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Master Thesis Health Sciences

Qualitative research into the requirements of a coaching technology for diabetes type 2 patients to motivate them into exercise and nutritional (lifestyle) changes.

Author: M.H.T. Lankheet (s1467557)

University of Twente
Ziekenhuis Groep Twente

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General information

Author: M.H.T. Lankheet
Student number: s1467557
E-mail: m.h.t.lankheet@student.utwente.nl
Date: 14-07-2017

University of Twente

Faculty: Science and Technology Faculty (TNW)
Study direction: Health Sciences
Master track: human centered eHealth and healthcare services design (eHealth)
Address: Drienerlolaan 5, 7522NB Enschede

Supervisors

Supervision University of Twente:
1st supervisor: Prof. dr. M. Vollenbroek
2nd supervisor: Dr. C. Bode
Supervision Ziekenhuis Groep Twente:
1st supervisor: Dr. G. Laverman
2nd supervisor: C. Gant

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ABSTRACT

Objective. Exercise and nutrition, combined also called lifestyle, are important factors in diabetes type 2. A proper lifestyle can improve blood glucose levels and decrease the chance of complications related to diabetes. Self-management is important in diabetes type 2 patients, as the patients can positively influence their illness by healthy lifestyle choices. Within self-management, self-efficacy determines how patients act upon their illness. Coaching can create awareness among patients, hereby motivating them on the subject of their diabetes and lifestyle choices. Technology is assumed to play an important part in coaching diabetes type 2 patients, though technologies developed in previous research did not lead to long-term success. This research aims to determine the awareness, self-management and motivation of diabetes type 2 patients to change their lifestyle, in order to explore the requirements for a technology to support patients into healthy lifestyle choices.

Methods. A qualitative research was conducted using questionnaires and interviews with 19 diabetes type 2 patients of the outpatient clinic of Internal Medicine / Nephrology in ZGT Almelo. The questionnaires were aimed at determining the awareness of diabetes type 2 patients on the subject of healthy lifestyle and their illness. The interviews focussed on self-management and motivation of diabetes type 2 patients to change their lifestyle and examined the requirements for the use of a future coaching technology to support healthy lifestyle choices.

Results. Of the 19 respondents who participated in this research, 12 were male and 7 were female. A minority of the respondents, 7 respondents in total, scored more than half of the questions of the questionnaire correctly, which is in this research linked to a sufficient awareness score. Most respondents did not have the supposed knowledge on how exercise and nutrition influence their diabetes. Despite this lack of awareness, respondents were positive about their self-management capabilities, autonomy and caregiver support and had a positive perception of their self-efficacy. Regarding motivation to change lifestyle, patients mentioned to be motivated to change nutrition and exercise in order to improve their diabetes outcomes and personal well-being. However, patients were only intrinsically motivated to change lifestyle for direct improvements, for instance a direct decrease in blood glucose levels. Respondents illustrated different functionalities for a future coaching technology, in which continuous blood glucose monitoring, information about exercise and nutrition and the provision of warnings based on their blood glucose levels were mostly mentioned.

Conclusion. Based on the results of this research, a future coaching technology should aim to improve the awareness of diabetes type 2 patients, by providing knowledge about the diabetes and diabetes related lifestyle choices. Due to this, the self-management capabilities and motivation of patients will be increased, which should support their healthy lifestyle choices. The coaching provided by the technology should be personalised and aimed at the patient's individual capabilities, needs and goals.

Keywords. Diabetes type 2, patients, coaching, technology, eHealth, motivation, self-management, awareness, support.

INTRODUCTION

Diabetes type 2

More than 1.000.000 people in the Netherlands are diagnosed with diabetes mellitus, from here on referred to as diabetes[1]. Of which, 100.000 have diabetes type 1 and 900.000 have diabetes type 2[1]. It is expected that approximately 1.300.000 people will be diagnosed with diabetes in 2025[1].

Patients with diabetes face lifelong treatment and lifestyle adjustments[2]. Especially in patients with diabetes type 2, in which overweight, unhealthy nutritional habits, and lack of physical activity are important factors for complicating the diabetes[3]. Diabetes type 2 can in first instance be treated by increasing physical activity and a specific diet, though in most patients glucose lowering medicine and insulin is necessary[4].

Exercise and nutritional habits, combined also called lifestyle, are important factors in diabetes type 2[5]. Not only can a healthy lifestyle improve the blood glucose levels of the patient, it can also decrease the chance of late complications, including cardiovascular diseases, retinopathy, nephropathy, and neuropathy[3]. The majority of diabetes type 2 patients is overweight, does not engage in enough physical activity and does not follow dietary guidelines provided to them[6]. Patients need to be aware of the consequences of these factors on their diabetes[7].

The importance of self-management

In a chronic illness like diabetes type 2 the need for self-management, also known as self-care, of the patient is emphasized[8]. Self-management and self-care, from here on mentioned as self-management only, are within this research defined as: “patients coping with the conditions, management, and practical issues of their illness”[9]. These issues include: dealing with problems as frustration, pain and fatigue, appropriate exercise, appropriate use of medication, communication with family, friends and health professionals, appropriate nutrition, decision making and evaluating new treatment options[10]. In this research, the cognition of the patient regarding self-management is used to determine the patient’s opinion on these issues concerning their diabetes.

An important factor in self-management is self-efficacy[9]. Self-efficacy is defined as: “people’s judgment of their own capabilities to organise and execute courses of action required to attain certain types of performance and outcomes”[9]. According to the Social Cognitive Theory of Bandura, self-efficacy determines people’s decisions and how they behave[11]. Self-efficacy thereby determines how patients act upon their illness and in what manner they self-manage actions linked to their illness[11]. Patient’s self-efficacy is reached by patients gaining confidence in their own abilities, eventually resulting in adequate self-management capabilities[12].

