. To manage the escalating obesity, the general healthcare, society, community, government, but also the individuals must collaborate[17]. In some countries, governmental approaches such as added taxes on unhealthy food or laws prohibiting advertisements of unhealthy food have been proposed and carried out[18]. Yet, the primary management in reversing obesity is to adopt healthier behaviors.

The cause of obesity is complex and multifactorial. To put it simple, obesity develops due to an unparalleled equation between energy intake and energy expenditure, where energy intake is constantly elevated, in relation to the amount of energy that the body needs to stay alive. A focus on dietary and physical activity improvements are therefore of significance. Dietary changes could either be performed by the individual at home or via controlled dietary restrictions assisted by the healthcare. Very Low Calorie Diet (VLCD) is commonly used for more rapid weight loss[19].

Social support and frequent progress checkups between individuals and health professionals may complement behavioral changes, enhancing the overall effect of treatment. Treatment of obesity embraces a comprehensive approach[16 20].

Pharmaceuticals have also been proposed in the treatment of obesity, but the availability is low. To date, Orlistat is the only pharmaceutical on the market, demonstrating discreet effects on weight loss[18 21]. The remaining, and last way out, treatment method is weight loss surgery. It has revealed promising effects on weight loss, weight maintenance, reduction of co-morbidities, and overall mortality rates when performed on morbidly obese individuals[22]. Among all treatment programs, high attrition rates and difficulties in achieving long-term weight loss maintenance are two factors constantly producing searches for new strategies[16].

To summarize, behavioral changes are possibly the most central, but challenging approach in obesity treatment. Herein the present thesis, all focus has therefore been brought to behavioral strategies targeting lifestyle-related health aspects.

1.2 INTERNET ACCESS WORLDWIDE, NATIONWIDE

The use of the Internet is increasing and there are no signs of deceleration. Data from 2011 demonstrates that Asia is the region topping the percentage of Internet users worldwide (45%), followed by Europe (22%) and North America (12%). The growth of Internet users among all continents has increased by 528% only between the years 2000 and 2011, according to Internet World Statistics[23].

In Sweden, the number of users reaches similar heights. Almost 90% of the Swedish population has access to the Internet. The major breakthrough of Internet usage is the emergence of mobile Internet, permitting individuals to access the Internet even outside their homes. In fact, twice (66%) as many individuals connect to the Internet via their cell phones (or Smartphones) today, compared to in 2010[24].

The dramatic use of the Internet in Sweden is prominent in all age groups. The most common activities performed while online are searching on Google, gathering information, using e-mail messaging, and searching for road directions, maps, or time tables, respectively[24].

Furthermore, two-thirds of the Swedish population visits social media online (see page 5), and the current prognoses point towards a penetration rate of 96% among the Swedish Internet users in the nearest future[24]. Hence, the Internet appears to serve as an important and well-recognized tool among the Swedish population.

1.3 MODERN MEDICINE, MODERN LANGUAGE?

The use of the Internet in medicine has dramatically increased the past decade, giving rise to a new language of describing the modern healthcare. “E-health”, “Medicine 2.0”, “Health 2.0”, and “E-epidemiology” are only a few examples of referring to the integration of the Internet in health screening, prevention, treatment, and research[25-28].

Because the Internet’s role in medicine has developed naturally, part of the evolutionary progress, there is no consensus regarding the definitions. However, according to the results of a systematic review of published definitions, the term “eHealth” embraces “a set of disparate concepts including health, technology, and commerce”[26].

The authors conclude that the most widely published definition of e-health is the one made by Gunther Eysenbach in 2000:

> "e-health is an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies. In a broader sense, the term characterizes not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve healthcare locally, regionally, and worldwide by using information and communication technology"[26].

According to Eysenbach, the "e" in e-health does not only imply "electronic" but also refers to the strengths and characteristics of e-health, suggesting the following list:

1. *Efficiency:* enhancing efficiency in healthcare, minimizing costs.
2. *Enhancing:* improving quality of care by efficient collaboration between providers and consumers.
3. *Evidence-based:* proving scientific efficiency and effectiveness of e-health research. A future priority.
4. *Empowerment:* creating opportunities for person-centered health, and patients' information online.
5. *Encouragement:* making the patient and the healthcare provider to collaborate, for jointly made decisions.
6. *Education:* delivering healthcare and information online, promoting enhanced education of health.
7. *Enabling:* exchanging knowledge between parties for uniform healthcare.
8. *Extending:* making health extendable to various populations and geographical settings.
9. *Ethics:* creating new challenges in healthcare, compared to conventional healthcare.
10. *Equity:* the primary focus of health where everyone has the opportunity to receive care. A "digital divide" may threaten equity[26].

The differences of "Medicine 2.0" and "Health 2.0" have been deliberated in previous literature, but the dissimilarities are vague[28 29]. The term "Medicine 2.0" has, on the other hand, been suggested to encompass a broader perspective, in which health is a given subcomponent. The "2.0" in this sense represents the various aspects and services of the Internet that are provided, such as those described below in the section of social media. To declare, the "1.0" is the Internet per se[28].

1.3.1 Social media

One of the strong sources directing a wave towards new approaches in medicine is the growth of social media, on the Internet. Social media are associated with activities of communicating and sharing information such as words, photos, videos or other forms of media through networks, blogs, discussion forums and much more[30].

In 2004, the social media channel Facebook was founded in the United States. Facebook comprises most of the features discussed above, in which networking holds its primary purpose. Recent statistics of Facebook points towards 529 million active users daily or 901 million users *monthly*. More than 55% of the monthly users connect to Facebook via their cell phone, or Smartphone. Between March 2012 and April 2012, the percentage of Smartphones users increased by 1%[31]. The immense power of Facebook cannot go unnoticed. YouTube and Twitter are other popular types of social media channels on the Internet focusing on videos, broadcastings, and rapid spread of communication through short messages, respectively[31-33].

In health, social media has shown promising value – predominantly as a component for social support. For instance, Facebook and Twitter have been used in providing social support for

patients coping with cancers and diabetes[35]. In addition, it has been used for patients undergoing weight loss treatment[34 35].

1.3.2 mHealth

Shortly after the term e-health was added to the dictionary of modern medicine, entered the term "mHealth" meaning mobile health or health via mobile technologies, patient monitoring devices, or Personal Digital Assistants (PDAs).

mHealth has received strong attention by the World Health Organization, interested in integrating mHealth in the conventional healthcare. Further, the advantages of mHealth have been recognized helpful in preventative and treatment-based approaches in low income countries – where standard healthcare is not generally provided outside of the big cities. With mobile technology, even those living in small villages or on the countryside may be reached[36 37].

The features used in mHealth may include everything from simple text messages to advanced health programs, particularly as a result of the emergence of Smartphones. The so called applications, or "apps", available in a Smartphone may be developed and tailored to any field of interest and design[38].

Burke et al report findings from using mHealth to encourage individuals to self-register weight loss. Although the total weight loss after 24 months were modest, the participants' adherence to the program were significantly greater using mHealth compared to paper-based material[39]. More research is needed to understand the applicability of mHealth.

1.3.3 E-epidemiology

The Internet also serves as a strong method in epidemiological research. Some of the components primarily benefited by an Internet-based approach are the distribution of questionnaires, data collection processes, storage of data, as well as health promoting activities on a large group of individuals. The term "e-epidemiology" has been acknowledged by some researchers[25]. The Internet has indeed become a common research method in epidemiology. The interest of finding effective strategies to recruit individuals to Internet-based research is growing[40].

1.4 *INTERNET-BASED HEALTH PROGRAMS*

To date, there is a wide variety of Internet-based services to enhance the public health, and to complement the general healthcare. For example, Internet-based programs have been found effective for physical activity[41 42], nutrition, eating disorders, and alcohol improvements[43-45]. The effects and design of Internet-based weight loss programs, nonetheless, differ immensely between previously reported studies. Consequently, it is challenging to draw conclusions of the overall effects of Internet-based weight loss treatments[46 47]. Yet, findings from a study conducted by Steele et al suggest similar effects on health improvement from giving advice on the Internet, as compared to face-to-face[48].

The Internet's potential to operate interactively characterizes a valuable aspect in successful interventions. It allows for tailored strategies where health information and counseling may be given in an instant, based on the participants' (responders') reported health aspects, personal interests, and goals. Unquestionably, the short time interval between participants' reported health habits and tailored health feedback produce strong advantages in health promotion.

This type of individually tailored health feedback has effectively been used in the general healthcare, the occupational setting[49], and in commercially provided health programs[50], prior literature states. Also, personalized automated health feedback served as one of the interventions in study II.

Some examples of features found valuable in Internet-based programs are[50 51]:

- Personalized messages, information, goals, and treatment plans (making the health program personal and relevant to the individual)
- Instant feedback (giving the individual direct feedback, based on reported habits through informational texts or interactive progress charts)
- Social support and exchanges of knowledge (chat, discussion forums, or blogs)

Overall, the Internet has widened the spectrum of obesity treatment. The emergence of modern technologies such as Smartphones, Personal Digital Trainers, computer games (i.e. Nintendo Wii Active Sports and X-box) and much more, gives each individual an opportunity to choose a health promoting tool matching the needs and preferences of his or her motivational trigger[50]. Moreover, Internet-based health services may allow for treatments or preventative care even for individuals who not yet have developed severe health problems.

*Examples of Internet-based health programs**

There are several Internet-based programs available to the public. For example, *Viktklubb.se*[52] (EN: weightclub.se) is an Internet-based weight loss club developed by the Obesity Unit at the Karolinska University Hospital, in collaboration with one of the Swedish largest newspapers, Aftonbladet, in 2003. It is the leading Internet-based weight loss forum in Sweden, with approximately 30 000 registered members. The membership fee starts from 37 EUR for four months, following 10 EUR for each subsequent month or 55 EUR for seven months[52].

The weight loss club offers a variety of features. Members are recommended to frequently record their weight, physical activity, dietary intake, motivation etc. in personalized online diaries. Feedback on reported habits is communicated by the weight loss club team through interactive progress charts, messages, and e-mails. In addition, the weight loss club provides a large database of healthy recipes, discussion forums, and blogs for the members to exchange knowledge or support one another during the weight loss progress. Data from Viktklubb.se was used in study I, in the present thesis.

Weightwatchers[53] is another well-known weight loss program both internationally and nationally which started about forty-five years ago. The total number of "points" per day (or food intake) versus total number of points lost (physical activity) serves as the main theory behind this weight loss service[53]. It is based on frequent information and support meetings and became an online service program[54] in 2010 in Sweden.

Other examples of Internet-based health programs are Patientslikeme.com[55] and Healthwatch.se[56]. The first mentioned was founded in 2004 and allows for patients to share experiences and find support through online forums or groups. It also gives patients the opportunity to take part of outcome-based health data[55] within the health area of interest.

Healthwatch.se is an information service covering a wide variety of lifestyle aspects, where individuals have the ability to register and measure health progress on a daily basis. The individuals receive feedback in an instant, communicated as progress charts, happy or sad faces, or statistics covering both the individual and group level, in relation to chosen health aspect[56].

