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# EFFECTIVENESS OF WEB AND COMPUTER-BASED CVD/T2DM INTERVENTIONS ON HEALTH BEHAVIOURS: AN UMBRELLA REVIEW

Master's Thesis

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# VEEBI JA ARVUTIPÕHISTE CVD/T2DM-I SEKKUMISTE TÕHUSUS TERVISEKÄITUMISELE: KIRJANDUSE KATUSÜLEVAADE

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Tallinn 2018

# Author’s declaration of originality

I hereby certify that I am the sole author of this thesis. All the used materials, references to the literature and the work of others have been referred to. This thesis has not been presented for examination anywhere else.

Hakkı Jankat Var

14.05.2018

# Abstract

*Introduction*: The use of the internet- and computer-based interventions have the potential to prevent or ease management of T2DM and CVD diseases through lifestyle behaviour changes. This study collects the studies done with this aim and utilises them to draw a wider picture on the effectiveness and common features of such interventions.

*Objective*: The purpose of this overview is to collect and synthesize evidence from multiple systematic reviews on the effectiveness of web and computer-based interventions in prevention and management of type 2 diabetes or cardiovascular diseases for patients to inform policymakers, practitioners and researchers.

*Method*: An umbrella review of systematic reviews was performed, following Aromataris‘ guidelines.

*Results*: The umbrella review resulted in 17 included studies of systematic reviews. The outcomes were analysed according to the thorough classification of intervention types, outcome measures, health behaviour targets, study locations and study designs. Recurring, coherent evidence for certain interventions were filtered and listed for further emphasis.

*Conclusion*: An overview of the computer and web-based lifestyle interventions for diabetes and cardiovascular disease patients was conducted. Amongst the intricacies of study design variance, several aspects of more effective interventions were deduced for future references.

This thesis is written in English and is 50 pages long, including 7 chapters, 2 figures and 6 tables.

# Annotatsioon

*Sissejuhatus*: Interneti- ja arvutipõhiste sekkumiste kasutamine võib ennetada T2DM ja CVD haiguseid või lihtsustada nende haldamist elustiili muutuste kaudu. Selles uuringus kogutakse niisugusel eesmärgil tehtud uuringuid ja kasutatakse neid, et luua laiem pilt selliste sekkumiste tõhususe ja ühiste tunnuste kohta.

*Eesmärk*: Eelle ülevaate eesmärk on koguda ja sünteesida mitmesuguseid süstemaatilisiülevaateid veebipõhiste ja arvutipõhiste sekkumiste tõhususe kohta 2. tüübi diabeedi või südame-veresoonkonna haiguste ennetamisel ja haldamisel, et teavitada poliitikakujundajaid, arste ja teadlasi.

*Meetod*: Aromataris suuniste kohaselt viidi läbi süstemaatiliste ülevaatuste katusülevaade.

*Tulemused*: Katusülevaate tulemusena viidi läbi 17 süstemaatilist läbivaatamist. Tulemusi analüüsiti vastavalt sekkumisliikide põhjalikule liigitusele, tulemuse mõõtmisele, tervisekäitumise eesmärkidele, uuringupaikadele ja uuringuplaanidele. Teatud sekkumiste korduvad ja järjepidevad tõendid filtreeriti ja lisati edasiseks rõhutamiseks loetellu.

*Kokkuvõte*: Viidi läbi ülevaade diabeedi ja südame-veresoonkonna haigustega patsientide arvuti- ja veebipõhistest eluviiside sekkumistest. Uuringute disaini variatsioonide üksikasjade hulgas oli tulevaste viidete jaoks tuletatud mõne tõhusama sekkumise aspekti.

See uurimus on kirjutatud inglise keeles, see on 50 lehekülge pikk, koosneb seitsmestpeatükist, kahest joonisest ja kuuest tabelist.

# List of abbreviations and terms

| | |
|---|---|
| TUT | Tallinn University of Technology |
| SR | Systematic Review |
| PA | Physical Activity |
| RCT | Randomized Controlled Trial |
| MA | Meta-Analysis |
| NZ | New Zealand |
| UK | United Kingdom |
| CVD | Cardiovascular Disease |
| BG | Blood-glucose |
| T2DM | Type-2-Diabetes Mellitus |
| QED | Quasi-experimental Design |
| NCD | Non-communicable Disease |
| WHO | World Health Organization |
| SMS | Short Messaging Service |
| HbA1c | Glycated Haemoglobin |
| LDL-C | Low-density Lipoprotein |
| FPG | Fasting Plasma Glucose |
| HDL | High-density Lipoprotein |
| 2HPPT | 2-H Post-prandial Test |
| FBG | Fasting Blood Glucose |

# Table of Contents

Author's declaration of originality ..... 3
Abstract ..... 4
Annotatsioon ..... 5
List of abbreviations and terms ..... 6
List of figures ..... 9
List of tables ..... 10
1 Introduction ..... 11
2 Background ..... 14
2.1 The scope, aim, hypothesis ..... 14
2.2 Research questions ..... 14
3 Methodology ..... 15
3.1 Aromataris' Umbrella Review Protocol ..... 15
3.2 Search Strategies ..... 16
3.3 Search Terms ..... 17
3.4 Inclusion/Exclusion Criteria ..... 19
4 Results ..... 20
4.1 Overview of the included studies ..... 20
4.2 RQ1: How many systematic reviews are there about web-based health behaviour change interventions to patients with T2DM or CVD during the years of 2011 and 2017? ..... 22
4.3 RQ2: What types of web and computer-based tools were used in the health behaviour interventions? ..... 22
4.4 RQ3: What kind of health behaviours were targeted by the web and computer-based interventions? ..... 30
4.5 RQ4: What are the effects of web-based interventions on health behaviours of patients with T2DM or CVD as reported in reviews? ..... 31
4.6 RQ5: How did the systematic reviews measure the effectiveness of the various health behaviour interventions? ..... 32

4.7 RQ6: What are the factors can be associated with success as reported in reviews if any? ..... 33
4.8 RQ7: What health targets were affected by the effective web and computer-based interventions as reported in reviews if any? ..... 33
4.8.1 Blood pressure ..... 33
4.8.2 Physical activity ..... 34
4.8.3 Diet ..... 36
4.8.4 Smoking cessation ..... 37
4.8.5 Weight loss ..... 38
4.8.6 Self-Management of T2DM ..... 39
5 Discussion ..... 40
5.1.1 Internet as a supplementary tool vs Internet as a substituent tool ..... 40
5.1.2 Health professional supported vs Self-managed ..... 41
5.1.3 Standardised vs Tailored ..... 41
5.1.4 Using computers and internet as the only tool vs Additional technologies ..... 42
5.1.5 Other notes ..... 42
5.2 Limitations of the study ..... 45
5.3 Further work and recommendations ..... 45
6 Conclusions ..... 46
7 References ..... 47

# List of figures

Figure 1 PRISMA Flow Diagram..... 18
Figure 2 Number of included reviews by years of publication. Source: Author..... 20

# List of tables

Table 1 Research Questions ..... 14
Table 2 Aromataris' Umbrella Review Protocol ..... 16
Table 3 Inclusion/Exclusion Criteria ..... 19
Table 4 Overview of eligible studies ..... 21
Table 5 Overview of Intervention Types ..... 23
Table 6 Outcome Measures ..... 32

# 1 Introduction

Noncommunicable diseases (NCDs) – also known as chronic diseases, were defined by the World Health Organization (WHO) as "diseases of long duration and generally slow progression". The four main types of such diseases can be categorized as follows:
1) cardiovascular diseases (e.g. heart attacks and stroke) 2) cancers, 3) chronic respiratory diseases (e.g. pulmonary disease and asthma) and 4) diabetes [1]. NCDs are the main cause of death worldwide. Death under 60 years of age due to NCDs ranges from 13% from 41% respectively in high and low-income countries. [2] In 2012, NCDs were responsible for about 38 million deaths worldwide and it is expected that by the year 2030, the death rates given rise by NCDs will increase further, a concerning 52 million. [3] The NCD-related deaths are more widespread in developing countries by a large margin (82% of the NCD-related deaths universally) [4]

This review concentrates on two of the NCDs, namely type 2 diabetes mellitus (T2DM) and cardiovascular diseases (CVD). One of the two focuses of this study, diabetes, is a highly prevalent major public health problem that contributes to increasing health care cost. [5] The estimations around adults who are affected are about 285 million worldwide and constitutes global healthcare spending of $376 billion in 2010. By 2030, the figures are expected to increase to 439 million adults and $490 billion healthcare expenditure. [6] Another study projecting the number of people who will be affected by diabetes by 2040 estimates the number to rise to around 642 million with approximately 90% of those cases being type 2 diabetes mellitus. [7]

Despite the fact that, over the years there is a growing number of treatment options available, the number of people suffering because of diabetes-related complications does not decrease. [8]