Researchers claim that as much as 98% of diabetes related care is self-management[9]. The self-management of a diabetes patient is linked to the patient’s health-related goals and the actions patients undertake to reach these goals. These health-related goals mainly

include: prevention of complications, maintain a good quality of life and achieve a certain sense of control over the diabetes[9].

According to a knowledge synthesis of the NIVEL, Netherlands institute for health services research, more attention has been drawn to self-management of patients over the past few years[13]. The management of diabetes type 2 involves complex decisions by patients, regarding care-related goals, self-management behaviour, and medical treatment[14]. As each patient decides differently, it is important to understand the goals and disease progress of the patients to meet their individual needs[14,15]. The so-called 'customized care' is a well-known incentive of health care providers[14]. Customized care is aimed at personalised treatment, in which the provision of care is adapted to the patient and their specific needs. In diabetes type 2 this personalised treatment could be important to improve self-management, as the individual needs need to be taken into account in order to support every patient individually[13]. By adjusting the treatment to the needs of a patient, it is most likely to improve the patients' self-management and hereby their quality of life and their illness outcomes[14].

Coaching for diabetes type 2

As an important step in improving self-management of diabetes type 2 patients, health coaching, in addition to existing diabetes care, may be of great benefit[16]. Health coaching is defined as: "the practice of health education and health promotion within a coaching context to enhance the well-being of individuals and to facilitate the achievement of their health-related goals"[17].

Previous research pointed out that health coaching can be effective when focussed on self-efficacy and self-management skills of the patient[18]. However, there is not much information, or evidence based research, about diabetes-specific health coaching for improvement of self-management and the design of this health coaching[19]. It is also not known how diabetes type 2 patients estimate their own capabilities of improving their self-management.

Coaching related elements

It is necessary for diabetes type 2 patients to have knowledge of the possible benefits of exercise and nutritional changes, in which health coaching can be important[7]. If patients know the possible benefits of these lifestyle changes, they can create awareness on the subject of their illness and with the proper motivation they can act upon these benefits[7]. Awareness and motivation are important elements to determine health coaching opportunities.

Awareness is hereby defined as: "knowledge of a person of a certain situation or fact"[7]. So, the awareness of diabetes type 2 patients includes the knowledge of a patient of the possible effects of lifestyle changes on their diabetes outcomes. According to previous research, patients' awareness on diabetes is low and action is required to raise this patient awareness and improve self-management[20]. However, no specific information is known

about the knowledge of diabetes type 2 patients on diabetes related items. It needs to be determined on what items diabetes type 2 patients lack knowledge, in order to draw conclusions on how to deal with this low awareness. Besides this awareness, patients must have the motivation to deal with the information on self-management issues and possible lifestyle changes, provided to them within health coaching, to be able to improve their diabetes outcomes[7].

Motivation into lifestyle changes

As coaching into lifestyle changes for diabetes type 2 patients is important, it is also the most challenging aspect of the self-management of diabetes to motivate patients into these lifestyle changes[21]. Patients are different in the way their illness progresses and need different motivation[5]. Certain types of coaching are therefore only effective for certain types of patients, again referring to the personalised treatment introduced earlier[13,22]. According to the Social Cognitive Theory, the proper motivation can increase the self-efficacy of the patients and improve their health outcomes[11].

But, how to motivate a diabetes patient? The Self-Determination Theory (SDT) of Deci and Ryan is a theory of human motivation and personality in social contexts[23]. The SDT assumes three basic needs: competence, relatedness and autonomy[24]. Competence includes the feeling of effectiveness of a person, and the ability of using one's capacities. Relatedness concerns the feeling of connectedness to other persons, and the feeling of being cared of. The final need of autonomy includes the perception of people to determine their own behaviour. So, the SDT determines the motivation of people[24].

Motivation is divided into different dimensions, mainly focussed on outcome-focussed motivation and process-focused motivation[25]. In outcome-focussed motivation the patient is motivated into completing a goal, which is motivation from the outside in which the behaviour is aimed at a reward. This type of motivation is also known as extrinsic motivation. In process-focussed motivation the patient is motivated to attend the different elements of the process to reach a goal and is motivated from the inside, in which the satisfaction lies in the behaviour itself[25]. This type is also known as intrinsic motivation.

Although different theories exist aiming at patient motivation and patient coaching, the SDT can be seen as a 'main' theory, which is reflected and cited in many other theories and studies[23]. The SDT can be used to determine patient motivation in their diabetes self-management. Both the Theory of Change and the Social Cognitive Theory add other important elements of motivation to the SDT. The Theory of Change of Weiss et al. focusses on long-term goals that patients set for an illness like diabetes and the steps that need to be taken to reach these goals[26]. The Social Cognitive Theory uses three core concepts to determine human behaviour, in which personal, behavioural and environmental influences effect a patient's behaviour[11].

The theories mentioned above, other supporting theories and previous studies on coaching and motivation are further explained in Appendix I and II. All theories and previous studies aim at improving the patient's self-management abilities by coaching and

motivation. The theories mentioned above are used as a starting point for this research, in which the other theories and studies are used for additional information.

Coaching interventions and technologies

Many of the previous studies pointed out the potential effects of coaching interventions on both exercise and nutrition change on the health outcomes of diabetes type 2 patients and other chronic illnesses. The use of technologies to deliver these interventions is often seen in the most recent studies, as technologies and self-management form a promising combination[12]. In these studies the so-called eHealth systems are introduced[12]. eHealth is defined as: "health and information services that are delivered or improved by using the Internet and other related information technologies"[27]. eHealth interventions provide promising opportunities to support the self-management of diabetes type 2 patients[28]. eHealth interventions include for instance: digital information provision, online therapy, digital reinforcement, e-consultation, self-monitoring and online patient-to-patient communities[12].

However, the effects of previous studies on eHealth on patient outcomes are mixed. Some interventions including coaching lead to improvement, where other interventions fail to improve the self-management of patients on the long term[12]. The reason for success of one intervention and failure of the other remains unclear[8]. It is not known why previous technologies aiming at lifestyle changes for diabetes type 2 patients did not lead to permanent use and resulted in failures[15]. Most studies seem to forget that eHealth cannot be seen as an independent form of care giving, but only as an addition to usual care in order to improve patient's self-management[12].