*The Internet-based health programs exemplified in this thesis have been written without personal or commercial interest, or order of relevance.

1.5 TELEPHONE COUNSELING

The Internet is not the only strategy to promote healthcare by crossing the geographically set borders; the telephone may also permit advantages in health treatment. To date, telephone counseling has primarily been used for smoking and alcohol cessation with promising effects on health improvements[57 58]. In addition, Digenio et al propose that a high frequency of telephone counseling targeting weight loss has been as effective as those results achieved from high frequency of face-to-face contact[59].

In the present thesis, there are three telephone counseling services provided to the participants in study II:

1. The Quit-Smoking-Hotline[60]
2. The Alcohol-Hotline *and*
3. The Diet- and Exercise Hotline.

The Quit-Smoking-Hotline and The Alcohol-Hotline are public health services in Sweden, free of charge, operating in collaboration with the national healthcare system. The Diet-and Exercise hotline was developed for the purpose of serving as one of the intervention arms in study II, only available during the course of study.

The Motivational Interviewing technique (MI)[61] and the *Stages of Change Theory*[62] are two commonly used strategies to encourage healthier habits in telephone counseling. William R. Miller was one of the founders of the MI technique, acknowledging the importance of giving direct person-centered counseling triggering a person's understanding and reflection of key components viable in behavior change[61].

The Stages of Change theory was originally developed by Prochaska and DiClemente in 1983. It entails the various stages or processes an individual experiences when eliciting or maintaining a behavioral change[62].

The five stages in a behavioral change include precontemplation (not planning to make a change), contemplation (considering making a change), preparation (making small changes), action (actively engaging in a new behavior), and maintenance (sustaining a change over time). These stages do not have to occur in the order listed above. They are merely used in counseling to understand an individual's progress towards a change[62].

The Stages of Change model was used in the lifestyle questionnaire provided in study II. It also represents the question on "motivation to change health habits", examined as one of the outcome variables in study II.

1.6 PARTICIPATING COMPANIES IN THE PRESENT THESIS

A total of four companies in the railway industry represent the study population in this thesis. All companies participated in study II and IV; The Swedish Transport Administration participated in study II, III and IV. As noted previously, study I was not carried out at a company, rather, it was conducted using data from an Internet-based weight loss club (Viktklubb.se).

A short description of each company participating in this thesis is provided below:

The Swedish Transport Administration (SW: Trafikverket) is responsible for the long-term planning of all national transportation systems in Sweden including the construction, operation, and maintenance of national roads and railways[63]. It was established April 1, 2010 and comprises 6,500 employees. Prior to its establishment, most of the federal units for each field (national road structure, railways, traffic) were working separately from one another.

SJ AB[64] is a limited company since 2001 with approximately 4,000 employees. SJ AB operates most of the profitable passenger rail services in Sweden. Both the Swedish Transport Administration and SJ AB are entirely owned by the Swedish state.

Stockholmståg[65] and *Veolia*[66] are companies operating in Stockholm, on mission by the Stockholm public transportation. They are responsible for the local commuter trains and subways, respectively.

From here on, the term "web" will replace "the Internet", with reference of suggested documentation of health and medical research on the Internet [2].

2 AIMS

The overall aim of this thesis was to gain further understanding of how the web could be used as a tool in obesity treatment, focusing on lifestyle-related behavioral changes.

We specifically aimed to study:

1. the performance of individuals participating in a web-based public weight loss program.
2. the effects of personalized automated web-based health feedback with or without telephone counseling on health behavior change, in comparison to no health counseling.
3. the ability (validity) of our newly developed web-based virtual food plate to assess food intake, compared with real food items on a real food plate.
4. the effects of reminders to encourage participation in a web-based intervention study, on overall participation.

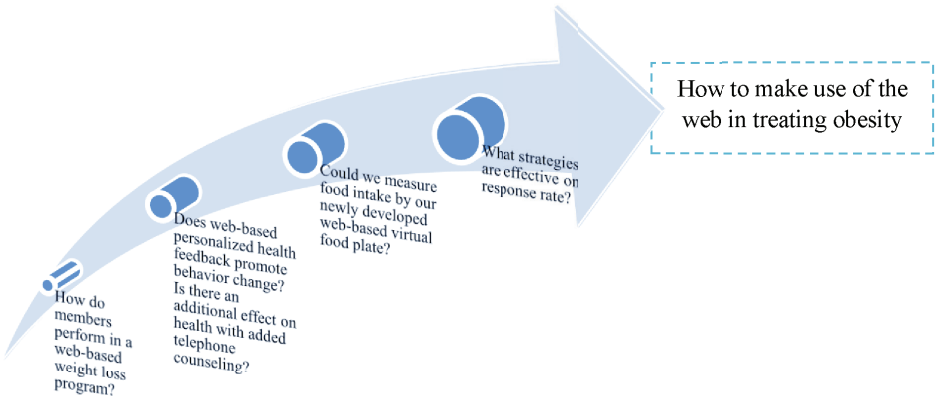


Figure 1. A presentation of the four research questions tackling the applicability of the web in obesity treatment.

3 SUBJECTS AND METHODS

The four research aims making up this thesis represent different study designs, overall methodology, and focus of interest. However, they all seek to gain further understanding of the applicability of the web in obesity treatment.

Study I and study II were conducted to examine the *practicality* of the web in obesity treatment. Study III was performed to *validate* a new web-based instrument to assess food intake, and the focus of study IV was directed towards examining the effects of various strategies of recruiting participants to web-based research.

Mainly, the study populations in this thesis characterize males, in the ages 18-65 years, with a BMI of $\geq 25 kg/m^2$. See below for a more complete summary of this present thesis.

Table 1. Overview of the four studies with respect to primary design, outcomes, and exposures.

INTERNETIZED OBESITY TREATMENT	Study designs	Target groups	Characteristics of populations*	Outcomes	Exposures
Study I	Cohort	Members in a web-based weight loss club	18-65 years 20% males BMI[1] 43.3kg/m² BMI[2] 39.6kg/m²	Weight loss %, usage of weight loss club (log-ins, recordings of health etc.)	Web-based behavioral weight loss club
Study II	Randomized intervention	Employees in the railway industry	18-65 years 67% males BMI 26.3kg/m²	Improved lifestyle-related health aspects, motivation to change health	Personalized automated health feedback, telephone counseling
Study III	Validation	Office workers in the railway industry	18-65 years 100% males BMI 25.8kg/m² (median)	Reported food intake via the web-based food plate vs. reported food intake in real life	n/a
Study IV	Descriptive	Employees in the railway industry	18-65 years 67% males BMI 26.3kg/m²	Response rates, response patterns	Reminders

*Data are mean unless otherwise indicated.

[1] Men, [2] Women

4 STUDY DESIGN, POPULATION, AND OVERALL METHODOLOGY

The choice of study design is dependent on various factors, typically the temporality of data collection. However, the availability of study subjects, data collection methods, directionality of exposures, number of planned observations, as well as accessibility of resources are other factors determining the most appropriate study design in research[67].

The present thesis represents four different study designs including a prospective cohort, randomized intervention, validation, and a descriptive study design to complete the picture of our research aim – to study web-based obesity treatment. Below, a general description of each study design will be given, followed by an interpretation of its applicability in the spectrum of this thesis.

4.1 STUDY I – A COHORT STUDY

A cohort is commonly referred to "a group of persons with a common characteristic" or "any designated group of individuals who are followed or traced over a period of time"[68]. In our study, we followed members of "Viktklubb"[52], a web-based weight loss club organized by the Swedish newspaper Aftonbladet[69] in collaboration with the Obesity Unit at the Karolinska University Hospital in Sweden. Members who were part of the weight loss club between September 2003 and April 2005 characterized our cohort. The weight loss club is still operating, using similar layout and guidance (see page 7 for further information).

Methodology

Upon membership, all members were asked to fill out a questionnaire on personal and health-related aspects, including their interest in participating in the research study. Those with a target BMI $\geq$ 20kg/m^2 and without medical conditions contradicting weight loss met the criteria for membership.

Members were prospectively followed for six months. The participants' frequencies of using the weight club's website such as their number of log-ins and recordings of weight and physical activity habits were continuously registered, and sent to the researchers during and subsequent to the study. Questionnaires on health aspects were administered at baseline, at three months, and at six months of membership, irrespective of membership starting date. Hence, this health information made up our data for study I.

4.2 STUDY II – A RANDOMIZED INTERVENTION STUDY

An intervention is a study planned to "test the efficacy of a preventative or therapeutic measure"[67]. In study II, we chose to study the effects of personalized automated health feedback with or without added telephone counseling, on overall health improvements. At this time, personalized automated health feedback was rather unique, and limited research on its effects had been carried out.

Because study I suggested that web-based behavioral programs were effective, primarily among middle-aged men and older, we stretched our findings to the male-dominated railway industry at high risk for obesity and obesity-related health aspects. More specifically, we conducted a web-based lifestyle intervention among employees representing four companies in the Swedish railway industry – a geographically unlimited approach strongly suitable for a traveling target group such as ours. To complement the web, we used the telephone as our second intervention tool.

To study the effects of health counseling over the web and telephone, we applied a randomized study design allowing the participants an equal probability to be assigned into either the treatment group, or non-treatment group[67]. Study II used a complete web and telephone-based approach.

Methodology

Banverket (Swedish Transport Administration), SJ AB, Veolia, and Stockholmståg were the companies asked to participate in the study. At first, Green Cargo served as one of the potential participating companies but declined due to conflicts with another health promoting activity. Therefore, we asked Veolia to take part thus increasing our study sample, resulting in 3876 potential study participants for study II (and IV). Only those with a work e-mail were considered for this study, however, receiving an e-mail address upon employment was a standard approach for all companies. A list of the employees' e-mail addresses was sent to us prior to study start.

In September 2008, the employees were e-mailed a web link (aka URL) to access a lifestyle questionnaire comprising nine health sections to be assessed (self-perceived health, body composition, diet, physical activity, stress, sleep, alcohol- and tobacco consumption, and motivation to change health habits). All but one of the questionnaire sections, the diet part, had been validated previously, which however exemplifies the purpose for study III.

In 2007, the questionnaire in its entirety was pilot tested on 15 administrative personnel at Green Cargo. In addition, the questions for physical activity were examined on 42 safety personnel (train drivers, track workers etc.) at SJ AB. At both times, the questionnaires were studied using a paper-based version. In 2008, the diet section of the questionnaire (the web-based virtual food plate, examined in study III) was pilot tested on 35 employees using the web-based version to evaluate its usability, clarity etc.

Lastly, pilot tests of the final web-based questionnaire were administered continuously prior to study start on employees at several different work places (the hospital, research center, web

company etc.) and among the general population. Hence, the questionnaire used in the present study was extensively pilot tested prior to study start.