This significant burden of diabetes management calls for the use of innovative tools in order to improve health outcomes and financial drain. The key element for this regard seems to be making a combination of appropriate lifestyle changes and more traditional diabetes therapies. [9] This means accommodating medication, nutrition and lifestyle changes in the scope of the diabetes treatments in order to achieve glycaemic control and therefore being able to reduce the risks of complications due to diabetes. [10]

However, making lifestyle changes can come with difficulties as it requires individuals to be able to adapt to their new life with diabetes and to the new ways of managing it [11]. According to series of surveys' portrayal of self-management amongst people with diabetes on national and international levels, poor self-care and insufficient fulfilment of daily demands of diabetes management lead to low quality of life and poor well-being. [12]

The second focus of this study, cardiovascular diseases (CVDs) are the leading cause of mortality worldwide, accounting for 30% of global deaths and 48% of deaths in Europe. [13] CVD is also one of the main contributors to morbidity and mortality of people with diabetes and a major cause of health care costs accompanying to diabetes. [14]

Fortunately, most cardiovascular diseases and diabetes type 2 are largely preventable and manageable by minimizing risk factors such as high blood pressure, tobacco use, raised blood glucose, physical inactivity, overweight and obesity by lifestyle changes. [2] CVD and diabetes share similar risk factors such as unhealthy diet, smoking, physical inactivity and obesity. [15] There are an extensive amount of evidence suggesting that healthy diet and appropriate physical activity can have preventive effects. [16] [17]

To exemplify this claim, it is being estimated that 25% reduction in physical inactivity is capable of eliminating about 1.3 million related deaths annually [18]
while a healthy diet and increased physical activity can prevent a significant proportion of the 18 million deaths caused by high blood pressure, high body mass index, high fasting blood glucose and high total cholesterol. [19]

As of December 2017, there are 4,156,932,140 internet users in the world which suggests that 54.4% of the world's population is connected to the internet. [20] This makes health behaviours to be widely penetrable via web-based interventions to effect change in order to prevent diseases like diabetes and cardiovascular diseases.

There are many published systematic reviews on the topic that take on randomized trials on health behaviour changes for the purpose of prevention and management of CVD and T2DM diseases between the years of 2011-2017 which brings about the need of presenting a general view of the effectiveness of the web-based health behaviour change interventions. With this paper, I aim to respond to this need.

This study will cover the overview of systematic reviews on Web-based health behaviour change randomized trials between the years of 2011 and 2017. The time-range of 6 years was chosen for it to be optimal for the consideration of the distribution and quality of papers in recent years and time and financial constraints.

# 2 Background

## 2.1 The scope, aim, hypothesis

The purpose of this overview is to collect and synthesize evidence from multiple systematic reviews on the effectiveness of web and computer-based interventions in prevention and management of type-2-diabetes mellitus (T2DM) and/or cardiovascular diseases (CVD) for patients to inform policymakers, practitioners and researchers.

The hypothesis of this research is that web-based health behaviour interventions with the aim of preventing T2DM and/or CVD create a positive impact on the patients' health levels.

## 2.2 Research questions

Table 1 Research Questions

| ID | Research Question |
|---|---|
| RQ1 | How many systematic reviews are there about web-based health behaviour change interventions to patients with T2DM or CVD during the years of 2011 and 2017? |
| RQ2 | What types of web and computer-based tools were used in the health behaviour interventions? |
| RQ3 | What kind of health behaviours were targeted by the web and computer-based interventions? |
| RQ4 | What are the effects of web-based interventions on health behaviours of patients with T2DM or CVD as reported in reviews? |
| RQ5 | How did the systematic reviews measure the effectiveness of the various health behaviour interventions? |

| | |
|---|---|
| RQ6 | What are the characteristics of successful health behaviour interventions as reported in reviews if any? |
| RQ7 | What were the health targets affected by the effective web and computer-based interventions as reported in reviews if any? |

# 3 Methodology

This study uses an umbrella review methodology, meaning that it is the synthesis of existing systematic reviews and meta-analyses. An umbrella review systematically collects and evaluates information from multiple systematic reviews and meta-analyses [21] for the purpose of providing a ready means for decision makers in health care to gain a clear understanding of a broad topic area and capture the breadth of outcomes, particularly when several outcomes are considered to highlight the strongest evidence there is. [22]

## 3.1 Aromataris' Umbrella Review Protocol

This umbrella review followed an existing protocol [23] for the purpose of providing a structured analysis of potential studies. Aromataris umbrella review protocol consists of ten main steps as seen in Table 2. Steps 1 through 5 is discussed in the following sections of methodology chapter. Step 6 is not performed in this research as the quality assessment is out of scope for this review.

Step 7-8 and 9-10 are carried out in this research and are detailed in the results and discussion chapters respectively.

Table 2 Aromataris' Umbrella Review Protocol

| Step No | Step Description |
|---|---|
| **1** | Developing the title and question |
| **2** | Background |
| **3** | Review question/objective |
| **4** | Inclusion criteria<br>a. Types of participants<br>b. Interventions/Phenomena of interest<br>c. Outcomes<br>d. Context<br>e. Types of Studies |
| **5** | Search strategy |
| **6** | Assessment of methodological quality |
| **7** | Data collection |
| **8** | Data Summary |
| **9** | Research synthesis |
| **10** | Presentation of findings |

## 3.2 Search Strategies

For this review, a systematic literature search of several major databases conducted. The selection of databases made based on their availability, access rights provided by TUT library and their focus of study.

The databases that are used for this review are as follows:

- **PubMed (Medline):** (https://www.ncbi.nlm.nih.gov/pubmed) PubMed is a free search engine accessing primarily the MEDLINE database of references and abstracts on life sciences and biomedical topics. It comprises more than 28 million citations for biomedical literature from MEDLINE, life science journals, and online books. It is maintained by National Centre for Biotechnology Information (NCBI) at the National Library of Medicine (NLM).

- **Cochrane Database of Systematic Reviews (CDSR)**: (http://www.cochranelibrary.com/) CDSR is the collection of databases in medical research provided by Cochrane and other organisations. In its essence, it is a database of systematic reviews and meta-analyses which summarise and interpret the results in the healthcare field.

- **Scopus**: (https://www.scopus.com/search/form.uri) Scopus, besides of including Embase and MEDLINE content, also includes other journals and features citation reporting. It covers more than 20,000 journals.

- **Web of Science:** (http://apps.webofknowledge.com/) is a collection of databases that combine citation indexing with web technology thus enable current and retrospective searching of quality, peer-reviewed journals.

- **Google Scholar:** (https://scholar.google.com/) Google Scholar is the Google's web search engine for academic studies. It covers journal articles, theses, books, and abstracts. It is argued that its estimated coverage is approximately around 80-90% of all articles published in the English language. [24] [25]

## 3.3 Search Terms

Search queries were designed for the aforementioned databases and the literature search was conducted in respective databases to capture all studies which incept from January 2011.

Keywords searched in abstracts and titles of papers were every possible combination of terms from each block:

Search terms:

(Block 1 ("internet," "web," "WWW," "online," and "computer")),

(Block 2 ("lifestyle", "behaviour")),

(Block 3 ("diabetes", "cardiovascular")),

(Block 4 ("systematic review", "meta-analysis")) and

"intervention"

An example of the used terms including search operators is displayed as follows:

((internet OR web OR online OR www OR computer) AND intervention AND (systematic review OR meta-analysis) AND (lifestyle OR behaviour) AND (diabetes OR cardiovascular))