Most technologies aiming at lifestyle changes used mobile eHealth interventions, in which patients received feedback on for instance their blood glucose levels, medication or pedometer data. Yet none of these technologies seem to have led to long-term usage. It is known from previous research that long-term changes in nutrition and exercise are difficult to maintain for most diabetes type 2 patients[29]. This, combined with the low awareness measured in diabetes type 2 patients in previous research, implicates that diabetes type 2 patients are a difficult target group to coach into lifestyle changes[20]. Due to the difficulty of this target group, it is hard for technologies to increase patient's motivation into lifestyle changes, even though it is known that technology based coaching can indeed improve nutrition and activity in chronically ill patients[30].

It seems that besides the difficulty of the target group, the developed technologies do not use the appropriate requirements, regarding the diabetes type 2 patients and their specific self-management capabilities[31]. Requirements are defined as: "the foundation of the technology design", as they describe what a technology should do, display and provide[32]. The long-term usage of a technology can turn out disappointing, if requirements are not designed based on the user's expectations[32]. A systematic review concerning multiple eHealth technologies for diabetes self-management concluded that the usability and functionality requirements of these technologies were generally limited[31]. The technologies

were for instance not adapted to the blood glucose measurement times of diabetics before eating, were only available in English or had difficulties with entering and adjusting data of for instance blood glucose values.

In conclusion, adequate requirements form the foundation of a coaching technology supporting diabetes type 2 patients into lifestyle changes that benefit their diabetes. By intervening at the developmental stage of the requirements of a coaching technology, with information provided by the diabetes type 2 patients themselves, this research will focus on the possibilities of a certain technology and how it should be designed to actually motivate the patients into lifestyle changes.

Research aim

This research will aim at exploring the requirements of a coaching technology for diabetes type 2 patients that targets improving exercise and nutritional choices. This will be done by determining the awareness, self-management and motivation of diabetes type 2 patients. By using these results, the aim is to design the requirements of a coaching technology that can motivate diabetes type 2 patients into exercise and nutritional changes.

Research questions

In this research the following four research questions are answered.

1. What is the awareness of diabetes type 2 patients about the effect of exercise and nutritional changes on diabetes outcomes?
2. What is the self-management of diabetes type 2 patients on their illness?
3. What is the motivation of diabetes type 2 patients on exercise and nutritional changes linked to their diabetes outcomes?
4. How to design a technology that motivates diabetes type 2 patients into exercise and nutritional changes, based on the results of research question one, two, and three?

METHODS

Research subjects

This research was conducted at Ziekenhuis Groep Twente (ZGT) at Almelo during a time period of February 2017 till July 2017. Patients with diabetes type 2 visiting the outpatient clinic of Internal Medicine / Nephrology for the DIALECT study, the DIAbetes and LifEstyle Cohort Twente, were included in this research. The DIALECT study aims to investigate the effect of lifestyle habits on diabetes outcomes in diabetes type 2 patients. In the DIALECT study, diabetes type 2 patients attending the hospital for (annual) checks by the diabetes doctor or diabetes nurse are included. Inclusion criteria for the DIALECT study are: patients with diabetes type 2, aged 18 years or older, follow-up taking place in the outpatient clinic in the ZGT hospital and with written informed consent. Exclusion criteria are: patients dependent of renal dialysis, severe general disease or mental disorders making participation impossible and drug abuse. These diabetes type 2 patients are referred to the hospital by their general practitioner, in order to expand the care of their illness and improve their diabetes outcomes which the general practitioner cannot further improve. For the DIALECT study, patients attend the outpatient clinic of Internal Medicine / Nephrology two or three times, depending on the study protocol, with each appointment one week apart. All patients visiting the outpatient clinic for the DIALECT study were contacted for participation. Patients were asked to participate in this research during the first visit of the DIALECT study, or were contacted by phone, and the patients that agreed to cooperate, participated in this research during their second or third visit of the DIALECT study. During the time period set for inclusion of patients for this research, 28 patients were appropriate for inclusion. Of these 28 patients, 9 were hindered due to personal circumstances or illness. In total, 19 respondents participated in this research.

Measurements

By means of qualitative research the requirements of a coaching technology for diabetes type 2 patients were examined. Questionnaires and interviews were designed, based on previous literature on patient motivation and coaching for diabetes and other chronic illnesses.

The questionnaire focussed on the awareness of diabetes type 2 patients on the subject of their illness, also covering their opinion on self-efficacy. The questionnaire is included in Appendix III. The Social Cognitive Theory, determining people's decisions and how they behave, is used as a framework for the development of the questionnaires. The items used from the Social Cognitive Theory are: self-efficacy, health-related goals of diabetes (including prevention of complications), and patient's capabilities in handling their illness regarding their lifestyle. In addition to this Social Cognitive Theory, the Summary of Diabetes Self-Care Activities is used, as this is a self-report instrument for measuring the self-management of diabetes patients[33]. The items included of this instrument in the questionnaire are: diet, exercise, and self-management of a patient's illness. The answers of

the questions on preferred exercise and nutrition are based on guidelines of the Dutch Institute for Health and Movement. The questionnaire started with five questions regarding patient characteristics: gender, age, education, profession and social status. Additional information on complications was looked up in their electronic patient record. Items of the questionnaire concerning a five-point scale used answer categories classified as followed: none, little, neutral, reasonable and much, based on the question that was asked.