By using the list of e-mail addresses, the employees were randomized to be e-mailed either: A) a questionnaire, or B) a questionnaire + personalized automated health feedback, or C) a questionnaire + personalized automated health feedback + telephone counseling. The feedback was saved at a personalized website available for the participants (explained on the following page). The questionnaire's web link was activated during a three month period, until December 2012.

We collaborated with a web company[70] responsible for the distribution of questionnaires, management of web pages and other related tasks to maintain smooth data collection. A follow-up questionnaire was sent nine months after the administration of the baseline questionnaire. See figure below for a complete view of the study design.

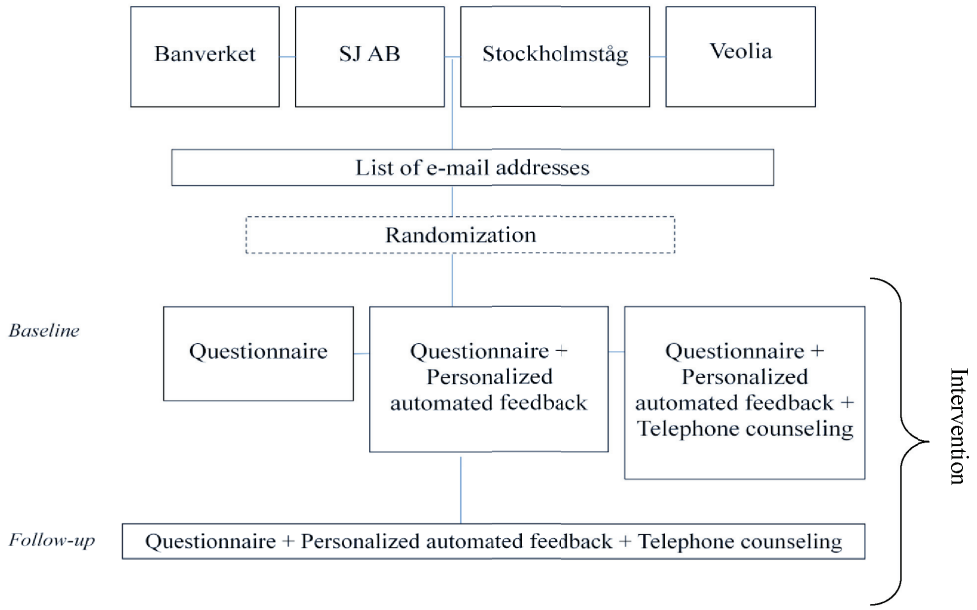


Figure 2. A flowchart of the study design.

Several strategies were performed to encourage study participation in this intervention study (examined and described in study IV). For example, we spent a significant amount of time to instruct our participants about the completion processes through oral presentations, or researchers' presence at the four companies. Also, a helpdesk was conveniently provided. The participants completed the questionnaire via computers available in the companies' recess area, at their office, at home, or through their palm computers.

The instant personalized automated health feedback in the questionnaire appeared instantly as the participants answered to the questions. It was given both to encourage already established health behaviors, and to provide recommendations for future management of healthier behaviors. The feedback was given for all assessed health aspects and saved at a personalized website upon submission of the questionnaire online. The participants could enter the website any time, using a participant code. Information about the personalized website was e-mailed in conjunction with the send-out of the questionnaire (see page 35 for an overview of the completion process of the questionnaire and the interventions).

The feedback was written by us and based on the national guidelines. For instance, we used the recommendations by the Swedish National Institute of Public Health, the Swedish National Food Agency, and the other nationally leading sources such as experts within each health field.

The telephone counseling was offered to the participants, if their reported health habits did not meet the recommended national guidelines or if the participants themselves reported an interest to change health habits, according to the stages of change model. Upon referral to the telephone counseling in the questionnaire, the participants were asked whether they wished to leave their phone numbers to be contacted by the hotlines, dial themselves, or deny contact.

Three hotlines were offered for the participants: The Quit-Smoking-Hotline[60], the Alcohol-Hotline and our own developed Diet- and Exercise hotline (SW: Kost- och Motionslinjen). All three hotlines were either free of charge to the participants, or used local phone call ratings. Our new hotline was based on formats and theories suggested by the already well-established Quit-Smoking-Hotline and the Alcohol-Hotline. The Motivational Interviewing technique and the Stages of Change model were the primary methods used.

We started out with one active health coach at our Diet- and Exercise hotline, available during the three-month data collection period. Interestingly, during this time no participant called the hotline voluntarily. Nonetheless, in January 2009, our health coach received the list of those 112 participants who had left their telephone numbers to be contacted. As a result of this high number of interested participants, two additional health coaches were recruited for assistance.

Figure 3. The logotype used for the Diet- and Exercise hotline (created by Martin Qvänstedt).

The interventions, the personalized health feedback on the website and the telephone counseling, were available during nine months (from September 2008 to May 2009). To adhere to the recommendations made by the ethical committee, all participants were given version C at follow-up (except the service of the Diet- and Exercise hotline, as this was developed solely for the purpose of study II).

4.3 STUDY III – A VALIDATION STUDY

The "ability of a measuring instrument to give a true measure" describes validity[67]. For instance, in study III, we aimed to study whether our newly developed web-based virtual food plate had the ability to accurately measure food intake. Our instrument was developed as an alternative method to assess food intake since misreporting is common[71 72]. It had not been used or validated previously, except for its part in the dietary section of the lifestyle questionnaire provided in study II.

Moreover, our virtual food plate was available on a website. By clicking on "+" or "-" buttons with the computer mouse, the participants could interactively add or subtract pictures of suggested food items to the virtual food plate. Because this was a new instrument, we chose to study one single food intake. We selected lunch intake with the assumption that most participants have regular lunch intakes and consume similar portion sizes at each time.

To assess the validity of our new instrument, we had to compare the composed food intake with results from another instrument. Hence, we studied if a reported food intake, using our web-based virtual food plate, matched the composed food intake of real foods on a real food plate. The relationship of study and examples of food items provided for the meal compositions have been clarified below:

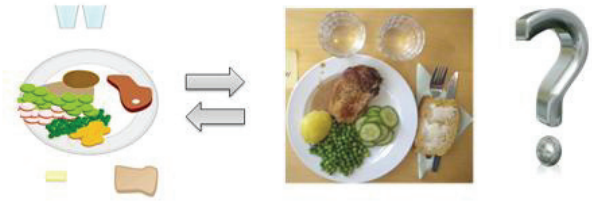


Figure 4. Does the reported food intake using our web-based virtual food plate correspond to a composed food intake of real food items on a real food plate?

Methodology

We have validated our new instrument twice – first on obese patients, and then on male employees (office workers) in the railway industry. The first mentioned study was initially thought to serve as the only and main study, but due to challenges in the data collection process and valuable experiences gained from carrying out this study, it therefore now serves as a pilot study. Both studies have been described herein this section. However, the enclosed manuscript has been based on the secondly conducted study on railway employees.

First, 22 patients under care (support group meetings once a month for weight maintenance) at the Obesity Unit, Karolinska University Hospital, in Stockholm, Sweden were asked to participate in the study. We recruited the patients in conjunction with their ordinary visits at the Obesity Unit.

Upon recruitment, the patients were asked to complete:

1. a "typical" lunch meal using our web-based virtual food plate with suggested food items, using a laptop provided by us onsite *and*
2. a "typical" lunch meal using a real food plate, with real food items – identical with step 1.

The patients were randomized to start with either the web-based virtual food plate or the real lunch, but asked to complete the remaining part within an interval of three weeks to minimize recall bias[73]. The practical part of the lunch meal took place in the kitchen area at the Obesity Unit – a place where the patients attended cooking classes and overall practical education on nutritional aspects. The atmosphere and kitchen utensils were thus familiar to the patients. We were responsible for the grocery shopping, preparations of meals, as well as in the assistance of participants' meal composing. The participants ate their lunch meal in the kitchen, by the researchers' presence.

An unseen eating monitor was connected to a computer attached to the table where the participants ate their meals. The monitor, called VIKTOR, registered weight (kg), total intake (g, kcal), duration (mins), rate (g/mins), and rate of consumption. VIKTOR was first developed by Kissileff *et al*[74] but modified by us[75].

Prior to and subsequent to eating, we took a photo of the participants' food plates to study the portion size/quantity of food items, in order to compare it to the reported intake via the web-based virtual food plate. Directly after eating, the participants answered a questionnaire about the lunch, eating motivation, feelings of hunger-, appetite, fullness, and prospective consumption, developed by Blundell *et al*[75], to confirm that their composed lunch meal represented an ordinary intake.

Hence, three food intake assessment tools (the web-based virtual food plate, photos and questionnaire) were jointly used to evaluate food intake.

Based on our experiences from the above-mentioned pilot study, we validated our web-based food plate on 55 employees at the Swedish Transport Administration, Sundbyberg, in Sweden, using similar study design but with some revisions. Again, we asked the participants to compose a typical lunch meal using our web-based virtual food plate, and by real food items and on a real food plate. Also, the patients ate their lunch meals onsite (at this time, in the company's own lunch area). Photos were taken before and after meal intake.

In contrast to above, the eating monitor VIKTOR, was excluded from the study design. We found the monitor difficult to use and seemed to produce unreliable results. For instance, when the

participants cut their meat, the weight on the food scale increased, influencing the total food weight and progress of registered lunch intake. In addition to this exclusion, we revised and minimized some of the steps in the study design (i.e. how the participants were instructed to compose their lunch meal and how the food items were ordered on the table during the meal composing process). Overall, we found that our initially planned study comprised too many steps difficult for the researchers to keep track on, threatening the overall quality of study.

Furthermore, we found it inappropriate to validate our new instrument on obese patients under care, due to their tendency to frequently be on a diet or possessing concerns of restricting food intake or certain nutritional components. For instance, at this time in Sweden, a strong media attention to the restriction of carbohydrates was brought to the Swedish public. Although the actual reported food intake did not impact the overall validity of our instrument, our low number of available food items disallowed the participants to find alternative food items. In fact, vegetarians were excluded from the study since our instrument did not offer non-meat protein sources.

Our experiences from conducting the validation study on our obese patients generated valuable knowledge about the practicality and applicability of the study. Yet again, the final study reported in the enclosed manuscript presents data and findings from the 55 employees at the Swedish Transport Administration.

4.4 STUDY IV – A DESCRIPTIVE STUDY

The last part completing this thesis is our descriptive study, in which we examine the effects of various strategies used to encourage partaking in study II, on overall participation. We primarily describe the number and types of reminders and the participants' characteristics with respect to overall participation. Although we used an analytical method to examine the effects, we still refer to this as a descriptive study, with reference to its purpose.

Methodology

During the data collection process in study II, we spent a significant amount of time to encourage the four companies and their employees to participate in the study. For instance, we handed out flyers, were present in the lunch area, and performed oral presentations. About ninety oral presentations were made to increase awareness about the study. See table 2, page 19, for an overview of the approaches taken to encourage partaking.