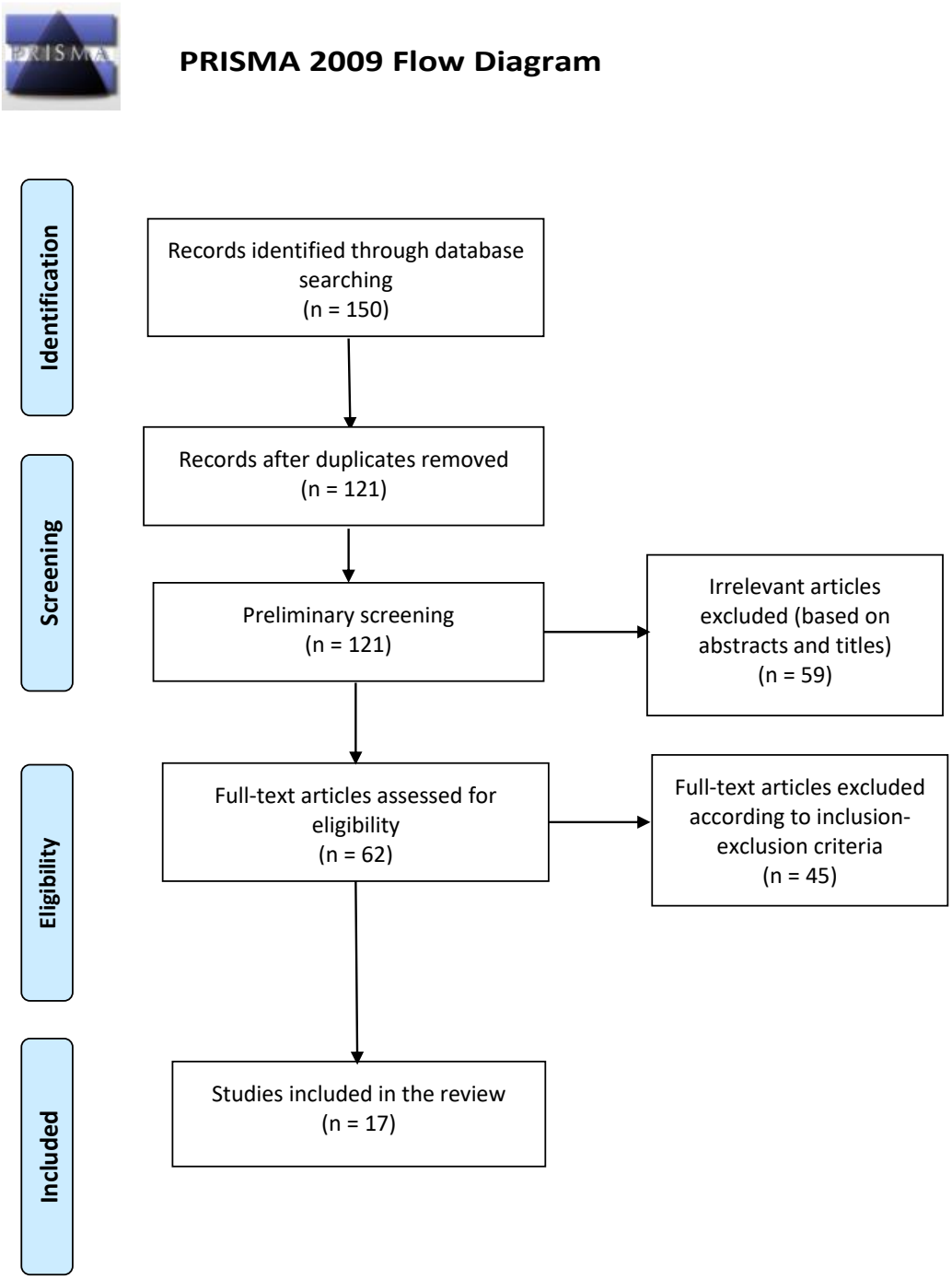


Figure 1 PRISMA Flow Diagram

## 3.4 Inclusion/Exclusion Criteria

Systematic reviews of technology-based interventions for the prevention or management of T2DM and/or CVD compared with a control condition are included.

The selected reviews had to match a certain set of criteria:

(1) published between January 2011 and December 2017;

(2) trial targets consist of the general adult population;

(3) the interventions used primarily focused on improving lifestyle behaviours (e.g. smoking, diet, weight control, physical activity) to prevent or control CVD or T2DM. Reviews with a wider scope than T2DM and/or CVD, as well as interventions with mental-health focus are excluded

(4) the interventions used primarily focused on the web or computer-based technology. Reviews with a wider scope (e.g. interventions that mainly use social media) are excluded.

(5) only systematic reviews and meta-analyses are included, other types of reviews such as scoping reviews or meta-epidemiology studies were left out;

(6) written in the English language.

Table 3 Inclusion/Exclusion Criteria

| | **Inclusion Criteria** | **Exclusion Criteria** |
|---|---|---|
| **Timeline** | Publications between January 2007 to December 2017 | Published before 2007 or after 2017 |
| **Language** | English language | Any other languages |
| **Type of study** | Systematic reviews and meta-analysis | Other types of reviews such as scoping reviews or meta-epidemiology studies |
| **Target of the study** | General, adult population | Non-adult, specifically focused (e.g. elderly, people with disabilities) |
| **Intervention Type** | Web and computer-based interventions | Reviews with a wider scope (e.g. interventions that mainly use social media) |

# 4 Results

## 4.1 Overview of the included studies

Selected reviews were published between the years of 2011 and 2017 although distribution overwhelmingly falls in favour of the years between 2011 and 2015. (93.75% (n=15)). The more recent study was conducted in 2017 [26] whereas there were no studies eligible in 2016. (Figure 2)

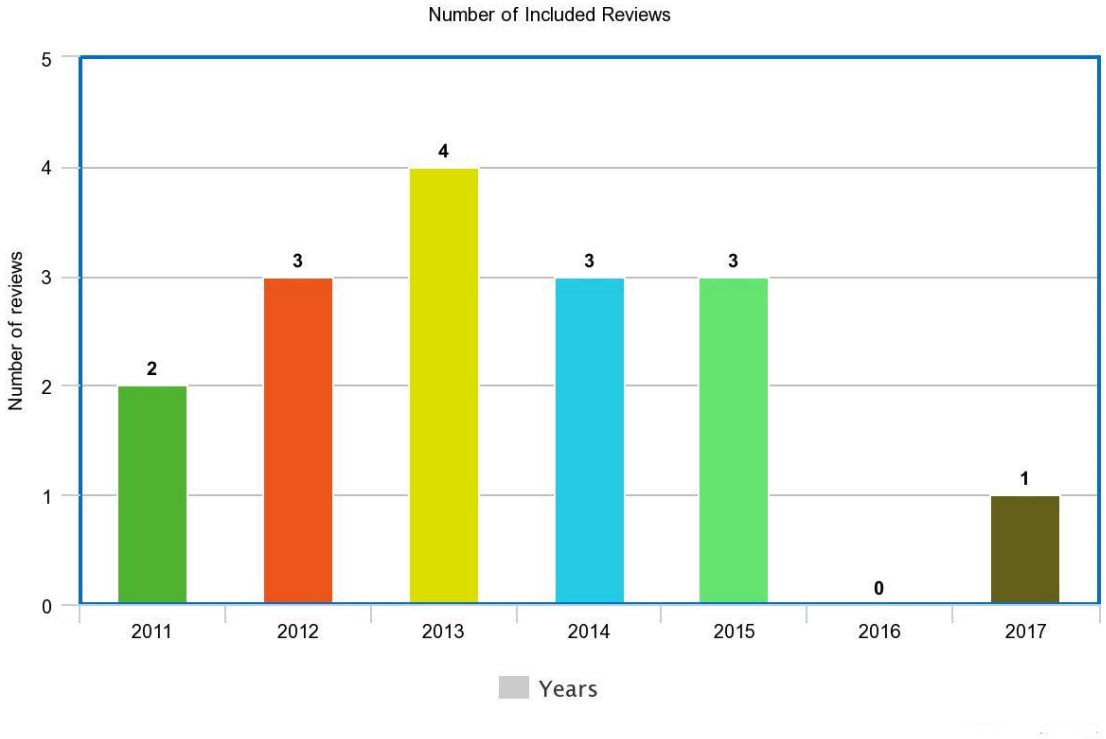


Figure 2 Number of included reviews by years of publication. Source: Author.

Regarding the languages used in the reviews, all the included studies were published only in English, with one exception being Angeles et al (2011) by being published in French and English. In terms of the languages the reviews made their searches in can be categorised into the ones that had no constraints language-wise in order to avoid publication bias, Reed et al. (2012), Kodama et al (2012), Levine et al (2014), Foster et al (2013) and the ones that conducted their inquiries only in English. There is a third group that added a second language besides English, Taylor et al (2017), English and Spanish; Pal et al (2013) English and Chinese; and Yu et al (2011) English and French. Nine amongst included studies comprised only randomised controlled trials while four

also reviewed studies with quasi-experimental design on top of randomised controlled trials. Follow-up studies only included in Aneni et al (2014) where Pietrzak et al (2014) and Yu et al (2011) also included observational studies. The rest have minor nuances regarding the selection of studies such as including comparative effectiveness designs in Pareira et al (2015), pilot studies in Pietrzak et al (2014), clinical controlled trials and pre-post studies in Yu et al (2011).