The interview aimed at the self-management and motivation of the patient and examined the possibilities for the use of technology in coaching into exercise and nutritional changes. The interview guide is included in Appendix IV. The theories used in the interview are: the Self-Determination Theory, the Theory of Change and again the social Cognitive Theory. Besides these theories, items of the different studies on coaching, motivation and self-management are used to develop the questions. The used literature is included in Appendix I and II. The items included of both the theories and the studies are: self-management, autonomy, relatedness, caregiver support, lifestyle effects, competence, overall motivation, intrinsic motivation, extrinsic motivation, diabetes goals, coaching, peer motivation, knowledge of technology, possibilities of technology and technology motivation. The self-management as it is questioned in the questionnaire and interview focussed on the cognition of the patient. That is, patients are not asked for their actual self-management, but their perception of their self-management and what they expect and know to be desirable for improvement of their diabetes.

Analysis

Questionnaire

Results of the questionnaires are analysed in Microsoft Excel. The five questions regarding patient characteristics, questions 1 to 5, were rated in numbers and percentages per category. The other questions using a five-point scale were analysed by scoring the most negative rate with a -2, the lesser negative one a -1, neutral answers with a 0, a positive rate with a 1, and the most positive answer with 2 points.

In order to evaluate respondents on their awareness, the knowledge questions of the questionnaire were rated, resulting in a personal awareness score. Questions number 6, 7, 8, 9, 10, 11, 15, 17, 19 and 20 cover the knowledge questions about the awareness of diabetes type 2 patients on exercise and nutrition. These questions were rated by providing points for the correct answer that is given by the respondent. For question 6 to 9, using a five point scale on exercise and nutrition, 1 point is rewarded to respondents answering that the influence of lifestyle choices on their diabetes is much, and 0.5 point is rewarded to respondents answering that the influence is reasonable. Respondents answering that the influence is only little were granted with 0 points, as are respondents who gave the answer of neutral influence. In questions 10, 11, 15, 17, 19 and 20, the correct answer is granted with 1 point and the false answer with 0 points. In question 19 particularly, covering the food types with influence on the diabetes, the answers soda, meat and alcohol were all rated with 1 point. The points rewarded to each question were summed in Microsoft Excel.

In total, respondents could gain 12 points. Respondents with more than 6 points, so choosing half of the answers correct, were regarded as aware on the subject of exercise and nutritional effects regarding their diabetes.

Question 12, 13, 14, 16 and 18 were evaluated separately, as in these questions respondents determined the self-efficacy, self-management and capabilities regarding their diabetes. On the answers of these questions, numbers and percentages per answer were calculated in Microsoft Excel. For the questions used in the rating of the awareness the numbers and percentages per question are also calculated and included in Appendix VI.

Interview

The interviews are recorded and afterwards literally transcribed in Microsoft Word. The transcribed interviews are uploaded in Atlas.ti 8.0 and coded by means of a coding scheme. One researcher coded the interviews. The coding scheme is included in Appendix V. Each code is based on the items included in the interviews, as mentioned above. For each item the codes were divided into different answer possibilities, in which patients could be either negative or positive towards an item, so that the item could be analysed based on the frequency per code. Each code is used only once per interview. Sentences corresponding with different codes were coded double, so that each of the codes is covered and with a maximum of once per respondent. When in doubt, a code was not assigned to a sentence. The option Code Document Table was used to analyse the occurrence of each of the items of the interview. This option can distinguish a selection of codes between interviews. Hereby, all items could be analysed and processed into a result on the categories of self-management, motivation and technology design. The outcomes are used to determine possible requirements for a technology for coaching of diabetes type 2 patients into lifestyle changes. This is supported by an evaluation of the outcomes of the interviews by 2 experts, one researcher and one diabetes doctor. Finally, the answers are used to draw conclusions on the self-management, motivation and technology options of the respondents.

RESULTS

Respondent characteristics

A total of 19 respondents participated in the questionnaires and interviews of this research. All respondents were patients with diabetes type 2 and visited the outpatient clinic of Internal Medicine / Nephrology for the DIALECT study. Table 1 contains the characteristics of the respondents included in this research.

Table 1. Respondent characteristics

Characteristics	**Respondents** (N = 19)
Gender – number (%)	
Male	12 (63)
Female	7 (37)
Age – average (standard deviation)	64 (11)
Educational level – number (%)	
Primary education	7 (37)
Secondary education	5 (26)
Higher education	6 (32)
Scientific education	1 (5)
Social status – number (%)	
Single	3 (16)
Married	12 (63)
Divorced / widow / widower	4 (21)
Complications – number of patients (%)	
Any type of complication	14 (74)
Macrovascular complications	5 (26)
Microvascular complications	13 (69)

Of the respondents participating in this research, 12 were male and 7 were female. The average age of the respondents was 64 years old. Most respondents had primary, secondary or higher education and were married. On the topic of complications, macrovascular complications include cardiovascular diseases, while microvascular complications include nephropathy, retinopathy and neuropathy[34]. In this respondent group a total of 14 respondents, 74%, suffered from either one or both of the two types of complications. In total, 26% of the respondents had macrovascular complications and 69% had microvascular complications.

Awareness

For the first research question, respondents were asked for their awareness and knowledge of the subject of diabetes type 2, by means of a questionnaire. Respondents were asked questions about the following items: influence of nutrition and exercise on the diabetes, complications of the diabetes, self-management of the respondent, and desirable behaviour

on exercise, nutrition and weight. First, the overall awareness of the respondents, based on the questionnaire, will be discussed, and afterwards each item will be discussed separately.

Overall awareness

The questions about the influence of nutrition, exercise and desirable behaviour on exercise, food types and weight were rated by granting points to the (correct) answers provided by the respondents. Adequate awareness of nutrition and exercise is defined as more than 6 correct answers. Figure 1 shows the number of points respondents scored based on the questionnaire. The red line shows the 6 points, which indicates that the respondents above this line have an adequate awareness.