The research question for this study arose prior to conduct of study II, but was strengthened during the data collection process. In fact, it may be hypothesized that the more reminders given to participants, the greater the response rate. However, during the data collection process we noticed markedly strong differences in response rates between the four companies, although similarly administered number of e-mail reminders.

Due to convenience and geographical premises, we made the greatest efforts to encourage participation at SJ AB, Stockholmtåg, and Veolia since they all were situated in the Stockholm area, nearby the research institute. The remaining company was located 500km from the research center making it difficult for the researchers to be physically present on a frequent basis.

Table 2. The amount of reminders was administered as follows*:
Veolia=low, Banverket & SJ AB = medium, and Stockholmståg = high

Approaches conducted at baseline				
Approaches	**Veolia**	**Banverket**	**SJAB**	**Stockholmståg**
Information e-mail	X	X	X	X
6-email reminders	X	X	X	X
Presentation by the research group for managers	X			X
Information on intranet		X	X	X
Information in internal magazines		X	X	X
Information on bulletin board		X	X	X
Informative e-mails sent to unit managers		X		
Visit by research group to the lunch/recess area			X	X
Presentation by research group at employee meetings 2-5 days/week a' 20 mins				X
1 SMS message sent to participants from company manager				X

* Please see the enclosed paper (published) for a more specific table of the strategies.

To study the effects of reminders, we categorized the number of reminders into three amounts:
1) low amounts of reminders: ≤ 6 reminders
2) medium amounts of reminders: 7–10 reminders *and*
3) high amounts of reminders >10 reminders.

The three categories of reminders were based on the total number of reminders, including both e-mail reminders and additional reminders such as those listed above. All companies received an equal amount of e-mail reminders (4 or 5 e-mail reminders at baseline and 11 e-mail reminders at follow-up). Two companies received 4 e-mail reminders at baseline as a result of entering the study two weeks later (due to conflict with another questionnaire administered at this time period).

Likewise the validation study (study III), prior work had been carried out before the final study design was set. More specifically, in 2010, we started a collaboration with the Public Health Institute in Denmark, aiming at comparing the results from study IV, with a similarly conducted lifestyle intervention on web-based physical activity promotion in Denmark[76]. We sought to examine the effects of reminders among two different study populations (the railway industry and the general public in Denmark), thus significantly increasing our study data.

However, after six months of work combining the two intervention studies, we changed our plans. Because our study was uniquely conducted using several different strategies in addition to e-mail reminders, we found it more interesting to separate the two studies. The Danish study used only e-mail reminders as their type of reminders; we used more than nine different reminders making the two studies incomparable.

Prior research has been conducted on the effects of e-mail reminders, but most focus has been brought to comparing response rates achieved from paper-based research materials and web-based material[77-79]. The present study (IV), on the effects of various types of reminders on overall participation, is therefore rather exclusive.

5 DISCUSSION OF THE METHODOLOGICAL CONSIDERATIONS

There are several methodological aspects of this thesis requiring further attention. Some of these aspects are grounded in the selection of study participants, other in the participants' ability to report correct information, or from the use of research instruments. Some methodological challenges even occur by nature, or must be excused. Careful planning of study design or considerations of these factors in the management of data may facilitate dealing with these challenges.

A common word to describe these "challenges" in research includes "bias". There are several definitions of bias, in which one is "deviations of results, or inferences, from the truth"[67]. A discussion on selected methodological issues of the present thesis will follow.

5.1 VALIDITY

In the methodological part describing study III, the concept of validity was defined as the "ability of a measuring instrument to give a true measure", for example, the participants' reported food intake using our web-based virtual food plate. Validity also implies that the conclusions drawn from the results of a study are representative to other populations and settings. Hence, two types of validity have been defined: internal validity and external validity, respectively. To have good external validity, the internal validity must be achieved[67 68].

5.1.1 Internal validity

Selection bias

Errors related to how study participants are selected or factors manipulating participation is called selection bias. In the present thesis, it may be acknowledged that without selection bias, this thesis would not have been conducted.

First, using the web as a research instrument means that only those with access to the tool(s) (i.e. computer/Smartphone + the Internet) could participate in this research. In other words, those without these tools were unintentionally excluded from partaking, and a "digital divide" has been created between potential participants[25 80]. However, recent statistics of Internet availability in Sweden speak against a concern about this. Almost 90% of the Swedish population has access to the Internet to date[24] – and about 89% had access to the Internet at time of conduct of study II, III, and IV. The data which study I has been based on, however, may indeed represent greater degree of selection bias. A lower Internet availability between the years of 2003 and 2005 is highly likely.

Second, this research could not have been performed if the participants themselves were not interested (self-selected) in participating in the four studies (I, II, III, and IV). In study I, all participants were motivated to lose weight. They signed up for membership and paid the membership fee. A selection bias of higher socioeconomic status among the participants in study I is therefore probable. Further, it should be mentioned that about 80% of these study participants were women, suggesting a strong underrepresentation of men. Also, in study II, III,

and IV, all participants were encouraged to participate by their employers, supporting an enhanced health among their employees. Even here, a selection bias may be present.

In study IV, we examined the characteristics of the study participants. However, because the intervention study was entirely web-based with e-mail addresses as the only information about the study population, we were unable to study the "non-participants". Comparisons of those who participated versus those who not participated were thus unlikely. Hence, a selection bias *within* the companies is also a factor to consider in the question of internal validity. Lastly, it may not be forgotten that our study population was recruited mainly from the railway industry, representing only an ample of all occupational groups and populations in Sweden.

Information bias

The fact that the present thesis has been based on solely web-based data raises questions of the validity of the research method used to approach the participants. As discussed previously in the background section, using the web as a tool in research and treatment is rather new in medicine. The instruments used (questionnaires) in study I, II, III, and IV have all been validated in prior studies, or through pilot studies before study start. Nonetheless, the *method of administering the questionnaires online* has not been validated previously or during conduct of the present thesis. Does participants' reporting of health aspects using a web-based questionnaire match their reporting using paper-based questionnaire or by face-to-face assessments? Limited research has been conducted examining the validity of web-based health research[81 82] . However, in study III, we validated our new web-based virtual food plate in relation to its ability to accurately measure food intake. Our findings support the web as a research method.

Reporting bias

The difficulties of recalling past experiences such as health behaviors may lead to bias. More specifically, the idea of *telescoping* in the present thesis is a subject for discussion. Telescoping occurs when participants are asked to report health behaviors including frequencies and amounts of certain health aspects occurring in the past, but in which the participants tend to remember more recently performed activities rather than those that actually occurred[83]. The present thesis, focusing on lifestyle-related health behavior aspects, included several questions directed towards this type of assessments of physical activity, food intake, stress or sick-leave.

Prevarication bias is another important concept to emphasize herein the discussion of the methodological considerations. It takes place when participants' have underlying reasons for not reporting honestly. Some target groups or health aspects may be more prone to untrue-, or put differently, misreporting or misestimation[67]. Prior research suggests that women, overweight or obese individuals, and those of low socioeconomic groups are more likely to misreport food intakes[84].

This thesis comprises outcome variables such as weight loss, BMI, food intake, and physical activity – variables claimed threatened by misreporting. For instance, weight, and BMI are usually underreported; the level of performed physical activity is frequently overreported. Regarding food intakes, the degree of misreporting is commonly associated with how healthy a certain food item is considered: the intakes of sugary and high fat foods are usually underreported, whereas the intakes of fruits and protein tend to be overreported[84-88]. Undeniably,

nutritional research faces difficult challenges. There is no measurement tool to confirm factual food intake except for protein intake[89]. Generally, most research relies on self-reporting.

Furthermore, all data in the present thesis were self-reported. Reporting bias may indeed impact the overall quality of data. In study III, we examined food intake. However, because the purpose of the study was to validate the instrument, aiming for similarly reported intakes between the two instruments, underreporting of food intake does not negatively impact the quality of the study itself. Interestingly, a study evaluating the accuracy of weight reporting in a web-based obesity treatment program, compared to reporting weight in person, implies high accuracy[81].

Confounders

Another possible type of bias in research and in the present thesis is "confusion of effects", meaning when the effect of the exposure of interest is influenced by another external variable[67]. There are several well-known "confounders" in health and medical research. For instance, age, sex, socioeconomic status, culture etc. may all manipulate a chosen health outcome. Most confounders can be controlled in the selection of study population or in the management of data – with the assumption that they have been identified. In study I, the outcome variable was weight loss, a variable highly associated with age, sex, pregnancy, genetics etc[6].

An example of how we dealt with confounders were to *restrict* our analyses to those who were not pregnant or had medical conditions leading to weight loss, or conversely, weight gain. By restricting our analyses, we excluded participants with these characteristics. Another strategy to handle confounders is to *stratify* the analyses based on the confounding factors (age, sex, occupation etc.) and thereby examining the outcome variable with respect to group. *Randomization* is a third way to get around potential effects of confounders. In study II, III and IV, we randomized our participants into different groups. In study II and IV, the employees at the four companies were randomized to receive either 1) a questionnaire or 2) a questionnaire + personalized automated health feedback or 3) a questionnaire + personalized automated health feedback + telephone counseling. We performed descriptive statistics of the participants' baseline characteristics suggesting no statistical differences in characteristics between the three groups. Hence, by randomizing our study participants into three different groups, we assume that the known and unknown confounding factors and their effects were equally present in the groups[68].

5.1.2 External validity

Could we extend the findings from the present thesis to other populations and settings? The answer to this question gives the degree of external validity of our research[68]. To answer the question, the above stated factors must present satisfactory results. Because this thesis has been based on results from selected groups, it may be difficult to stretch specific findings to other populations and situations. Still, it might be suggested that the results gained from this research may add applicability in similar populations. Finally, our findings are unique indicating effective web-strategies primarily for populations representing middle-aged or older, overweight men, with high internet availability.

5.2 CONDUCTING A WEB-BASED INTERVENTION IN THE RAILWAY INDUSTRY

To conduct an intervention study (study II) at one of the largest organizations in Sweden (The Swedish Transport Administration) and its subordinate companies has been a challenge. During the planning process and conduct of study II, the research team has collaborated with six different contact persons, responsible for all internal and external communication at the Swedish Transport Administration. At the other three companies, about two different contact persons at each company were replaced during same time period.

The high dynamics of constantly new contact persons has not only given the responsible researcher a new challenge in the information and adherence processes of the study; it may also have negatively influenced the response rate at the companies. When a new person enters a research study, he or she has to learn about the study from scratch, find and get to know the network of involved persons, and then inspire colleagues and the potential participants to take part in the study. In fact, a health researcher usually connects with a contact person (the manager, the health administer, or other), who then is responsible for delivering the information further down the organizational network.

The complex structure in a large organization requires both patience by the researchers and flexible, but strategic project work. The project may indeed face prolonged duration of the study, or study start, which happened in study II. Although the final outcomes may not have been affected by the changes, the overall planning of resources (work force, material etc.) may entail alternate manners. To effectively motivate participation, from one organizational level to another, is a true challenge.