Table 4 Overview of eligible studies

| **Author (Year)** | **Review type, year range of studies** | **Study Location** | **Study Designs** | **No. of studies (total n)** |
|---|---|---|---|---|
| Aneni et al. (2014) [27] | SR (2001-2012) | Not reported | RCTs, follow-up studies | 29 (n=15261) |
| Angeles et al. (2011) [28] | SR and MA (2004–2009) | Korea, Finland, Canada, USA | RCTs | 9 (n=926) |
| Foster et al. (2013) [29] | SR and MA (1991-2011) | Not Reported | RCTs | 11 (n=5862) |
| Kodama et al. (2012) [30] | MA (1980-2011) | USA, Japan, The Netherlands, UK, Korea. | RCTs | 23 (n=8697) |
| Levine et al. (2014) [31] | SR (2001-2013) | Not reported | RCTs | 16 (n=6786) |
| Lustria et al. (2013) [32] | SR and MA (1999-2009) | USA, Australia, UK, NZ, Netherlands, Canada, Belgium, Switzerland | RCTs, QEDs, no treatment control | 40 (n=20180) |
| Pal et al. (2013) [33] | SR and MA (1986-2011) | USA, South Korea, Australia, UK, China | RCTs | 16 (n=3578) |
| Pereira et al. (2015) [34] | SR (2006-2012) | Not reported | RCTs, QEDs, Comparative effectiveness designs | 14 (n=2802) |
| Pietrzak et al. (2014) [35] | SR (2004–2012) | USA, Canada, Netherlands, Spain, South Korea, Switzerland, Australia | RCTs, observational, studies, pilot | 23 (n=9615) |
| Ramadas et al. (2011) [36] | SR (2000-2010) | USA, South Korea, Taiwan, Canada | RCTs, QEDs | 13 (n=1644) |
| Reed et al. (2012) [37] | SR and MA (1985–2009) | Not Reported | RCTs | 11 (n= 1866) |

| | | | | |
|---|---|---|---|---|
| Seo, Niu (2015) [38] | MA (1980-2014) | Not reported | RCTs | 31 (n=8442) |
| Taylor et al. (2017) [26] | MA (-2016) | Not Reported | RCTs, QEDs | 33 (n= 115135) |
| van Vugt et al. (2013) [39] | SR (2002–2012) | North America (n=10), Europe (n=2), Asia (n=1) | RCTs | 13 (n=3813) |
| Vegting et al. (2013) [40] | SR (2003-2012) | Not Reported | RCTs | 9 (n=1995) |
| Yu et al. (2011) [41] | SR (2003–2008) | Not reported | RCTs, controlled clinical trials, pre-post, observational studies | SR, 57 (n=), MA, 12 (n=2731) |

## 4.2 RQ1: How many systematic reviews are there about web-based health behaviour change interventions to patients with T2DM or CVD during the years of 2011 and 2017?

The initial literature search yielded 150 results. After application of inclusion/exclusion criteria, as it is listed in the respective field and portrayed in Figure 1, literature search results finalised with 16 reviews that are apt for this study.

## 4.3 RQ2: What types of web and computer-based tools were used in the health behaviour interventions?

This umbrella review contains various types of interventions with different study aims from the education of diabetes patients to controlling dietary intake, increasing their physical activity to employing multimedia tools to utilise psychological theory models, using reminders for periodical tasks such as medication intake, medical tests and so on. Despite the fact that there is a wide spectrum for the study designs, objectives and settings, it is possible to classify the interventions under several shared labels. The most commonly observed themes for interventions are as follows:

- Self-management
- Monitoring
- Social support
- Prompts/cues
- Motivational tools
- Educational tools
- Tailored feedback
- Mixed interventions
- Professional counselling
- Smoking cessation tools

Table 5 Overview of Intervention Types

| Author (Year) | Types of Interventions |
|---|---|
| Aneni et al (2014) | The interventions focused on cardiovascular well-being. They were grouped into two main categories: 1. mainly internet-based programs with minimal interaction with the environment or study personnel 2. multi-component interventions where non-internet interventions played more than a minor role. The interventions used in this study can be grouped as follows:<br><br>• Self-management<br>  ○ Self-assessment (health-risk assessments psycho-social assessments, health surveys, questionnaires…etc)<br>• Monitoring<br>  ○ Monitoring through physical activity monitors and devices<br>• Social support<br>  ○ Social networking in the means of social support<br>• Prompts/cues<br>  ○ E-mail reminders<br>• Motivational tools |
| Angeles et al (2011) | The interventions focused on the education of patients with diabetes with respect to glucose control using web services. These educational interventions were either standardised or personalised. The interventions used in this study can be grouped as follows:<br><br>• Educational tools<br>  ○ Standardised education (i.e. online health materials linked to the web-based tool)<br>  ○ Standardised education<br>• Tailored feedback<br>  ○ Personalised feedback (nurse/ pharmacist/physician through e-mail/short messaging service/video conferencing) |

| | |
|---|---|
| | • Computer and cell phone combined interventions<br>• Self-monitoring<br>  ○ Self-reported blood glucose levels through web tools |
| Foster et al (2013) | The interventions were focused on increasing the patients' physical activity levels. Remote and web 2.0 based interventions can be grouped into two categories; 1. Interventions that have individuals as the only subject 2. Interventions that use social aspect. The individual-based interventions are as follows:<br><br>• Prompts/cues<br>  ○ SMS messaging reminders of places where user-preferred physical activities can be taken<br>• Tailored feedbacks<br>  ○ Computerised tailored feedback based on the user's current physical activity behaviour through e-mail<br>• Social Support<br>  ○ Telephone support for physical activity related public health recommendations<br>  ○ Interactive forum websites to plan physical activity<br>  ○ DVDs to be distributed by post and to be played at workplaces to raise the physical activity by giving instructions<br>  ○ Online networks in which users compare their physical activity levels with other users |
| Kodama et al (2012) | The interventions were focused on controlling dietary intake and increasing physical activity using internet tools. The outcome was measured by measuring absolute body weight change. The role of the internet in the interventions were either to be supplemental or as a substitute. The interventions used in this study can be grouped as follows:<br><br>• Self-monitoring<br>  ○ Physical activity<br>  ○ Dietary intake<br>• Professional counselling<br>• Educational tools<br>  ○ Tailored website instructions<br>• Social support |
| Levine et al (2014) | The interventions chose the setting as ambulatory primary care unit and focused on the weight loss aspect. The interventions used in the study can be grouped as follows:<br><br>• Self-monitoring<br>  ○ Pedometers to measure the levels of physical activity<br>• Social support<br>  ○ Remote support through telephone/website/e-mails<br>• Motivational tools<br>  ○ Web-based tailored behaviour change goals<br>• Educational tools<br>  ○ Skills training through the website |

| | |
|---|---|
| | • Professional counselling<br>  ○ Remote counselling through telephone with a trained health educator<br>• Tailored computer intervention<br>  ○ Computerised tailored diet programmes |
| Lustria et al (2013) | The interventions were focused on web-based, computer-tailored health interventions and their long and short-term effects. The intervention tools used in the studies can be grouped as follows:<br><br>• Self-monitoring<br>• Prompts/cues<br>  ○ E-mail reminders/support from peer coaches<br>• Educational tools<br>  ○ Interactive tailored quizzes<br>• Social support<br>  ○ Discussion forums<br>• Multimedia tools<br>  ○ Animated instructors<br>  ○ Streaming audio narratives<br>  ○ Graphic interfaces for facilitated communication<br>• Tailored feedback<br>  ○ Tailored e-mail/SMS/phone feedback<br>• Self-management<br>  ○ Shopping list adjusting website to decrease high-fat purchases<br>  ○ Tailored nutrition advice<br>• Motivational materials<br>  ○ Sex and age-tailored role-model stories<br>  ○ Goal-setting facilities |
| Pal et al (2013) | The interventions were focused on self-management of diabetes through computer-based tools. The studies that included mobile devices were also included as they were not the focus of the studies. The computer-based intervention tools used in the studies are as follows:<br><br>• Self-management<br>  ○ Touchscreen assessments for action planning<br>  ○ Touchscreen assessment for dietary barriers<br>  ○ Computer-based assessments for physical activity and diet barriers<br>• Educational tools<br>  ○ Computer-based education sessions<br>• Social support<br>  ○ Peer support and education through moderated forums<br>• Prompts/cues<br>  ○ Mobile devices and pagers for reminders (medication, blood glucose/blood pressure testing, meal-time reinforcements)<br><br>• Tailored feedbacks |
| Pareira et al | The interventions were focused on the education aspect of the self- |

| | |
|---|---|
| (2015) | management of diabetes. Some interventions provided a social support via message boards, e-mail and discussion groups. Other interventions used tailored e-mail and phone contact-based interaction. The web-based intervention tools used in the studies are as follows:<br><br>• Self-management<br>  o Interactive web programme for tracking nutrition and blood glucose<br>• Educational tools<br>  o Web-based diabetes education<br>  o Automated text messages for nutrition information<br>• Social support<br>  o E-mail groups<br>• Professional counselling<br>  o Diabetes tailored coaching programme |
| Pietrzak et al (2014) | The interventions were focused on prevention of cardiovascular diseases through Internet-based interventions and reduction of cardiovascular risk factors. The interventions included advice and treatment for 1) smoking cessation; 2) maintenance of normal BP; 3) lowering serum cholesterol concentration and changing the lipid profile; 4) lowering serum glucose; and 5) providing information on lifestyle risk factors, such as physical activity, diet, obesity, and alcohol consumption, and how they can be reduced. The web-based intervention tools used in the study are as follows:<br><br>• Social support<br>  o "Heartweb" website that provides social support to decrease fat consumption<br>  o Moderated chat-room<br>• Self-management<br>  o Interactive website and mobile phone applications<br>  o E-mail prompts for self-monitoring of diet, physical activity, and weight-loss<br>  o Self-reported web-based diary<br>• Educational tools<br>  o Behavioural lessons in the audio format provided periodically online<br>  o E-mail messages regarding diet, exercise, and smoking.<br>  o Weekly education sessions including exercise tasks<br>• Professional counselling<br>  o Web-based (through synchronous and asynchronous messaging) counselling with a lifestyle coach<br>• Monitoring risk factors<br>  o Automatized brief messages according to the sequential monitoring values for 13 diabetes risk factors through web-based colour-coded diabetes tracker<br>• Tailored feedback<br>  o On measurements and recommendations on medication adjustments, diet and exercise, and general information about diabetes through the internet. |