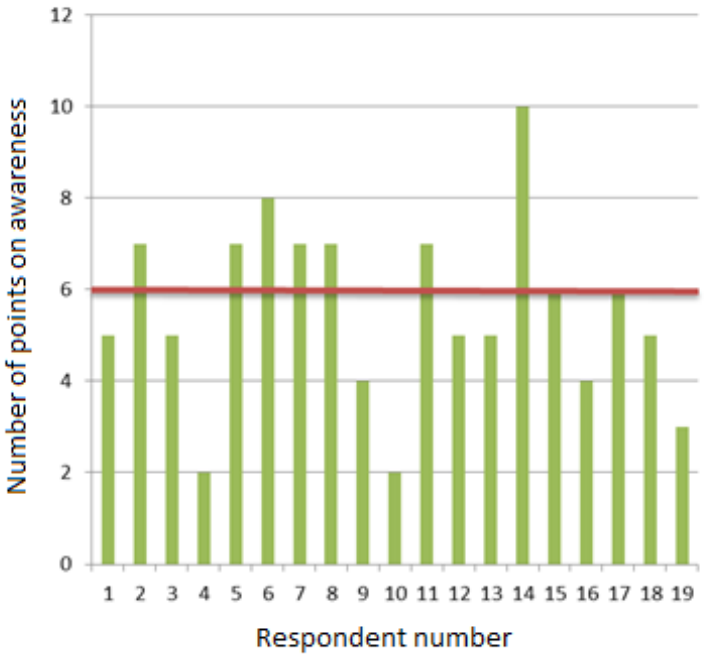

Figure 1. Awareness of respondents based on the questionnaire

As can be seen in Figure 1, a total of 7 respondents were aware of the effects of exercise and nutrition on their diabetes, as they scored the sufficient number of points on this awareness scale. None of the respondents answered all questions correctly and 2 respondents even gained a score of only 2 points.

Influence of nutrition and exercise on the diabetes

Respondents were asked for their opinion about the extent of influence of nutrition and exercise on diabetes. Respondents were asked for the influence on both the variations in their blood glucose level and on the occurrence of complications related to diabetes.

No respondent scaled the influence of both nutrition and exercise to none or little influence. 58% of the respondents indicated that nutrition has much influence on the variations in the blood glucose levels, while only 32% thought that nutrition also has this

much influence on the occurrence of complications. For the exercise this was even less. Only 42% of the respondents indicated that exercise has much influence on variations in the blood glucose levels and 16% said that exercise has much influence on the occurrence of complications.

The majority of the respondents assigned a reasonable influence to the effects of nutrition and exercise on both variations in the blood glucose level and the occurrence of complications. A number of respondents variating from 11% to 26% were neutral about the influence of nutrition and exercise, mainly because they indicated to lack knowledge about the subject.

Complications of the diabetes

Respondents were asked for their opinion on the prevention of the occurrence of complications of diabetes. The proposed complications were: retinopathy, neuropathy, nephropathy, cardiovascular disease, or all of the complications mentioned combined.

A total of nearly 68% of the respondents indicated that all of the complications mentioned could be prevented. Of the other 32% of the respondents, the complications retinopathy, neuropathy and cardiovascular diseases were mentioned three times, while nephropathy was mentioned only once. Two respondents indicated that none of the complications can be prevented. The reason for this indication is that the complications cannot be prevented, because they are linked to the diabetes and therefore unavoidable.

Self-management of the respondent

In order to gain insight into the self-management of the respondents, three questions were asked in the questionnaire. In the first question respondents were asked for the influence of diabetes on their quality of life. The second question was about the sense of control of the respondents over their diabetes. In the third question the capability of the respondent to take actions for improvement of their diabetes was measured.

Regarding the first question on the influence of the diabetes on the respondent's quality of life, the respondents were diverted in their opinion. 27% of the respondents noted that the diabetes had no or little influence. 42% of the respondents thought the influence is neutral, so not to be categorized negatively or positively. The remaining 31% of the respondents noted that the influence is reasonable or much.

Respondents were more like-minded on the question about the sense of control they have over the diabetes. A total of 63% of the respondents note that this sense of control is reasonable and 16% notes that this sense of control is even bigger. Only 21% of the respondents note to be neutral on this item.

The answers on the third question about capability of the respondent to take actions for improvement of the diabetes show that 58% of the respondents thought that they were capable to do so. Further, 16% noted that they are very much capable to do so, and another 16% thought that their capability is little.

Desirable behaviour on exercise, food and weight

On the item of desirable behaviour on exercise, food and weight, respondents were asked for: the desirable number of steps per day, the desirable number of minutes of movement per day, the food that increases the risk of diabetes, and the percentage of weight loss that can improve the blood glucose levels of the respondent.

Only 21% of the respondents expected that 10000 steps per day is desired. These 10000 steps are the actual guideline according to multiple studies on the subject of healthy behaviour[35]. 58% of the respondents thought that 5000 steps per day are suitable, and 21% of the respondents already settled with only 1000 steps. For the desired amount of movement per day, 68% of the respondents correctly answered this question, with 30 minutes of movement per day. These 30 minutes are set as the guideline by the Dutch Institute for Health and Movement (NISB)[36]. 26% of the respondents thought that 60 minutes of movement is required, while 5% thought that only 15 minutes will be sufficient.

After asking the respondent about the desirable number of steps and minutes of movement per day, they were asked for both questions to what extent they think they meet these guidelines. Most respondents indicated to meet the guidelines for the desired number of steps and minutes of movement per day. For the number of steps 47% noted to reasonably meet this goal, 26% is neutral in this statement, and the other 26% thought that they do not meet this guideline, or only in a small amount. For the minutes of movement per day 63% of the respondents noted to meet the desired number of minutes answered by them in the corresponding question. 21% was neutral in their answer and 16% noted that they do meet this guideline, but in a small amount.

On the subject of food types that can increase the risk of diabetes, 79% indicated that soda can increase this risk, 16% thought that coffee can, 5% thought that meat and yoghurt can increase the risk, and finally 69% thought that alcohol can increase the risk. The Dutch Nutrition Centre provides information about the effects of the different food types on diabetes[37]. Soda and several types of processed or red meat can indeed increase the risk of diabetes. Vegetables, coffee and yoghurt can, on the other hand, decrease the risk of diabetes. Alcohol can both be beneficial and unfavourable for the risk of diabetes, where the higher the amount of alcohol the higher the risk.