5.3 ETHICAL CONSIDERATIONS

The four studies included in the present thesis have each been approved by the Ethical Committee at the Karolinska Institutet, Stockholm, Sweden. The permissions are listed below.

1. Protocol 2003/85:03, October 3, 2003, Karolinska Institutet (Study I).
2. Protocol 2008/974-31/3, August 13, 2008, Karolinska Institutet (Study II and IV).
3. Protocol 2009/989-31/5, June 25, 2009, Karolinska Institutet (Study III).
4. Protocol 2010/1940/32, December 6, 2010, Karolinska Institutet (supplementary application and approval for protocol 2008/974-31/3).

All data was made anonymous prior to analyses, to protect individual/patient privacy.

5.4 ROLE OF FUNDING SOURCES

This thesis was financially supported by the Swedish Transport Administration, Department of Traffic and Railways (Banverket), and by the Karolinska Institutet's partly funding (KID-funding) between 2008 and 2012. The funders played no part in the planning process of the study, analyses, write-up of papers, and did not read or comment any version of the manuscripts (study II, III and IV).

The web-based weight loss club (Viktklubb.se) used in study I already had an established collaboration with some of the researchers (Stephan Rössner, Josefine Jonasson, and Yvonne Linné), at the Obesity Unit, Karolinska Institutet, Stockholm, prior to conduct of study. It should be declared that study I was conducted without any specific or related funding.

6 STATISTICAL METHODS OF RELEVANCE

The analyses conducted and reported in this thesis were computed using the three following statistical softwares: SPSS 15.0 (SPSS Inc. Chicago, IL, USA), STATA version 12 (Statacorp LP, College Station, TX), and SAS version 9.2 (SAS Institute Inc., Cary. NC).

The primary statistical tests used in the four studies have been summarized below.

Table 3. **Statistical tests and methods used in the present thesis.**

Statistical tests/methods	Study I	Study II	Study III	Study IV
Pearson chi-square	x	x		x
ANOVA/Kruskal-Wallis/Mann-Whitney		x		
Generalized Estimated Equation Model		x		
Pearson/Spearman correlation coefficient	x		x	
Concordance correlation/Bland Altman			x	
Odds ratio				x

*Descriptive statistics[90] were standard in all four studies.

6.1 STATISTICAL RELEVANT PREPARATIONS

6.1.1 Study I

In total, 23,233 members agreed to participate and 22,860 members filled out complete information about basic characteristics. We restricted our analyses to active participants (n=4,440 active members), based on their frequency of logging in to the website. We stratified our analyses by sex and age to specifically study program progress, weight loss, and relevant health aspects (i.e. physical activity).

The active members were in turn divided into age tertiles, separately for men (19-37, 38-49, 50-79 years) and women (18-33, 34-44, 45-83 years) and by < 65 years or ≥ 65 years. The age tertiles were compared in relation to program progress using the Pearson chi-square test, estimating a possible difference between a statistically generated expected result and an actual result, other than that expected by chance[90]. Means of independent variables such as weight loss and overall participation were compared using the non-parametric Kruskal Wallis test, since data was not normally distributed for these variables. The parametric equivalence of this test is the Analysis of Variance (ANOVA). Both tests compare means of more than two groups. To further explore our variables in relation to age tertiles below and above 65 years, the Mann-Whitney test was used[90].

Correlations between baseline BMI and weight loss were computed using the Pearson's correlation coefficient for parametric data; Spearman correlation coefficient was used for our non-parametric data[91], such as for baseline physical activity and weight loss. Tests of correlations estimate the strength of a linear relationship between two outcome variables, x and y. It is a dimensionless number where the maximum value is 1; the minimum is -1 giving the following relationship $-1 \leq r \leq 1$. A value of -1 or 1 means that there is a perfect linear relationship between x and y[91].

6.1.2 Study II

Descriptive statistics of the participants' characteristics and reported health habits (age, BMI, self-perceived health, dietary intake, physical activity, stress, sleep, tobacco- and alcohol consumption, diseases, and motivation to improve health) were produced at baseline and follow-up and by version of questionnaire (A, B, and C). We specifically studied the question "Are you motivated to improve your dietary/physical activity habits?" according to stages of change model. We summarized the proportions of responses within the yes-intervals. The participants' referral to the telephone hotlines, including the Diet- and Exercise hotline was also studied.

An index was created to study overall dietary intake, by summarizing the participants' answers on frequency of intakes from carbohydrates/fibers, sugar, saturated fats/high fat intake, and unsaturated fats/low fat intake. Alcohol consumption was studied using the Alcohol Use Disorders Identification Test, AUDIT-C[92].

We studied differences in proportions of participants' reported health aspects at baseline and follow-up between the three groups (A vs. B vs. C). We considered a health improvement if the participants' had changed their habits towards the direction of the Swedish national health recommendations. Similar to study I, the Pearson chi-square test were used to study possible differences in categorical variables. ANOVA or Kruskal Wallis was used for continuous variables. The GEE regression model[93] (adjusted for sex and age) was computed to study specific effects of the interventions over time (interaction between type of intervention and time) in relation to changes in reported health habits. The GEE model is a method used to analyze correlated variables, such as categorical data or binary longitudinal data[93].

6.1.3 Study III

A total of 55 employees agreed to participate in the study (4 were excluded due to incomplete data). Descriptive statistics (median and interquartile range [IQR]) were performed to summarize the participants' characteristics (age, BMI, Physical Activity Level [PAL][94 95], and meal satisfaction). Medians, rather than means were primarily used as data was rather small, representing similar frequencies. IQR is a measure of statistical dispersion dividing the data into four parts[90].

Summary statistics of the participants' composed meals with respect to total energy intake in kilojoules (kJ) and quantity of food items and nutritional components (total energy intake [EI] and energy percentage [E%] of carbohydrates, proteins and fats) were computed for the two meals, and compared. The before and after pictures were used to calculate quantities of food items in the meals. Energy intakes from beverages, bread, and butter were excluded in the analyses.

Participants were categorized into "computer plate-real lunch plate" or "real lunch plate-computer plate" based on the order of completing the two assessments and according to BMI ($< 25 kg/m^2$, $\geq 25 kg/m^2$) as well as age (< 45 or ≥ 45).

Spearman rank correlation coefficient was used to study the association between the reported energy intake, nutritional components, and food items between the two assessments. To further study the associations, we used the Concordance Correlation Coefficient which is an intraclass correlation that duplicates the readings as replicates (random) rather than two distinct readings such as the Pearson and Spearman correlation measures[96]. Bland-Altman plots[97] were computed to assess the differences between means of energy intake (kJ) estimated from the computer plate and the real lunch plate, plotted against the mean energy intake from the two methods. To interpret the agreement, we considered participants with reported energy intake within the interval of ± 10% from the mean (3014kJ/720kcal) of the real lunch plate, as acceptable values of our new instrument. Correlations and 95% confidence intervals (CI) were computed and stratified by groups. The scores from the questionnaire on meal satisfaction were summarized. The real lunch plate served as the reference.

6.1.4 Study IV

Analyses were based on data from study II. Descriptive statistics of the participants' characteristics (age, sex, BMI, smoking, motivation to change physical activity habits, amount of received reminders, and work type) were summarized at baseline and follow-up.

Participants were categorized into office workers or field workers (non-office based). We divided the participants into age tertiles (≥ 34, 35-49, ≥ 50 years) and according to BMI.

The number of received reminders, in relation to the participants' submissions of the questionnaire, was divided into time tertiles (participating after receiving 0 e-mail reminder, 1 e-mail reminder, or ≥ 2 e-mail reminders). Proportions of questionnaire submissions (response rates) were calculated accordingly and stratified by participant characteristics and amount of received reminders. Proportions of total responses, three days prior to and three days after the e-mail reminder was sent (including the day it was sent), were calculated separately for each e-mail reminder and summarized.

The Odds Ratio (OR), commonly used to estimate the odds of a disease or chosen outcome to occur[91], was calculated. We assessed the participants' odds of participating at baseline with respect to received amount of reminders, and stratified by work type. OR of participating at follow-up, based on the participants' partaking at baseline or not, was also studied[98]. Confidence Intervals were calculated. Pearson chi-square tests were computed to study differences in proportions.

We considered $p < 0.05$ as statistically significant.

7 MAIN RESULTS

7.1 STUDY I

Most of our participants were women (80%), 40.2 years old, and had an average BMI of 29.3kg/m^2 at baseline. See figure 5 on page 30 for an overview of the results, stratified by sex.

Participants' activity in the weight loss club

Men had a higher tendency of being "active" in the weight loss club compared with women. Overall, the participants in the older age teriles had the highest percentage of remaining active in the weight loss club for at least six months.

When subdividing the older age tertiles, the oldest age tertiles (women 65-83 years; men: 65-79 years) were still found to present the highest percentages of being active in the weight loss club. In addition, they had the highest frequency of recordings of food intake and current weight.

Men above 65 years logged in to the website more frequently, on average 161 times during the six-month study period, compared with women in the same age group (149 times).

Weight loss %

Our results point towards an overall higher weight loss percentage among men across all age groups. Generally, men aged 38-49 years accomplished the greatest total weight loss (7.7%). Among women, the highest weight loss was achieved in the oldest age tertile (6.8%).

Between those below or above the age of 65, irrespective of sex, the highest weight losses were reported for those in the older age groups (5.6kg, 6.8% and 6.4kg, 6.8% for women and men respectively).

Physical activity

Both our female and male participants in the oldest age tertiles reported the highest degree of physical activity per week. About 74.4% of the men and 77.3% of the women were physically active at least 4-6 hours per week.

Correlations between baseline health and total weight loss %

A significant ($p<0.001$) but weak positive correlation between baseline BMI and weight loss percentage was found for both our female and male members (r=0.08 and r=0.14, respectively). No significant correlation was found between the participants' physical activity level at baseline and total weight loss percentage.

Figure 5. Overview of participants' performance
Female vs. male participants in study I.

7.2 STUDY II

Most of our participants were men (67%), 44 years old, and had a BMI of 26.4kg/m^2. About 66% of the participants took part at both baseline and follow-up.

Health improvements

All groups improved most health habits (diet, physical activity, alcohol intake, smoking, stress, and sleeping), with no significant differences between the three groups. See table 4 for an indication of specific health improvements.

Motivation to change

At baseline, the intervention groups (B and C) reported higher motivation to improve dietary (48%-51%) and physical activity habits (60%-63%), compared to group A (34% for diet; 50% for physical activity). At follow-up, the intervention groups were less motivated to make lifestyle changes, whereas group A increased ($p<0.001$) their motivation.

Diet and Exercise hotline

A total of 474 participants (32%) were referred to the Diet- and Exercise hotline through the questionnaire. Out of these, 112 participants (24%) left their phone numbers to be contacted by the health coaches, 135 participants (28%) reported an interest in the hotline but responded that

they would call the hotline themselves, and 227 participants (48%) denied contact. Interestingly, none of the participants called the hotline voluntarily.