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| Ramadas et al (2011) | The interventions were focused on self-management of T2DM through web-based interventions. Main targets were characterised as self-monitoring, physical activity and combined interventions. The interventions used in this study can be grouped as follows:<br><br>• Tailored feedback<br>  o Based on the data provided by the patients on their blood-sugar readings, exercise programmes, weight changes, blood pressure and medication, feedbacks from a healthcare professional via e-mail<br>• Motivational tools<br>  o Goal-setting<br>  o Identified and developed strategies to overcome barriers<br>• Professional counselling<br>  o Case management and group education by registered dietitians<br>• Social support<br>  o Discussion boards<br>  o Peer group support areas<br>• Self-monitoring<br>  o Web-based, colour-coded diabetes tracker, which provided sequential monitoring values for 13 diabetes risk factors and brief advisory messages<br>  o Internet-based glucose monitoring system (IBGMS) to upload blood glucose, medication, blood pressure, weight and recorded changes in the patients' lifestyles<br>• Educational tools<br>  o Providing links to other web-based diabetes sources<br>  o "eMOD" real-time information about diet, dining-out, hypoglycaemia, sick-day and stress management.<br>  o Integrating patients' medical care data into their education program components and presenting them on the Web |
| Reed et al (2012) | The interventions were focused on the computer and web-based dietary and weight-control interventions for diabetes self-management. The web and computer-based intervention tools used in the studies are as follows:<br><br>• Self-monitoring<br>  o Website diary<br>  o PDA diary<br>  o Computer-based programme for self-monitoring<br>  o Hand-held computers<br>  o Wearable technology for body monitoring<br>• Professional counselling<br>  o E-mail counselling<br>• Self-management<br>  o "eDiets" website for meal planning<br>  o "SHED-IT" website for weight-loss<br>• Educational tools<br>  o "Nutri-expert" computer software<br>  o "Eating Machine" computer software |

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| | ○ "EATS" computer software |
| Seo et al (2015) | The interventions were focused on reducing waist circumference through web-based lifestyle interventions. The web-based intervention tools used in the studies are as follows:<br><br>• Social support<br>○ Bulletin board facility<br>○ Online discussion groups<br>○ Facebook support group<br>• Standardised educational tools<br>○ Online brochures<br>○ E-mail education (1 year / 2 years long)<br>○ Websites with general health information<br>• Personalised educational tools<br>○ E-mail feedbacks<br>○ Online behavioural therapy<br>• Professional counselling<br>○ E-mail counselling<br>○ Online monitoring and feedbacks |
| Taylor et al (2017) | The interventions were focused on smoking cessation. The interventions differed from low-intensity interventions such as providing a list of websites for smoking cessation to more intensive interventions, i.e. internet, e-mail and mobile phone delivered interventions. Interventions varied and included computer-generated advice letters, web-based cessation guides, computer-generated text messages, and peer e-mail support. The web-based intervention tools used in the studies are as follows:<br><br>• Social support<br>○ Bulletin board facility<br>○ Social media support (e.g. Facebook, Twitter, WeChat)<br>○ Chat groups<br>• Tailored internet interventions<br>○ Multimedia tools<br>○ Custom-made stories and message sources<br>• Smoking cessation tools<br>○ The web-based version of approach-avoidance task<br>○ Face-ageing simulation tool<br>• Professional counselling<br>○ Nurses / peer coaches / tobacco treatment specialists |
| Van Vugt et al (2013) | The interventions were focused on the use of behavioural change techniques in web-based self-management programs for T2DM patients. The web-based intervention tools used in the review are as follows:<br><br>• Self-management tools<br>• Professional counselling<br>○ Online coaching<br>○ Telephone contact |
| Vegting et al | The interventions were focused on the effects of Internet-delivered |

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| (2013) | multiple modifiable lifestyle interventions complementary to usual care on cardiovascular risk factors in the primary and secondary healthcare setting. The web-based intervention tools used in the review are as follows:<br><br>• Professional counselling<br>  ○ Physician-supervised-nurse / Case manager / Dietician / Health coach / Pharmacist<br>• Self-monitoring<br>  ○ Obesogenic behaviour change goals<br>  ○ Blood pressure / Blood glucose / Weight / Smoking status / cholesterol / Heart rate<br>• Educational tools<br>  ○ Interactive educational modules<br>• Self-management<br>  ○ Web-application generated tailored advice<br>• Tailored feedback<br>  ○ Feedback on blood glucose by an assigned nurse |
| Yu et al (2012) | The interventions were focused on identification and evaluation of the effectiveness, clinical usefulness, sustainability, and usability of web-compatible diabetes-related tools. The web-based intervention tools used in the review are as follows:<br><br>• Educational tools<br>  ○ Educational CDROM games<br>  ○ General diabetes education computer application<br>  ○ Interactive, tailored health promotion websites<br>• Self-management tools<br>  ○ Self-management of diabetes through online tools and DVDs<br>  ○ Interactive website providing tailored advice on lifestyle modification and risk factor screening<br>  ○ Computer-automated e-mail counselling<br>  ○ Weight-loss web site<br>• Professional counselling<br>  ○ E-mail counselling<br>• Smoking cessation tools<br>  ○ Online smoking prevention and cessation programme<br>  ○ Interactive, multimedia smoking prevention and cessation tools<br>• Clinician behaviour change counselling tools<br>  ○ web-based motivational interviewing educational programme on teaching effectiveness |

## 4.4 RQ3: What kind of health behaviours were targeted by the web and computer-based interventions?

Even though targeted health behaviours varied from one review to another, the commonalities between the targets were that all being lifestyle-related behaviours that have a significant impact on the prevention or the management of CVD and T2DM.

One noteworthy aspect of the health behaviour targets in the review is that there are no clear-cut definitions of concepts. In other words, the individual reviews found numerous overlaps between the targets in the studies as the implications of one aspect is greatly intertwined with another study's sole target. To illustrate, designating "reducing CVD risk factors" as a target includes weight loss and weight loss includes physical activity and all the dietary interventions including educational ones. Overall, it is not optimal to consider the health targets inside of definitive and exclusive categories.

| Author (Year) | Health Behaviour Targets |
|---|---|
| Aneni et al (2014) | PA, diet |
| Angeles et al (2011) | Self-management of T2DM |
| Foster et al (2013) | PA |
| Kodama et al (2012) | Weight loss |
| Levine et al (2014) | Weight loss |
| Lustria et al (2013) | PA, diet, smoking cessation |
| Pal et al (2013) | Self-management of T2DM |
| Pareira et al (2015) | Self-management of T2DM |
| Pietrzak et al (2014) | Weight loss, diet, PA, smoking cessation |
| Ramadas et al (2011) | Self-management of T2DM |
| Reed et al (2012) | Weight loss |
| Seo et al (2015) | Waist circumference reduction |
| Taylor et al (2017) | Smoking cessation |
| Van Vugt et al (2013) | Diet, PA, smoking cessation |
| Vegting et al (2013) | CVD risk factors, self-management of T2DM |

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| Yu et al (2012) | Diabetes/CVD risk factors |

## 4.5 RQ4: What are the effects of web-based interventions on health behaviours of patients with T2DM or CVD as reported in reviews?