Finally, a weight loss percentage of 5% can improve the blood glucose levels of a diabetes patient. Only 37% of the respondents were aware of this small percentage of weight loss and its beneficial effects. The other 63% of the respondents thought that 10% or even 20% of weight loss is required to actually improve their blood glucose levels.

Summation

In sum, the awareness of the respondents was low. Only 7 of the respondents answered more than half of the questions of the exercise and nutrition questionnaire correctly. Most respondents did not know the desired amount of 10000 steps per day, though they were aware of the guideline advising 30 minutes of movement per day. Most respondents did not know of the influences of the different food types on the risk of diabetes. In addition,

respondents did not know that even a small percentage of weight loss has an effect of improvement on the blood glucose levels.

Self-management

In the interviews, respondents were asked for their opinion on self-management of diabetes. This self-management was aimed at the cognition of the respondent. So, respondents were asked for their opinion regarding their self-management and what they think is desirable for improvement of their diabetes. Different items were included in this part, among others: self-management capability, self-management support, patient autonomy, relatedness, support by diabetes doctor, nurse or dietician, options of lifestyle changes and patient competence. These items are in line with the theories and studies explained in the Methods.

Self-management capability

On the item of self-management capabilities, a majority of the respondents reported to be able to adequately self-manage their diabetes. Respondent mainly referred to self-management as the daily care and daily issues related to diabetes. An indication of one of the respondents on the item of self-management is: *'Yes, everything is well actually. Sure, it is a lot to deal with. But for me, after 30 years of dealing with diabetes, it has become a part of my life.'* (interview 9). A small group of respondents mentioned not to be able to deal with the daily care related to diabetes, including medication, blood glucose measurements, insulin injections, healthy exercise and nutrition. One of the respondents explained: *'Well, it's never actually under control with me. I either have a hypo or a hyper. It has never been good actually, and that's very difficult.'* (interview 3). Another respondent mentioned: *'It is a lot you have to deal with and I am quite struggling with that at the moment.'* (interview 8).

In addition, almost all respondents mentioned that they do not need any support to improve their self-management. *'I know quite well what I need and what I do not need. I know what is approved and what not, so that's not the point.'* (interview 6). *'The doctor and diabetes nurse explain enough. I can always ask them if I have any questions. And I have a nutrition list, which really helps me with what to eat and what not to.'* (interview 4).

Autonomy

On the item of autonomy, almost all the respondents mentioned to be able to make their own choices within their diabetes. Own choices were herein described as: the opinion of the patients to be able to keep their feeling of control over the diabetes, within their treatment, medication, doctors, contact moments, healthy exercise, nutrition, etcetera. A small part of the respondents reported not to be sure about the ability of making own choices: *'I don't know actually. I do whatever the doctor says. That should be alright I think.'* (interview 6). Though, another respondent answered: *'Yes, I always consult everything and then I hear whether it is possible or not. It's just how hard you make it for yourself. Some people make such a point of it, but that is not necessary at all.'* (interview 5).

Relatedness

A majority of the respondents mentioned to positively experience the item of relatedness regarding their diabetes, in which relatedness is defined as support by connected individuals of the patient. These could be direct family, friends or other relatives. One of the respondents said: *'Yes, their support is enormous. Whenever I forget my medicine for instance, they pay attention to that. So that's fine.'* (interview 2). One of the respondents with negative experience on the item of relatedness mentioned: *'No, I don't have that support around. I do everything myself. But that is fine, I know what to do.'* (interview 4).

Caregiver support

As the previous item of relatedness referred to family, friends or other relatives of the respondents, the item of caregiver support referred to the professionals involved in the diabetes care. On this item of caregiver support, respondents all mentioned to be positively informed by their diabetes doctor, diabetes nurse, or dietician. Respondents stated: *'Yes, they provide tips. But I know very well what to do and what not to.'* (interview 2), and *'They tell me what to try, with nutrition and exercise and stuff. And there is always something to ask them about.'* (interview 11). Though, respondents did mention that the support is minimal, and not very in-depth: *'Well, it is not very extensive about that nutrition and exercise. More about how I am doing at the moment, and they take blood samples to check my HbA1c. But nothing more.'* (interview 9).

Competence

On the item of competence, nearly all respondents stated to be positive about their capabilities. One of the respondents reported: *'Yes, if there is anything that needs to change, I am capable of doing so myself.'* (interview 16). Another respondent added: *'If anyone advices you to do something, with nutrition for instance, you just need to tackle the issue and start working on it.'* (interview 5).

Respondents were uncertain about the specific effects of nutrition and exercise on the diabetes. They stated: *'I think the glucose measurements and insulin will always be needed, I don't know if that will ever go away.'* (interview 5) and *'Yes, I think lifestyle changes will indeed have effect. Fitness for instance, that suits the entire body. So also my diabetes. But it is not certain that after an hour of fitness my blood glucose levels are lower or anything.'* (interview 9). Respondents did state that for themselves, they can notice differences: *'I clearly notice the difference. I started with insulin, and it only became more and more. Now, I have changed my life drastically and started looking for information on healthy food for instance. Now I am regulated quite well!'* (interview 1). It appears that on the item of self-management, the respondents referred to their blood glucose levels as the most important outcome of their diabetes. Blood glucose levels are measured as direct diabetes outcomes and respondents tend to focus on these measures.

Summation

In sum, respondents mentioned to be positive about their self-management, autonomy, caregiver support and capabilities, all regarding their daily diabetes care. Though, they do mention to be uncertain about the possible effects of nutrition and exercise on the diabetes.

Motivation

The second item of the interviews was the motivation of the respondents into lifestyle and nutritional changes that could benefit their diabetes. Respondents were asked for their opinion regarding motivation, lifestyle changes, diabetes goals, diabetes coaching and peer motivation.