Our preliminary results suggest that those participants in contact with the hotline were satisfied with the counseling – more than 45% achieved healthier behavioral changes. Because the other hotlines were public health services, no data of this type could be obtained.

Table 4. Indication of health behavior change* at follow-up of selected health aspects, between the three groups (n=981).

Health aspects	**Questionnaire (A)**	**Questionnaire + personalized automated health feedback (B)**	**Questionnaire + personalized automated health feedback + telephone counseling (C)**
BMI	⇧	⇩	⇧
Days eating breakfast	⇧	⇧	⇧
Days of physical activity per week	⇧	⇧	⇧
Stress	⇩	⇩	⇩
Sleep ≤ 5 or ≥ 9hrs/night	⇩	⇩	⇩
Consuming alcohol ≥ 4-6 times/week	⇧	⇧	⇧
Intake of ≥ 5 glasses of alcohol /occasion	⇩	⇩	⇩
Smoking daily	⇧	⇩	⇩
Using snus[1] daily	⇧	⇧	⇧

* No health changes were significantly different between the groups.

[1] Moist powder tobacco (loose or packaged, placed under lip).

⇧ = increased behavior
⇩ = decreased behavior

7.3 STUDY III

The 55 participants had a median age of 45 years and a median BMI of 25.8kg/m^2 at baseline.

Energy intake

The participants' median reported energy intake was higher (3044 kJ) on the web-based virtual food plate, compared to the real lunch plate (2734 kJ). Those participants with a BMI ≥ 25kg/m^2, aged ≥ 45 years, and those starting with the real lunch plate overestimated their energy intake less than their comparison groups (lower BMI, younger age, and those who started with the web-based virtual food plate).

Quantity of food items

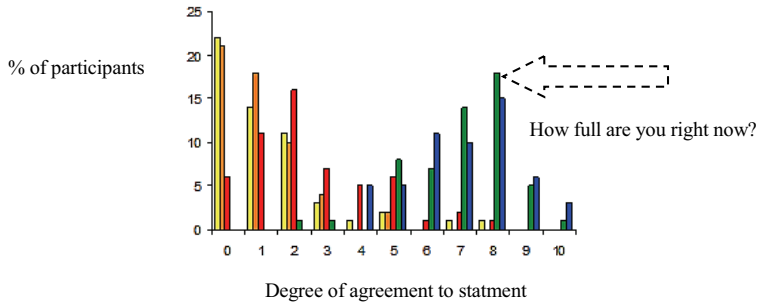
The quantity of reported food items using the two instruments were similar, however the median number of potatoes were somewhat higher on the computerized food plate, compared to the real lunch plate.

Correlations

Overall, our Spearman and concordance correlations between the two instruments were both equal to 0.70 for total energy intakes, 0.59 and 0.76 for carbohydrates, 0.70 and 0.81 for proteins, as well as 0.58 and 0.66 for fat. All correlations were significant. More than 60% of the normal weight participants' energy intakes were represented in the ± 10% interval, using the Bland-Altman plot. A stronger pattern of agreement was found among our overweight participants (78%).

Higher correlations (Spearman respective concordance) of reported number of food items, using the two instruments were found for those with a BMI ≥ 25kg/m^2, for those starting with the real lunch plate (0.80 and 0.61) and for those who were ≥ 45 years, compared to their comparison groups.

Based on the questionnaire on meal satisfaction, the participants reported on average a level of 7 (mode 8) on the grading scale 0-10 (low to maximum) for fullness after meal intake. See figure 6 and marked frequency below:



7.4 STUDY IV

Most participants were men, 35–49 years, and field workers (non-office based).

Response pattern

About 29% of the participants submitted their baseline questionnaire before any e-mail reminders had been sent, 26% after one e-mail reminder, and 45% after ≥ 2 e-mail reminders ($p<0.0001$). A similar pattern was found at follow-up, although a higher proportion (58%) of participants responded after more than two e-mail reminders ($p<0.0001$). Participant characteristics were not related to when the participants responded. See figure 7 below, demonstrating the response patterns at baseline, and when the various reminders were administered. Each dot represents one submitted questionnaire.

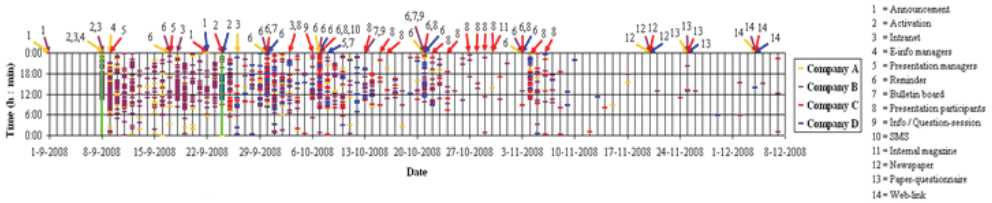


Figure 7. The overall response pattern at baseline.

Effect of reminders

The 4–5 e-mail reminders increased the total response rate by 15%, the eleven by 21%. The greatest increases in response rates were found in the month of September.

Those receiving medium amounts of reminders (reference) had the highest response rate (75 %) compared to those receiving low and high amounts of reminders, where response rates were 11% and 14% respectively ($p<0.0001$). Likewise office workers (54%) had higher response rates compared to field workers (33%).

The odds of participating

The odds of participating at follow-up, for those participating at baseline were OR=13.07, (CI: 11.03-15.21), than those who did not participate at baseline.

8 LESSONS LEARNED

8.1 DEVELOPING AND ADMINISTRATING AN INTERACTIVE WEB-BASED QUESTIONNAIRE

Based on the experiences gained from conducting study II, in which an interactive web-based questionnaire with personalized automated health feedback was developed, administered, and used to assess and promote healthier habits, several key points may be considered to facilitate the practicality of future web-based research.

The recommendations are:

Inform all participating parties about the study

- inform IT-responsible about incoming e-mails to prevent entering the junk e-mail
- inform participants about incoming research e-mails and sending source (researchers and research institute)

Send e-mail reminders for increased response rate and questionnaire web link readily available

- send e-mail reminders on a continuous basis
- confirm e-mail lists to ensure appropriate send-outs, if automatically set

Restrict participant codes

- limit the use of participant/log-in codes (to questionnaire, personalized website) to only one, maximum two codes
- if using codes, make them short, containing common characters such as letters and numbers with same letter size
- personalize web links to limit code usage
- control personalized web links for uncommon characters, complicating opening of questionnaire, with respect to Internet browser

Design questionnaire with respect to tool

- develop the questionnaire appropriate for tools to be used (stationary computer, Smartphones, web browsers etc.)
- pilot test the questionnaire for the specific tools

Use logical linkages in questionnaire

- confirm automatic summarizations and question-answer linkages in the questionnaire
- pilot test the completion process, from information to intervention, to confirm smooth and well-functioning participation/linkages

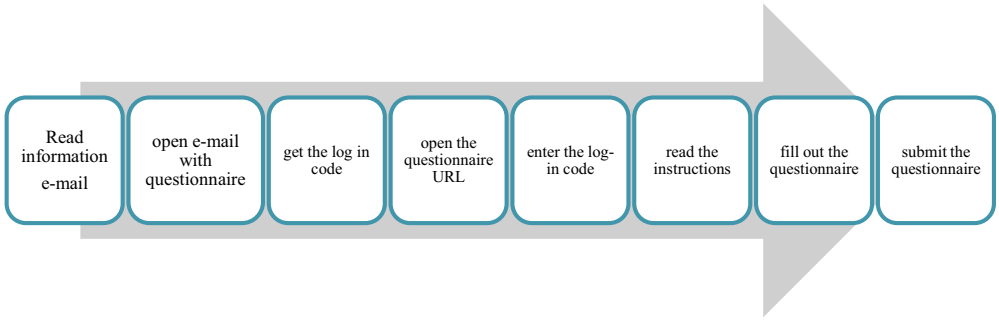
Have as few steps as possible in the completion process

- Minimize the number of steps in study participation from information to submission

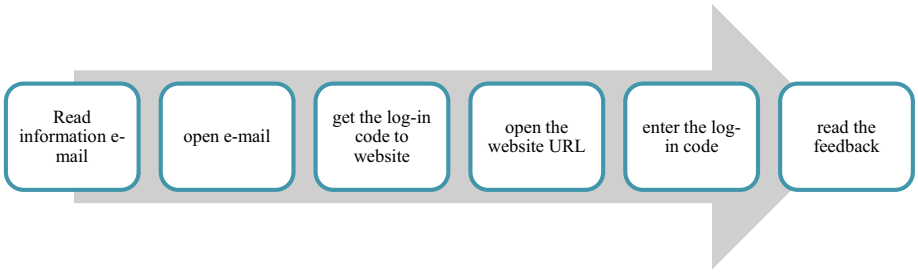
The most important point to highlight herein this section is to reduce the total number of steps in the overall completion process. In fact, the participants who received questionnaire version C (with personalized health feedback, personalized website, and telephone counseling) in study II were required to complete a total of twenty steps to fully participate in the study.

The likelihood for participants' drop-outs or mistakes during partaking is therefore high. The three large arrows below present each of the steps to be taken in study II, to fully complete the intervention study.

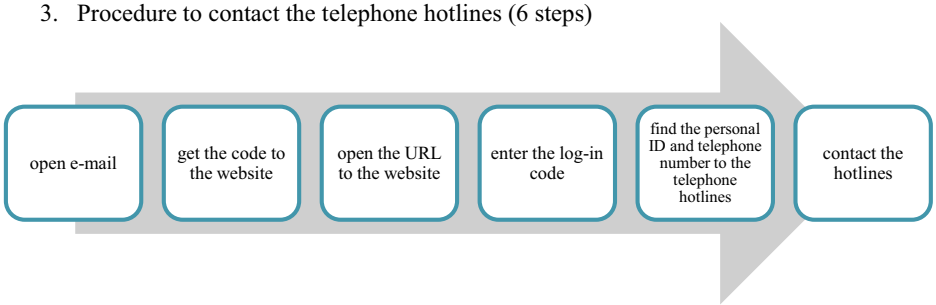
1. Procedure to complete the questionnaire (8 steps)



2. Procedure to enter the personalized website (6 steps)



3. Procedure to contact the telephone hotlines (6 steps)



9 CONCLUSIONS OF STUDY I, II, III, IV

As a result of the findings from the four studies making up this thesis, the following conclusions may be drawn:

1) **Older members (≥ 65 years) of a public web-based weight loss program performed equally well or better than younger members (< 65 years) in the weight loss club**
   a) Greater weight loss
   b) More frequent log-ins to the website (foremost men)
   c) More frequent recordings of diet and weight

2) **An overall improvement of the web-based lifestyle intervention per se was found, rather than for specific health interventions.**
   a) Personalized automated health feedback with or without telephone counseling was not superior when compared to no health counseling.
   b) Personalized automated health feedback may have positively enhanced the participants' motivation to change health habits.