The shorts summaries of review results were demonstrated in the Table 5.

| Author (Year) | Results of Reviews |
|---|---|
| Aneni et al (2014) | No effect on PA, dietary outcomes, lipid profiles, or hypertension. Modest improvements observed in weight.<br>Successful interventions included "human contact" and environmental modification, or targeted specific disease entities, e.g, hypertension. |
| Angeles et al (2011) | Web-based tools better than usual care for HbA1c and LDL-C.<br>Heterogeneity among studies with 12-month intervention. |
| Foster et al (2013) | Positive, moderate-sized effects on increasing self-reported PA and cardio-respiratory fitness at 12 months.<br>The effectiveness of interventions supported by moderate-high quality studies. |
| Kodama et al (2012) | Using the Internet had a modest but significant additional weight-loss effect compared with non-Web user control groups. |
| Levine et al (2014) | Technology-assisted weight loss interventions compare favourably to other modalities.<br>Twelve (75%) interventions achieved weight loss (range: 0.08–5.4 kg) compared to controls, while 5%–45% of patients lost at least 5% of baseline weight. |
| Lustria et al (2013) | Tailored websites and programs more effective.<br>Targeting general populations more effective than specific groups. |
| Pal et al (2013) | Small effect of BG control, with a larger effect in the mobile phone group.<br>Little evidence for improving depression, health-related QoL, or weight. |
| Pareira et al (2015) | Effective at improving BG control and diabetes knowledge compared with UC.<br>Interventions with a human element seen as more attractive to users. |
| Pietrzak et al (2014) | Majority of studies reported improvement in blood pressure and HbA1c in patients with T2DM.<br>Fewer CVD events and lower weight, improved lipid profile, eating habits, increased physical activity. |
| Ramadas et al (2011) | Goal-setting, personalised coaching, interactive feedback, online peer supports all successful.<br>Strong theoretical basis, longer intervention duration increased success, i.e., only relatively longer studies (12 weeks) reported positive findings. |
| Reed et al (2012) | Computer group lost significantly more weight.<br>Substitution studies: no difference between intervention and control. |
| Seo et al (2015) | Internet-based interventions showed a significant reduction in waist circumference. |
| Taylor et al (2017) | In joint results, Internet programmes that were interactive and tailored to individual responses led to higher quit rates than usual care or written self- |

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| | help at six months or longer. |
| Van Vugt et al (2013) | Nine saw improvements in depression, diabetes distress, well-being, self-efficacy, stress, communication.<br>Seven grounded in theoretical model; self-regulation theory, social learning theory most common. |
| Vegting et al (2013) | Four had a significant difference in BMI/weight; 2 had a significant difference in SBP; 2 had a significant difference in DBP.<br>Multiple modifiable lifestyle behaviours. Internet interventions in primary or secondary care not superior to UC for CVD risk factors. |
| Yu et al (2012) | Few tools met criteria for effectiveness, usability, usefulness, and sustainability.<br>Need to identify strategies to minimize website attrition and enable patients and clinicians to make informed decisions about website choice. |

## 4.6 RQ5: How did the systematic reviews measure the effectiveness of the various health behaviour interventions?

The outcome measures of individual reviews were demonstrated in Table 6.

Table 6 Outcome Measures

| Author (Year) | Outcome Measures |
|---|---|
| Aneni et al (2014) | Increased physical activity, Weight/BMI/Body fat reduction, blood pressure reduction, improvement in diet, smoking cessation |
| Angeles et al (2011) | HbA1c and LDL-C |
| Foster et al (2013) | Self-reported PA, cardio-respiratory fitness |
| Kodama et al (2012) | Weight loss |
| Levine et al (2014) | Weight loss |
| Lustria et al (2013) | Weight/BMI reduction, smoking cessation |
| Pal et al (2013) | HbA1c, blood pressure, weight loss |
| Pareira et al (2015) | FPG, HbA1c and glycemic control measures |
| Pietrzak et al (2014) | Weight/BMI/Body fat reduction, HDL, LDL, blood pressure |
| Ramadas et al (2011) | HbA1c, FBG, 2HPPT, total cholesterol |
| Reed et al (2012) | Weight loss, BMI |
| Seo et al (2015) | Waist circumference |
| Taylor et al (2017) | Prolonged self-reported and biochemically validated smoking abstinence in the past 3 months, smoking status and glycosylated haemoglobin levels after certain periods |

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| Van Vugt et al (2013) | Weight/BMI reduction, smoking cessation |
| Vegting et al (2013) | Weight loss, cardiovascular disease risk management, hypertension control, blood pressure, diabetes management |
| Yu et al (2012) | HbA1c, weight loss/BMI, waist circumference, body-fat percentage, quality of life |

## 4.7 RQ6: What are the factors can be associated with success as reported in reviews if any?

There were parallels found in the outcomes of the reviews.

The findings are discussed in detail in the respective sections within the Discussion chapter.

## 4.8 RQ7: What health targets were affected by the effective web and computer-based interventions as reported in reviews if any?

### 4.8.1 Blood pressure

Four of the investigated reviews contain studies that include web- or computer-based interventions on blood pressure. There is no study solely focused on the adjustment of blood pressure per se, yet it was included in the reviews as one subcategory of a larger one, for instance under the title of “CVD / T2DM risk factors”.

Aneni et al. [27] reported that more studies showed no effect on blood pressure than the ones with significant blood pressure reduction. Five of their seven high-quality studies did not find a significant effect of the intervention on blood pressure while the results of other two indicated a statistically significant reduction in blood pressure. Thus, they inferred that general web-based wellbeing interventions (multi-hit programs) may not be viable at BP lessening and that there is deficient proof to finish up for or against web-based intercessions focused at people with hoisted BP/hypertension. Vegting et al [40] found that two of their included studies were relatively successful in clinically significant blood pressure reduction through the important program. Significantly though, both studies used internet interventions as an addition to their usual care instead of a replacement. Interventions of the investigated studies of Pal et al. [33] focused on a touch-screen utilising computer-based technology. In their indirect approach, the studies

aimed to adjust blood pressure through increasing physical activity, however there found to be no significant effect. On the other hand, as they stated in their review, two other studies used different intervention tools such as a pager and a mobile phone that resulted in statistically significant blood pressure reduction. According to Pietrzak et al. [35] the majority of studies that they included stated that there are clinically important improvements in blood pressure observed in their patients, yet the success rates were remarkably reliant to the population target. They observed blood pressure levels to decrease in almost all the studies targeting the populaces with T2DM. In contrary, the interventions on patients who were diagnosed with CVD the results were inconsistent, with half of the studies showing an improvement and half showing no change.

The studies Aneni et al. included reported no intervention effect on blood pressure were conducted amongst at-risk of elevated blood pressure populations. However, only a single report was focused on people who were hypertensive and indicated a clinically important reduction in blood pressure. Population target played a significant role in Pietrzak et al.'s review as their success rates were highly dependent on the characteristics of the population. They observed positive impacts only when the interventions were on patients who were diagnosed with T2DM.

### 4.8.2 Physical activity

Six investigated reviews contain studies that include web- or computer-based interventions on physical activity. Aneni et al [27] found that only one study demonstrated significant intervention effect on physical activity. (Moderate exercises of 30 mins/day on 5 or more days a week observed more in the intervention group with 10% margin.) Only two studies found an improvement in the physical activity levels (by the outcome measure being a number of people completing 10000 steps per day with the help from the pedometers, websites, e-journaling and social support through their online networks) although the quality of the studies was assessed to be low. While Aneni et al. [27]'s conclusions suggest the interventions on physical activity show no significant effect, the other reviewers' inputs create a dispute in this regard with possible reasons which are going to be discussed further in this work.

Pietrzak et al. [35]'s outcomes contain combined interventions of multiple tools with 5 out of 23 studies including physical activity interventions. 2 of these interventions demonstrated that there is moderate to high effect of interventions by evaluating blood-

lipid profile, weekly physical activities and self-reported (self-reporting was conducted through a questionnaire) exercise capacity which is also assessed by a treadmill exercise stress whereas the 3 of them did not consider physical activity as an outcome measure yet concluded that overall CVD factors were observed to be decreased judging by decreased number of cardiovascular events. The interventions on physical exercises consist of exercise tasks with heart-rate monitoring, data monitoring of risk factors and 1-to-1 communications with healthcare professionals, i.e. a nurse, an exercise specialist or a dietitian. Even though Pietrzak et al.'s conclusions do not categorically confront Aneni et al.'s as they lack assessing the quality of the two studies that showed a positive impact on physical activity, Foster et al. [29] has conclusions that found consistent supportive effectiveness evidence for physical activity through remote and web interventions. The quality assessment of the studies were found to be moderate to high. These positive, moderate sized effects were assessed by self-reported physical activity levels and measured cardio-respiratory fitness.

Regarding the properties of the successful interventions, Van Vugt et al [39] reports that the interventions that include tailored, supportive and motivational elements such as goal setting with personalised feedback, barrier identification and problem solving, personalised self-management coach who adjusts the physical activity programme based on participants' assessed motivational stage and web-based activity counselling were to be found the most effective. Similarly, Foster et al. [29] demonstrated that interventions that applied tailored approach according to the type of physical activity and flexible physical activity programmes with support and feedback from exercise coaches and health professionals via telephone were to be found the most potent interventions. What is more, this is not the only review that came to similar conclusions. Lustria et al. [32] also found out that the interventions that are web-based and tailored tend to be more successful than the standard interventions in achieving behavioural outcomes. Amongst their selected studies, the most frequently studied behaviour was physical activity (by being 42% of all behaviours). Besides being tailored, Lustria et al, found that web-based interventions have been most successful when the target of the studies are towards general population rather than any age- or illness-specific groups. Lustria et al. also brought about a different aspect of the interventions which is the location characteristics: these web-based, tailored, general population targeted interventions were described to be more effective when conducted in the United States comparing to

the study's results originated elsewhere. Another significant finding from the same study is about using single vs multiple factors in health behaviour interventions. The studies that targeted single health behaviours were shown to be less successful comparing to those targeting multiple health behaviours.