A majority of the respondents mentioned to be motivated to perform actions to improve their diabetes outcomes. Diabetes outcomes are hereby referred to, by the respondents, as immediate changes in blood glucose levels or their sense of fitness. The main reason for respondents to perform these actions is to feel fit and control their diabetes properly. One respondent stated: *'When my actions really result in something, I can do quite a lot!'* (interview 2). Another respondent said: *'When it really improves my diabetes, then I would change my habits. For sure. If my blood glucose levels are improved for instance, not that much fluctuation. And I just want to feel fit.'* (interview 4).

Respondents mentioned to be willing to change their lifestyle habits if it suits their diabetes and their fitness. Though, they state to have issues with keeping up these healthy habits and seek for obstacles for not being able to perform the healthy lifestyle choices. One respondent stated: *'I lack discipline to make that happen. I do want to exercise more, but I cannot motivate myself into a walk or an hour of training. And I want to eat healthy, but the 'bad' food is also the easiest food to choose.'* (interview 8).

Respondents were also asked for their way of 'exercising' in order to improve their wellbeing and increase their quality of life. A majority of the respondents mentioned to be able to perform the exercise they like. The other part mainly stated to be unable to perform any form of exercise, mainly due to other circumstances like other illnesses withholding them to do so. One respondent reported: *'In the evening when I am home, I am glad to be able to sit. I have to visit my husband every day in his nursing home and that takes up a lot of my energy, and time of course.'* (interview 3). Another stated: *'I don't like to move. With my fibromyalgia I cannot walk or bicycle, and I am not motivated to do anything else. I watch TV, or play cards with friends, but nothing more actually.'* (interview 7).

Respondents were mainly motivated in an intrinsic manner. They stated: *'I want to feel fit and be able to do my own things.'* (interview 1), *'I want to feel better by it, and therefore do it.'* (interview 12), and *'I can really notice that the exercise helps, and that is very important to me.'* (interview 15). Though, this intrinsic motivation was only mentioned whenever there were direct improvements in blood glucose levels or wellbeing of the respondents. Extrinsic motivation is mentioned whenever a respondent stated to perform healthy behaviour on the advice of the doctor. *'The diabetic nurse knows my situation, so she will know what is best for me and suggest that.'* (interview 3).

Coaching

Respondents mentioned, as stated earlier, to lack discipline in controlling their diabetes and their lifestyle habits. Coaching could be an option, as one respondent stated: *'I would like people to encourage me. Tell me what to do and what not to. Generally, they only measure the standard things here, and that's it. But I want to know what to do in my specific case!'* (interview 14). Other respondents mentioned: *'I don't need much coaching I think. If I can manage my illness than that's fine.'* (interview 4) and *'Some things I can look up for myself I think. With the food and exercise. I just need to know what is best for me, I have to figure that out. What works for me.'* (interview 11).

Peer motivation

On the item of peer motivation, nearly all respondents mentioned to reject the idea of other patients telling them what to do or supporting them. One respondent stated: *'No, I would hate the idea of people complaining with each other. I think it would only discuss the negative points, there is too much diversion within patients for that.'* (interview 6). Only one respondent mentioned: *'If it benefits me than yes, I would like that. Maybe if other patients can tell me how they handle certain situations, everyone handles things differently you know.'* (interview 19).

Summation

In sum, respondents were motivated to change their nutrition and exercise in order to directly improve their diabetes outcomes and personal well-being. The item of peer motivation was considered to be unhelpful.

Technology design

For the final part of the interview, and the fourth research question of this research, respondents were asked for their opinion regarding a technology for coaching diabetes type 2 patients. This technology could support their lifestyle changes and their diabetes.

Nearly all respondents mentioned to be familiar with technologies, and would see no difficulties in working with a technology that could support their diabetes care. A majority of the respondents stated that a technology could indeed support them and motivate them into changing their lifestyle and diabetes outcomes. The other part of the respondents was either unaware of the possibilities of a certain technology, or did not need a technology to support them because they were confident with their diabetes regulation at the moment. One respondent stated: *'I don't want to be reminded of my diabetes all day. I like the continuous glucose sensor, that really helped me, but something on my phone or laptop? No, I don't think I am capable of working with that sort of technology, I don't need that extra support.'* (interview 17). However another respondent reported: *'Yes, that would be ideal. With a device for glucose measurements, and if I could see my movement. If I move my blood glucose level drops, so it makes me fitter. If such a device could help me with that, I would really like to try it!'* (interview 4).

Finally, the respondents were asked for their opinion regarding this proposed coaching technology. What should it contain? What should it look like? Respondents mentioned a total of twenty possible functionalities of the coaching technology and these functionalities are displayed in Table 2. These functionalities include the preferences of the respondents based on the idea of a future coaching technology. The functionalities at the top of the Table are mostly mentioned, descending to the bottom of the Table.

Table 2. Functionalities of the proposed coaching technology for diabetes type 2 patients

Blood glucose measurement (continuous)
Information about nutrition
Provide warning if blood glucose level is too high or too low
Overview of all important factors (blood glucose, steps per day, nutrition)
Information about exercise
Linked to a step counter
Provide warning if patient does not exercise enough
Graphs of blood glucose levels
Include a nutrition diary
Measure carbohydrates intake
Linked to a mobile phone, iPad, tablet or laptop
Show calories burned by the performed exercise
Easy to use
Provide warning if patient forgets to measure
Information about diabetes
Linked to the computer of the doctor
Linked to heart rate measurement device
Show fluctuations of blood glucose levels during a day
Linked to blood pressure measurement device
Automatically adapt insulin intake

Summation

In sum, respondents mentioned to be capable to use the proposed coaching technology in the future and think of it as an opportunity to motivate them into improving their diabetes. The functionalities mentioned in Table 2 above are possible features of the technology that the respondents would like to use. Overall, the inclusion of a blood glucose measurement, information about nutrition, exercise and diabetes, an overview of important factors on the self-management of the diabetes and the provision of warnings on the patient's blood glucose levels were the most important functionalities regarding the diabetes type 2 patients interviewed in this research.