3) **Our new web-based virtual food plate has the ability to assess food intake, when compared to participants' reported intake of real food, on a real food plate.**
   a) Correlations or reported energy intake, and quantity of food items were high
   b) Higher correlations were found for those who were overweight, ≥ 45 years, and those who started with the real lunch plate.

4) **Frequent reminders were effective on response rates, especially for those with high Internet availability (office workers).**
   a) Highest increases in response rates were found in the month of September
   b) The participants' characteristics were not related to when they responded

10 DISCUSSION ON OVERALL CONCLUSIONS AND IMPLICATIONS

A common thread striking through the four studies making up this thesis suggest an overall positive effect of web-based research and treatment, targeting obesity.

More specifically, the two health promoting studies (I and II) imply promising results of web-based behavioral counseling on weight loss, and overall health improvements – not to disremember, motivation to change habits. The beneficial effects of our web-based health counseling add strong value in healthcare and the public health. The major strength of a web-based approach lies in its ability to reach a large scale of individuals, at once. For instance, the web-based weight loss club in study I, collaborating with one of the Swedish largest newspapers, has approximately 2.5 million readers daily[69], giving us a unique study population. Although the total sample size of participating members came out to be 23,000 and that our final analyses were based on 4,440 individuals, the total number of individuals "in treatment" is of significance in medicine, healthcare and public health.

However, a high number of individuals available for study does not automatically generate a high response rate. Even if the study populations in study I, II, and IV were rather large, the final response rates were much lower than in previously conducted studies[78 79 99]. Our response rates for study I and IV ranged between 23%-38%, and 67% in study II because the analyses were based on the participants who took part at both baseline and follow-up. Consequently, even if the response rates in web-based research seem low, the total number of actual participants matters affecting the overall power of study.

Again, we propose that personalized automated health feedback acknowledges the participants' health, and thereby producing an increased motivation to change health habits. Although we did not find any specific effects of the interventions per se, our discoveries on increased motivation speaks in the direction of a bright stance for future success. The web-based weight loss club in study I was also based on interactive personalized automated health feedback accompanied with several additional approaches to encourage weight loss. Its strong effect on health improvements are therefore supported even in study I. Hence, personalized automated health feedback is recommended to use in future health promotions.

Our findings from study III, the validation of our web-based virtual food plate, support the applicability of a web-based food assessment tool. In fact, our virtual food plate does not only give valid estimates of food intake, it may also add pedagogical value in screening and treatment. For instance, it could be used to educate healthier habits by allowing individuals to add and subtract food items to the virtual food plate and, in an instant, receive feedback on the composed meal. Also, it may be used by dietitians or other health professionals when educating patients about an appropriate intake, according to the individual's own health profile. Interactivity has been shown to be effective in both health behavior improvements and in estimating food intake[50 100 101]. Still, the concept of our web-based virtual food plate is new in health research. Future consideration regarding its applicability and advancements deserve special attention. Advancements such as the ability to include infinite numbers of food items or making our web-based food plate three-dimensional, exemplify strong aspects of future research.

The fourth study completes our previously identified conclusions, giving us valuable knowledge on how to effectively recruit participants to web-based research. However, study IV does not

add new knowledge on the effects of reminders which has been previously reported[102 103] rather, it opens new eyes for *how* reminders could be administered in web-based research – and to what extent. For instance, it appears that a higher number of reminders sent in web-based research is more acceptable than in non-web-based studies, perhaps due to the World Wide Web's abstract format of reminders as opposed to paper-based reminders physically visible. Interestingly, we found seasonal differences in response rates documented in September, suggesting that the most appropriate time period for administering e-mail reminders was in conjunction with employees' return to work after summer vacation. However, even if the time period suggests an enhanced motivation to participate in health research, the results from study IV propose no association between the participants' characteristics (i.e. higher motivation or BMI) and faster response rate. Consequently, once the participants' have been recruited, their characteristics do not influence when they chose to participate.

It may not go unforeseen that the participants in all four studies characterized middle-aged or older, overweight, and primarily men. Earlier conducted research reports a concern of middle-aged men with a tendency to abstain or prolong their time to seek healthcare[104]. Any health improvements accomplished from the conduct of the present thesis are therefore of significance in future medicine, healthcare and public health.

Additionally, web-based treatment may indeed serve as a valuable strategy to reach obese patients not likely or willing to seek ordinary healthcare. Obese individuals may not only suffer from excess bodyweight, but also by psychological, emotional, and social consequences[6] leading to decreased motivation to leave homes. The web may thus allow for anonymous care, social support, and overall communication with individuals of similar background and interests. Even so, web-based treatment may enhance the health of older individuals, as indicated by study I, demonstrating an enhanced interest, activity level, and overall program progress when compared to their younger counterparts. However, elderly do not generally suffer from the condition of overweight or obesity. Rather, underweight, loneliness, and decreased desire to plan, cook, and eat food are aspects commonly threatening older individuals' health[105]. The web could for that reason function as an inspirational tool for increased interest in food, as well as for social support, or camaraderie.

The initial cost of development of web-based treatment may seem much, when compared to other treatments[106]. Nonetheless, once the web-based treatment or service has been developed, the number of possible users is infinite. Besides, the information uploaded to the web could be updated on a frequent basis. Hence, the total cost of web-based treatment in relation to usage and time of treatment is fairly low. Furthermore, the web allows for complete treatment representing components such as screening, counseling, and social support at once in one piece of device, not available in ordinary treatment.

The ethical considerations should be emphasized in the discussion of web-based treatment. When using web-based strategies, personal information is readily available on the Internet. To date, it is unknown how this information is handled. Health researchers using the web are therefore urged to exercise caution and ensure confidentiality and privacy[107]. Some research has been conducted to gain further understanding of the role of the Internet with respect to ethics, knowledge-secured issues[108], and how to protect children's use of the Internet[109]. Yet, further research is needed to gain more understanding of the ethical challenges of web-based research.

Another drawback of using the web in medicine, particularly in screenings, is the lack of research on validity. Do web-based screening methods produce the same results as paper-based or face-to-face examinations? The answer to this question deserves consideration and further research. Moreover, the participants' overall comprehension of health material delivered over

the web has not yet been studied – not the computer literacy, but the users' "health technology literacy"[110]. The participants' understanding and absorption of health information communicated over the web characterizes the concept of health technology literacy. Thus, because the web is still a rookie in medical science, it is highly recommended that future initiatives focus on the "behind the scenes" area of web-based research, such as health technology literacy and validity in health screening and treatment. A strive for valid results may not be underestimated.

To conclude, the findings from this thesis bring valuable knowledge to the field of medicine, general healthcare, public health, occupational health as well as to the individual. The difficulties in treating lifestyle-related health issues such as obesity may still remain. However, the emergence of web-based tools opens new doors for individually tailored health strategies, suiting the needs and preferences of the individuals.

Last but not least, to integrate new strategies in health treatment is not only a way to reach a large number of individuals at once; it is also an important gesture of adhering to the evolutionary progress of medicine. Are we ready to introduce the Internetized era of medicine?

Figure 8. Adapting new strategies in obesity treatment. Big problems, small solutions?

11 HOW TO PROCEED WITH THESE FINDINGS?

11.1 FUTURE RESEARCH

The findings and experiences from this thesis are only the first step of integrating the Internet in health and medicine. Future web-based research is recommended to further explore:

- the usage and applicability of interactive features (automated health counseling, chat forums etc.) in health behavior improvements.
- the development and advancement of our web-based virtual food plate to obtain complete food intake assessments (representing a wide variety of food items and intakes from breakfast, lunch, dinner and snacks).
- the validity of web-based health assessments with respect to research tools (computer, cell phones/Smartphones etc.).
- the users' level of health technology literacy.
- the ability to stretch the findings from the present thesis to various settings and populations other than those included herein.

11.2 FUTURE IMPLEMENTATIONS

The findings and experiences gained from the present thesis suggest:

- the use of web-based health strategies in screening (questionnaires, virtual food plate) .
- the use of web-based health treatment (automated web-based counseling, virtual food plate for educating healthier food habits) .
- future implementation of web-based health strategies in the general health care, public health, occupational field and at the individual level.

Web-based approaches targeting health and medicine may reach individuals irrespective of geographical position.

12 SAMMANFATTNING PÅ SVENSKA

Bakgrund: Förekomsten av fetma uppnår alarmerande siffror i världen. Dagens hälso- och sjukvård har begränsade möjligheter att behandla alla. Det finns en strävan att finna nya hälsostrategier. Internet, till exempel, har potential att nå en stor skala individer oberoende av geografisk position. Huvudsyftet med den föreliggande avhandlingen var därför att utvärdera Internets roll vid förebyggandet och behandling av fetma, med fokus på livsstilsrelaterande hälsovanor.

Metoder: Den här avhandlingen har baserats på fyra delstudier (I, II, III & IV). I delstudie I användes en *prospektiv kohort design* för att studera medlemmars framgång och användningsområden i en Internet-baserad viktminskningsklubb. Vi studerade sex månaders medlemskap (n=23,233, 20% män) och begränsade våra analyser till ”aktiva medlemmar” (n= 4,440, 18% män). Delstudie II var en *randomiserad intervention studie* (n= 3,876, 67% män), där deltagarna fick antingen ett livsstilsfrågeformulär och Internet-baserad personlig återkoppling på hälsovanor med eller utan adderad telefonrådgivning, jämfört med endast frågeformulär utan återkoppling. Effekten av respektive interventionsarm studerades i relation till förbättrad hälsa efter nio månader. Delstudie III var en *valideringsstudie* av oss nyutvecklad Internet-baserad virtuell tallrik för att mäta kostintag. Deltagarna (n=55, 100% män) komponerade en typisk lunchmåltid via vår virtuella tallrik och föreslagna livsmedel, som sedan jämfördes mot en lunchmåltid komponerad av riktig mat på en riktig tallrik. Slutligen i delstudie IV använde vi en *deskriptiv studiedesign* för att från ett helhetsperspektiv beskriva effekten av påminnelser (via e-post, flygblad, muntliga presentation etc.) på studiedeltagande och svarsmönster i delstudie II.

Resultat: Studie I visade att medlemmar över 65 år var mer aktiva (utnyttjade flest funktioner, hade högre inloggningsfrekvens) samt var lika framgångsrika eller bättre än yngre (< 65 år) medlemmar (viktnedgång kvinnor ≥ 65 år: 5.6kg, 6.8%; män ≥ 65 år: 6.4kg, 6.8%). Resultaten från delstudie II påvisar hälsoeffekter av interventionen i sin helhet, snarare än för specifika hälsostrategier såsom Internet-baserad personlig återkoppling med eller utan telefonrådgivning. Dock indikerar resultaten en positiv effekt av personlig återkoppling på ökad motivation för att förändra hälsovanor. Delstudie III stödjer tillförlitligheten av vår virtuella tallrik för att mäta kostintag, med (Spearman respektive concordance) korrelationer mellan 0.58-0.70 and 0.59-0.81 för energi- och näringsintag. Vi fann en generell total överrapportering av vår virtuella tallrik (+310kJ), men mindre för överviktiga deltagare (+147 kJ). Delstudie IV fullständiggör avhandlingen som visade att ett högt antal påminnelser var mycket positivt på den totala svarsfrekvensen, framförallt hos deltagare med hög Internettillgänglighet. Deltagarnas egenskaper (ålder, BMI, motivation etc.) visade sig dock inte vara associerade med hur snabbt de valde att svara efter utskick av frågeformulär.