As tailoring programmes and personalising feedbacks seem to be key to increased effectiveness, Lustria et al. provide data concerning the tailoring strategies. One significant finding was that frequency of tailoring assessments not having a leading role in intervention efficacy. Likewise, with the aim of improving intervention efficiency, an additional support from health experts found to be just as effective when there is less expert input. That is to say, web-based tailored interventions for self-management can also be useful when there is lack of expert feedback readily available.

### 4.8.3 Diet

Reviews varied greatly over the outcome measures for diet. Only one review that was included in this review, Aneni et al [27], examined the dietary outcomes and the others included diet into various measures, most commonly as a joint intervention effect with physical activity interventions. Nevertheless, according to Aneni et al.'s findings, out of nine high-quality studies, five studies found no improvements in any dietary outcome where four studies demonstrated significant effects on nutrition. As stated in their study, the ones that reported positive outcome were assessed by diverse measures, such as self-efficacy and healthy diet attitude were considered for one study (Bennett et al. [42]) whereas for another study (Papadaki et al. [43]) the measures differed to be a greater intake of fruits, nuts and seeds. Furthermore, another reported study [44] adopted lower protein and sodium intake as their outcome measure for dietary interventions. This diversity in outcome measures was dictated by different aims in the individual studies which make decisive conclusions about the efficacy of Internet-based interventions through the internet on improving diet difficult to make.

Another review [45] contributing to this regard found small intervention effect of workplace wellness programs on diet, although there was not sufficient evidence to comment on the long-term effects of the interventions on dietary outcomes.

### 4.8.4 Smoking cessation

Smoking cessation was directly targeted in the studies included by two of the reviews. One review, Aneni et al [27] showed no effect in one study and positive improvements in internet interventions in three of their reviewed studies although the studies were of low quality. As a result, they concluded that there were too few high-quality studies to take into account to advocate that the internet interventions had any effect on the outcomes. On the other hand, another review, Taylor et al. [26] that solely focused on the smoking cessation as a health behaviour target and provided more comprehensive outcomes. On the review, the authors suggested to categorise the interventions into three main groups based on the characteristics of the interventions that are 1) interactive and tailored interventions 2) non-tailored and interactive interventions 3) internet interventions and additional behavioural support. The review also reported a wide range of internet interventions differing in intensity and levels of tailoring from a list of informative websites to the interventions with the supplementary internet, e-mail, and mobile phone components and from bulletin internet forums to high-depth personal stories and recommendations, respectively. The review has a greater coverage with 67 included studies, producing data from more than 110,000 participants, of whom 45,194 are included in the study. It has been suggested that compared to usual care or printed self-help, internet interventions had a relative effectiveness when they are tailored and interactive even though the reviewed studies suffered from the risk of bias and statistical heterogeneity. When the interventions are still interactive but not tailored, the outcomes became insignificant compared to the controls. This is a supporting evidence for the significance of tailored internet interventions produce. The studies also compared the effect of internet interventions and additional behavioural support to control groups. There has been no intervention effect to be found where the risk of bias was negligible.

Given the circumstances, smoking interventions seem to be of slightly more effectiveness than usual care, or printed self-help at six months and longer only when their features include being tailored and interactive. The negative outcomes from Aneni et al. [27] might be resulted from the selection of low-quality studies as they stated in their review. Taylor et al [26]’s outcomes seem to be more compelling considering the greater scope and fewer reported low-quality studies.

### 4.8.5 Weight loss

Six of the selected reviews employed losing weight as an element. Overall results indicated following findings: Aneni et al. [27] reported improvements from equal number of none and of to some degree; Kodama et al [30] indicated that the effect of internet interventions on weight loss is statistically relevant; Reed et al. [37] found that success factors for weight-loss are associated with long-term behaviour change, as in forming new habits such as changing the diet to low calorie and fat intake, engaging in physical activities more actively and also self-monitoring of weight. It is demonstrated in their study that the effects of internet interventions are only conditionally effective, that is to say addition of computer-based interventions produced better results than substitution with computer-based interventions; Levine et al. [31] utilised technology in a wider term (by employing web-based applications (63 %), clinician-guiding software (44 %), kiosks (19 %), home PCs (13 %), mobile applications (6 %), and short message services (SMS, “texting”)(6%) as their technology modality) in primary care settings. Their results principally supported the evidence from previously mentioned studies by suggesting technology assistance in primary care can help patients to achieve significant weight loss, by demonstrating that most of their selected technology-assisted interventions (12/16, 75 %) in the primary care setting help patients to achieve significant weight loss. In other words, technology can supplement and enhance the work of the primary care providers for weight loss outcomes. Vegting et al. [40] demonstrated that in three of their studies there found to be significantly reduced weight in the internet intervention group. Pietrzak et al. [35] contain four studies that included weight parameters but only two of them showed effectiveness, one is in the form of weight-loss, the other is as a decreased body mass index.

The degree of the effectiveness of internet interventions on weight change under certain conditions remains modest, however, as Kodama et al. found that they were less effective than the use of anti-obesity drugs. (These conditions will be discussed under the relevant section.) This verdict shows parallels to a previous review conducted by Benedict and Arterburn [46] who concluded that these programs have modest short-term improvements in body weight.

Including the internet component to weight loss interventions were shown to be beneficial under certain conditions. The period of their use, the way of usage of the

Internet, replacing face-to-face treatments with internet interventions or supporting the conventional methods with the use of the internet, the presence of social support and its impact on patients' quit rates all seem to have played significant roles in the effectiveness of the interventions. These will be discussed further in this review under respective section.

### 4.8.6 Self-Management of T2DM

Five of the investigated reviews contain studies that include web- or computer-based interventions on self-management of T2DM.

Angeles et al [28] focused on the education of patients with diabetes with respect to glucose control using web services. Their review showed that web-based tools were better than usual care in improving HbA1C and LDL-C levels. Where Pal et al [33] demonstrated a small beneficial effect from computer-based interventions on blood glucose levels control. They also were not able to conclude any other biologically, behaviorally, cognitively, or emotionally positive outcomes. Like Angeles et al., Pareira et al. [10] also mainly focused on the educational aspect of T2DM self-management. They compared Internet-based interventions with usual care and printed written interventions and concluded that all internet-based interventions were more effective in terms of better knowledge and glycemic control. Furthermore, Ramadas et al. [36] had multiple focus points and demonstrated that goal-setting, personalised coaching, interactive feedback, and online peer support groups were some of the most successful modalities concerning self-management of T2DM. It is also demonstrated that interventions containing self-monitoring producing particularly better results. Van Vugt et al. [39]'s focus was mainly on behaviour change techniques. As a consequence, despite the fact that only a relatively small number of theory-based online self-management support programs for T2DM being used, these techniques were found to be associated with positive outcomes for health behaviour change, psychological well-being, or clinical parameters.

# 5 Discussion

This umbrella review took on seventeen reviews that included more than two hundred different studies. Each study has their own objectives, study designs, set of intervention tools and numerous influencers. Yet, still parallels can be drawn, and the overall results can be analysed as it is aimed in this section.

### 5.1.1 Internet as a supplementary tool vs Internet as a substituent tool

There are consistent evidence supporting that replacing internet with face-to-face interventions resulting in less effective outcomes. With their aim being weight loss, Levine et al. [31] found that 86% and 85% of the internet interventions that employed clinician-guiding software and feedback from a healthcare provider showed significant weight loss. This is better demonstrated in comparison with only 33% of the fully-automated (without a human intervention) interventions showing a significant effect. Similar to this, Kodama et al. [30] reasoned for their modest weight-loss effects with those using the internet as a substitute for face-to-face support after their stratified analysis. Another finding from the same source is another emphasis on the increased weight loss effect of web-based programs when they are combined with face-to-face support. Reed et al. [37] support these evidences. Their study compares the interventions where the computer-based elements were added as addition with the ones where computer-based elements were substituted to standard weight-loss interventions. The results on the effectiveness were found to be favouring the use of computers as additional elements.

These outcomes propose that an in-person contact approach is better than the only technology-based approach from the perspective of the weight reduction measures; if utilized, a Web program needs to incorporate the segment of an up close and personal program for members to accomplish weight reduction. In other words, technology can not completely supplant human interactions provided by healthcare professionals. But from the viewpoint of time-saving and cost-decreasing, the focus should be on appropriate combinations of in-person and web- or computer-based support.

### 5.1.2 Health professional supported vs Self-managed

There are coherent evidence from two reviews. One being Lustria et al. [32] claiming that self-managing of health interventions requires more long-term determination and more active engagement, therefore, the results can be shaped by the motivations of individual patients. However, feedbacks and guidance from healthcare professionals direct the patients, renew their drive and increase the yielded results. In the same light, Ramadas et al. [36] emphasized the importance of programme compliance and deduced the same verdict, i.e. presence of a healthcare provider strengthens the intervention programme through increasing compliance.

### 5.1.3 Standardised vs Tailored

There are consistent evidence in favour of tailored interventions yielding better results. It is important to note that despite the fact that the reviews have various health behaviour focuses, the ones that included tailored and non-tailored interventions all found out tailored to be more effective. Lustria et al. [32] found out that the interventions that are web-based and tailored tend to be more successful than the standard interventions in achieving behavioural outcomes. Likewise, Taylor et al. [26] also concluded that compared to usual care or printed self-help, internet interventions had a relative smoking cessation effectiveness when they are tailored and interactive. Same outcomes were deduced from Foster et al. [29] as well, as they demonstrated that interventions that applied tailored approach according to the type of physical activity and flexible physical activity programmes with support and feedback from exercise coaches and health professionals via telephone were to be found the most potent interventions. Being parallel to the previous results, Van Vugt et al [39] also reports that the interventions that include tailored, supportive, and motivational elements such as goal setting with personalised feedback was found to be more effective than the ones without personalised elements. On the educational aspect, Pareira et al. [34] back the personalisation approach in also educational tools. As they advocate, tailored educational tools would provide the ability to individually clarify and customise the education needs of the patient. According to the amount and type of education suitable for patient’s needs the education content would be designed to be more dynamic, therefore possibly maintain the patients’ interests in learning about the new topic for long periods of time.

These outcomes suggest that instead of using standardised approaches, tailored and highly personalised intervention designs potentially have higher effectiveness.

### 5.1.4 Using computers and internet as the only tool vs Additional technologies

The evidence suggesting using only computers and/or internet as a sole tool having limited effectiveness comparing to interventions employing also portable electronic devices and new applications are noteworthy. Reed et al. [37] found that utilising a variety of modalities besides computer interventions, such as smartphones, social networking sites or smartphone applications have the potential to add additional capabilities. Similarly, focusing on blood pressure control, Pal et al. [33] suggest that improving blood pressure requires more frequent interactions and helps increase adherence to medication. In addition, as Angeles et al. [28]'s findings indicate, combining computer and mobile-phone interventions of web tools might be more effective rather than using computer-based delivery tools alone. Besides mobile phones, according to Aneni et al [27], having another environmental component in several of the studies was found to be more effective than having only web-based components. For instance, in one of their studies, (Watson et al. [47]) showed a clinically critical decrease in BP utilizing a program that had web-based reminders yet, in addition, made BP estimating machines accessible in the work environment. Agreeing with this, Ramadas et al [36] advocated that the utilization of other technology, for example, the cell phones were likewise observed to be an essential part of effective interventions.

Ramadas et al. advocated the use of other technologies such as the mobile phones has been proven to increase effectiveness through improving programme compliance with the internet interventions. Success rates being in compliance with programme adherence is a compelling argument. In the same light, Vegting et al. [2] supports this by demonstrating that in one of their included studies aiming to increase programme adherence by giving a choice to their users of their health behaviour targets, internet login frequencies of users who has chosen their targets increase comparing to the ones who received standard targets.

### 5.1.5 Other notes

There are several contributors to the outcomes of the studies that need to be mentioned. Some might play a negative role as in creating false negatives or contaminators to the

study whereas some of them might go undetected with the lack of further isolationist studies.

#### 5.1.5.1 Population targets

In some studies, designated population targets played a definitive role. For instance, Pietrzak et al. [35] which has adopted reducing blood pressure levels as one of their main focuses, found that the interventions that have a positive impact on T2DM patient did not show the same effects on CVD patients. They concluded that the absence of impact of the interventions on blood pressure may have been resulted because of the way that, in patients with CVD, the blood pressure was at that point all around controlled by medication. This exemplifies the requirement of meticulous consideration of various conditions during the study design and analyses of the results.

In other studies, regarding the population targets, the focus was more on the accessibility issues. In Lustria et al. [32], the interventions were widely preventative therefore they were not particularly applied to special groups. As the internet is a host of various multimedia elements, the patients who suffer from certain conditions (such as visual, mobile or mental disabilities that affect making use of computers or the internet) that make it physically, emotionally and mentally difficult for their engagement in the studies. These sorts of limitations should also be considered in the study design process if the intervention group includes individuals as such.

Another point of significance is that besides analysing the results of general populations, specific patient groups categorised according to their ages, sexes, individual internet affinities and so on can be helpful to explore the context as to which web-based tools can be the most effective.

The outcomes of the same interventions can also be differed based on the target country and the local culture study was set. Lustria et al. [32] found exemplary contradictory outcomes for the same interventions i.e. the web-based interventions were more successful compared with those conducted elsewhere. They speculated that "individualism-collectivism, in addition to other cultural-related constructs" playing a significant role in patients' individual health choices.

#### 5.1.5.2 Web utilisation

Studies with internet-based intervention elements realised their tools in numerous ways. (As portrayed in Table 5) Internet employs various elements because of its multimedia nature. Inefficient utilisation can be caused by insufficient user interface practices, using outdated technologies or design problems. [48] This can also cause suboptimal outcomes. Levine et al. [31] advocate poor web utilisation was common amongst their web-based intervention studies. Kodama et al [30] also found strong associations between the effect and the usage of the internet. These findings suggest that utilisation of websites require attention to serve patients' characteristics and usability rules.

#### 5.1.5.3 Long-term effects

The long-term effects of the interventions should be analysed based on the aim of the health target.

##### 5.1.5.3.1 Weight loss

Reed et al. [37] found that around 20% of overweight or obese adults could accomplish and maintain long-term weight reduction for at least 12 months. However, Levine et al. [31] reported that only 25% of the studies lasted more than 1 year, therefore, definitive outcomes are lacking. There is a need for long-term interventions or follow-up post intervention greater than 1 year.

##### 5.1.5.3.2 Smoking cessation

Taylor et al. [26] included no studies longer than 12-months, therefore, it prevents any conclusive inferences for the effectiveness of longer-term smoking cessation interventions.

##### 5.1.5.3.3 Self-management

Pal et al [33] reported lack of longer-term studies or follow-ups to determine the long-term impact on health outcomes of the interventions and look for evidence of harm. Aneni et al. [27] also refer to being unable to confirm that internet-based studies are minimally effective in the long term as there is not enough evidence.

#### 5.1.5.3.4 Physical activity

Foster et al. [29] claim to have more research to establish which exercise methods promotion encourage specific groups of people to be more physically active in the long term.

Overall, there are several reviews lacking follow-up studies longer than 1-year to conclude the sustainability of the intervention effects and possible long-term drawbacks.

## 5.2 Limitations of the study

Despite the rigorous attempts to single out every review in the scope, our study is not free from limitations. Primarily, there are the inherent time and human resources restraints for a study of this level. This limitation plays a limiting role during the literature search procedure. Even though the literature search was conducted in a meticulous manner, it is still possible that some relevant articles were missed or that publication bias led to underreporting of data concerning our question. The publication bias may have led to other types of interventions being existed but having not been submitted or accepted for publication.

## 5.3 Further work and recommendations

The effect of web-based interventions in the long-term could not be measured as the vast majority of the reviews were unable to reach to conclusive suppositions as their incorporated studies had moderately short follow-up periods with the insufficient amount for one year or longer.

Quality assessments were not conducted in every review for the selected studies. More high–quality internet-based intervention studies in both special risk groups and age, gender or internet affinity-based target groups need to be conducted to determine their utility and value in these populations.

Many interventions included components that would come with certain financial challenges. Therefore, further investigation would be needed to study the cost-effectiveness of the interventions. This aspect would put the intervention in financial perspective for practical reasons.

# 6 Conclusions

This study is attempting to review all the reviews done on the web and computer-based lifestyle interventions in order to prevent and manage T2DM and CVD. Methodological classification of this work is umbrella review.

This summary is made with caution since, as mentioned in the previous sections, there exist wide differences in study design, outcome measures, population targets and duration of follow-up in studies included by the reviewers. This divergence of factors may have made it more difficult to come to conclusions to indicate certain convictions as to the effectiveness of a particular intervention. The outcomes deduced from the reviews were discussed in respective sections for a clearer idea.

Nevertheless, rather than questioning a specific internet intervention's efficacy on the selected target diseases in a broad term and having to make vague and most probably misleading generalisations, it would lead to more enlightening outcomes to suggest drawing attention to main parallels drawn in the discussion section in this study. Such as the knowledge of health behaviour programmes that include tailored, interactive computer and internet interventions elements with assistance, motivation and guidance from health care providers having clear evidence over their alternatives might possibly yielding more desired health outcomes being more informative input for the future initiatives.

Internet and web-based interventions on prevention and management of diseases is a relatively new practice. Still, there are extremely varied ways to utilise such interventions for the desired health outcome. As exemplified in this study, not only the study designs that accommodate the interventions determine the outcomes, but also the target population, specific needs and characteristics of diseases and individual differences all play a role in seemingly positive or negative outcomes. In future, these reviews and analysis might help future researchers and entrepreneurs to perfect their study designs and products.

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