Slutsats: Internet har en unik potential i fetmabehandling. Den här avhandlingen presenterar värdefulla hälsoeffekter framförallt för medelålders eller äldre och överviktiga män – en ofta utmanande målgrupp att inkludera i hälsofrämjande insatser. Det här är endast en del av utvecklingsarbetet i hur Internet kan användas, appliceras och implementeras i hälso- och sjukvården. Framtidens forskning rekommenderas att fortsätta sökningen på de behov och önskemål som framtidens Internet-baserad hälsa och medicin innefattar.

13 ACKNOWLEDGEMENTS

The present thesis benefited from the insights and directions of several people. I would like to convey my warmest appreciation to the following:

Ylva Trolle Lagerros, my main supervisor, whom from the first day of my internship believed in my abilities to lead projects by sending me to Banverket's head office to represent the research group. Proceeding activities reflected even more challenges and independence, allowing me to gradually grow into the role as a researcher. Thank you for believing in me, and for devoting your time and knowledge to my professional progress. There is no doubt that our professional strengths and weaknesses have complemented one another. Or, that our bizarrely speeded work pace, producing priceless opportunities these years (!) have matched. I truly admire your positivity, creativity, and beliefs of that everything is possible. Lastly, thank you for always supporting, rather than opposing, my sometimes spontaneous ideas and travels all around the world! In fact, sometimes even the best idea originates from a MC-trip, breakfast meeting in the archipelago, or at a dinner in the city hall.

Stephan Rössner, my co-supervisor, for believing in me at the very beginning and for including me in your research group already as a summer student. Also, thank you for sharing your unique knowledge in project planning, manuscript writing and much more! During these years, I have always felt that you were present in my research progress. You have been there whenever I have needed you – irrespective of geographical position, time of day, or amount of work you have had! Lastly, thank you for all valuable advice regarding future choices and your overall thoughtfulness. It has not passed a day or a meeting (or even an e-mail) without your asking me "how I am doing!" You are a true inspiration!

Rino Bellocco, my co-supervisor, for your genuine support, for taking your time, and for always bringing a smile to our discussions! Your expertise, high productivity, and warm personality have made statistics rather interesting! I have always left our meetings happy and satisfied with whatever we have accomplished. It has been a pleasure to work with you. Thank you also for inviting me to your team at the Milan-Bicocca University, Italy. My research exchange did not only generate valuable knowledge, and future network; it also gave me completely new food cravings.

Scott Montgomery**,** my co-supervisor, for your support during my thesis. Although little collaboration, our meetings and discussions have been highly appreciated. I hope to continue our work together!

Anders Ekbom, head of the research unit, for making me part of your research unit and for allowing me to grow as a researcher under your wings. You have served as an extraordinary leader at KEP, creating a connectedness between all researchers, although different research paths. Thank you for caring about your PhD-students, acknowledging their personal achievements, and for ensuring that their future choices match the high quality they deserve.

Tobias Svensson, my colleague and friend, where should I start? You have made unbeatable contributions to my years as a PhD-student, not only for your efforts in study II and IV (and tons

of international conference abstracts), but also as a friend. You are the first person that I have turned to when expressing my joy (or achieved those scholarships that you never thought I would manage putting together on time). Thank you for supporting my spontaneity in decision making and for guiding me when met by challenges.

Linda Bakkman, my former colleague and office mate, but current inspiration and friend, for introducing me to this research field, for making sure that I started on a safe ground, and for always being there when questions arise. I have missed you since the day you left, but cannot do anything else but admire and learn from your steps towards a fantastic career!

Anna Westerlund, my PhD-colleague, current office mate and friend, for having "both feet on the ground", and for always sharing your well-thought ideas. I have always trusted you completely, both professionally and privately. You possess unique professional strengths and I would not be surprised if you will become the new "Rothman" one day. Finally, thank you for laughter, fun lunches, and travels. I will miss you (but as always, I will just be a phone call or chat away).

Stephanie Bonn, for efficient and impressive proofreading during short deadlines and for genuinely complementing the research group at KEP.

Elena Pasquali, my hero and Italian friend, for always smiling, for making life easy, and for giving me a valuable hand in finalizing study II. Nine months ago, we barely knew one another. Today you are one of my best friends, whom I would love to continue socializing, traveling, and collaborating with. You have not only taught me statistics, you have also incorporated many Italian habits and aspects into my life.

Michael Fored, my director of studies, life coach, and friend. Thank you for seeing life from a broad perspective and for tailoring your advice and ideas accordingly. You have allowed me to understand my professional and personal capabilities, abilities, and most importantly, how to organize the puzzle of life.

Andreas Wolff Hansen, colleague and co-author, for your patience and valuable efforts in the challenging work of paper IV. I hope to continue our teamwork and to further explore the Internet's role in future medicine!

Rosaria Galanti, colleague and public health expert, for initiating and contributing to our collaboration with the telephone counseling services. Also, thank you for valuable teaching offers and for pleasant work these years.

ALL colleagues at KEP! (old as new). You are the reasons for making it fun to go to the office. You have all contributed to an interactive research atmosphere and continuous learning opportunities. Some of you have left the unit during these years, but still many of you persist.

A special thank you to my closest colleagues and friends *Adina Welander, Elina Salonen, Eva Willis, Farzad Hedayaty, Gabriella Bröms, Lina Forssell, Kari Johansson, Mahan Hasanizadeh and Ulrika Undén.* There are not enough space here to express my gratitude to your friendliness, overall support, and partaking during these years. What would I have done without you all? Further, thank you *Lena Brant, Fredrik Granath, Julia Simard, and Sven Cnattingius* for

valuable assistance with statistics, and for always finding time to discuss with the unit's PhD-students, even if you are working on the most famous data ever.

Last but certainly not least, the primary KI-administrators above all, *Monica Rundgren, Anci Adestam, Mia Pettersson, Lillemor Melander,* have not only contributed to award-winning help these years, they have also facilitated an immense amount of administrative work behind the conduct of this thesis. It has been safe to leave my documents in your hands.

Finally, *the After Workers!* (You know who you are; you know what we have done!).

The Obesity Unit, particularly *Lena Mannström-Svensson, Vivica Petré, and Mary Hyll* for efficient and fun assistance in the pilot studies and conducts of study II & III – and for your thoughtfulness and overall interest in our research. A special thank you also goes to *Ingrid Forsman*, who has literally given me a "hand" in the write-up of some reports and manuscripts, not manageable with injured arms.

Collaborating and participating companies & resources including the ***Swedish Transport Administration/Banverket*** (primarily Nils Edström, Berit Gille, and Ingrid Bråborg) for your strong enthusiasm and partaking. ***Stockholmståg*** (mainly Lena Hadad and Maria Magnusson), ***Veolia*** (Ida Östergren), and ***SJ AB*** (particularly Anna Johnsson) for impressive and inspiring team work.

Lastly, I would like thank all employees at ***Sluta-Röka-Linjen*** and ***Alkohollinjen*** (primarily Teresa H, Kerstin Damberg Thakker, Asgeir Helgason) for sharing your expertise, and for your interest in teaming up. ***Carolin Alriksgård,*** public health educator, whom warmly and efficiently assisted us with the Diet- and Exercise hotline during high workloads in study II.

Twitch *(Fredrik Karlsson & Nina Svensson****),*** for your smooth and exciting teamwork in the conduct of study II, particularly the development and implementation of the Diet- and Exercise hotline. It has been a pleasure to work with you. I hope that you will continue to incorporate modern technologies in your health plans. A special thank you goes to Nina Svensson, whom with a personal interest and cheerfulness, brightened many study participants' lives.

Netsurvey (Pontus Sallstedt & Karolina Södergren) for fun and efficient team work when making our lifestyle questionnaire (used in study II) Internet-based. I hope you learned as much as we did!

Banverket, KI-Travel funds, Sven & Dagmar Saléns foundation, and Erik and Edith Fernström's foundation for believing in me and for giving me the opportunity to gain further understanding of my research field on international grounds such as Cambridge University (2010), UK; Maastricht, the Netherlands (2010); Nanjing, China (2011); University of Milan-Bicocca, Italy (2011); Stanford University, CA, USA (2011) and Harvard University, MA, USA (2012). Your financial contributions have added significant value to both my professional and personal development.

Banverket and KID-funding, for financially supporting this thesis.

University of Milan-Bicocca for warmly welcoming me to your department during my work on paper II.

Former students (primarily *Marianne van der mark* [also co-author of paper I], *Julia Olsson, Judith van der Broek, Frida Alvarez and Thomas Cammelbeeck)* for assisting in pilot studies, data collection of study II, III and IV, and preliminary work associated with this thesis. Also, thank you *Johan Bergdahl*, for sharing your comments on paper II, and for inviting me to collaborate with you on the ONJ manuscript.

The "pedda-group" and related units at Halmstad University for sharing valuable references, experiences, bringing new insights into my research, and for your overall interest in collaborating.

Engineer Martin Qvänstedt for creating some of the logotypes used in my projects.

Bertil Svensson, my father, for your invaluable help, positivity throughout life, and for being the illustrator for some of the drawings in this thesis.

Min älskade familj *(Ann-Louise & Christer, Bertil & Birgitta, Theresia & Martin, Thyra och Hugo)* för att ni alltid ställer upp oberoende av vilken situation jag möter. Ni har givit mig ett fantastiskt stöd genom livets privata och professionella berg- och dalbana och följt med mig på världens alla resor. Jag skulle aldrig ha åstadkommit det jag har gjort idag om det inte var för alla telefonsamtal, e-mails, stöttande SMS, söta vykort eller personliga besök. Ni alla besitter unika egenskaper, som tillsammans har fullbordat de behov och önskningar jag har haft. Tack även för att ni alltid har trott på mig och stöttat mig, trots att ni ibland inte haft någon susning av vad jag har gjort! Ni är mitt livs bränsle.

Markus, for patiently and happily sharing my experiences and for always standing by my side. The value of your daily support and sacrifices cannot be put into words. It has been a pleasure to walk all steps in the direction towards our goals, including this thesis! Can you believe? We managed these two years. Thank you for your warmth and caring during tough periods and for acknowledging and appreciating successful aspects. Your presence is one of the reasons for waking up in the morning. I love you.

Anna, Carolina, Helena, Makda, Lina, Sanna & Sosso, for participating in my life's experiments and for never being more than a phone call away. Thank you for your understanding, for motivating me to keep going, and for always giving me good advice on how to best tackle the obstacles of life. Above all, I am grateful for our friendship.

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