DISCUSSION

In total, 19 diabetes type 2 patients participated in this research. Generally, about 40% to 56% of diabetes patients suffer from one or multiple complications of the diabetes[38]. Of the patients included in this research, 74% suffered from any type of complication, either micro- or macrovascular. Also, what appeared during the interviews, is that a majority of the patients had issues managing their blood glucose levels properly. This suggests that the included group of diabetes type 2 patients belongs to the more severe category within diabetes care. These patients regularly visit the diabetes doctor and/or diabetes nurse and are in need of more intensive diabetes care and support.

Awareness

In this research the patients were questioned about their awareness and knowledge regarding their diabetes and the effects of nutrition and exercise on their diabetes outcomes. Only a minority of the patients were sufficiently aware regarding these effects. Most patients seem to underestimate the effect of exercise and nutrition on both their blood glucose levels and the occurrence of complications. In addition, they lack knowledge on the subject of healthy nutrition and exercise guidelines and recommendations. Patients think that they comply with the exercise guidelines, but estimate this guideline much lower than it is in reality. Patients seem to think they exercise enough and conclude not to need any additional movement. It seems that on the subject of healthy nutrition and exercise, the diabetes type 2 patients need additional guidance and support. Patients tend to come up with excuses for not being able to exercise or eat healthier, in which they lack insight into the small changes that could have a positive effect on their diabetes outcomes. The guideline requiring 30 minutes of activity also includes light activity, like walking or gardening[39]. As the diabetes type 2 patients in this research mentioned to fancy a walk with their dog or a bicycle ride with their partner, these small sets of physical activity should be emphasized. A certain level of awareness is important for diabetes type 2 patients, in order to create knowledge on the required lifestyle changes related to their illness[7]. Previous literature already pointed out that diabetes patients' awareness is low and in need of improvement, a fact that is emphasized within this research[20,40,41].

A remarkable fact regarding the awareness of diabetes type 2 patients, is that the patients themselves mention to be capable of adjusting their lifestyle habits in order to improve their illness and that they are very much capable of improving these habits. In contrast to this, the questionnaire pointed out that they lack the proper knowledge. It seems that the difficulty of this target group is the patient's own perception of their illness. This target group suffers from many complications, has insufficient control over their blood glucose levels and is in need of intensive diabetes care in the hospital. It seems they lack insight in their failures and are in need of the proper support to point them in the right direction by confronting them with these failures regarding their lifestyle habits.

Self-management

In the interviews patients were asked for their opinion on self-management regarding their diabetes. The majority of the patients were positive about their self-management skills and capabilities regarding actions improving their diabetes. Hereby they mentioned to positively experience autonomy, in which they were capable of making their own choices regarding their diabetes. Besides this, the majority of the patients mentioned to be well-informed by their diabetes doctor or nurse and positively experience support from relatives.

This all sounds acceptable. Patients mentioned they are able to act upon healthy lifestyle choices and have the proper information on this subject. However, it is revealed that the awareness of diabetes type 2 patients is insufficient and that their diabetes is also not regulated properly. This, according to the multiple complications they suffer from and the fluctuations in blood glucose levels they experience during the day, according to the interviews. It also seemed that, during the interviews, patients have a single measure for their diabetes self-management, namely: their blood glucose levels. These blood glucose levels fluctuate a lot during the day, but patients fail to link these fluctuations to their exercise and nutritional choices although they mention to note differences in blood glucose levels when eating healthier or exercising more. This, even though they mention to be well-informed by their diabetes doctor or nurse, who most likely will mention the effects of exercise and nutrition.

An important statement on the item of caregiver support is that patients experience the support as minimal and not very in-depth. Especially on the subject of nutrition and exercise they lack information and hereby knowledge. Patients thereby mention to be uncertain about the specific effects of nutrition and exercise on their diabetes. Caregivers may fail to reach the patient with nutrition and exercise information if this information is not adapted to the patient's preferences and needs, hereby referring to the importance of personalised treatment for diabetes type 2 patients[14]. The standard lifestyle information may not come through in every patient individually, as patients themselves think to self-manage their illness properly. Patients thereby lack the ability to apply the information on healthy lifestyle choices into their daily patterns.

When previous information on self-management is related to the Self-Determination Theory, it appears that the three basic needs of the SDT may not include all relevant aspects of motivation in this research regarding diabetes type 2 patients[24]. The basic needs of competence, relatedness and autonomy together predict a change of behaviour. If all three needs are met by a patient, the patient should be motivated to change behaviour in order to improve diabetes outcomes. However in this respondent group, patients mention to meet all three basic needs, but still fail to perform the healthy behaviour that is recommended. So, the aspects of motivation of the SDT may miss out one or more of the aspects needed to motivate patients into changing their lifestyle.

In addition, the Social Cognitive Theory uses the self-efficacy of a person to determine people's decisions and how they behave[11]. Self-efficacy states the potential of a person to correctly complete a certain behaviour[42]. According to the answers on the

interviews, diabetes type 2 patients have a proper self-efficacy, being able to self-manage their illness into improved diabetes outcomes. However, again the lack of awareness of the diabetes type 2 patients measured in the questionnaires comes forward. Patients' awareness is insufficient, which makes it impossible for them to correctly complete the behaviour of healthy lifestyle choices because of their insufficient knowledge. Even though patients have a positive perception of their self-efficacy, they need additional knowledge on exercise and nutritional choices to be able to perform this behaviour properly and actually improve their diabetes outcomes.

Motivation

In the interviews also the motivation of the diabetes type 2 patients regarding lifestyle choices related to their illness was discussed. Almost all patients mentioned to be motivated to participate in nutrition and exercise changes if these would benefit their direct diabetes outcomes. These direct diabetes outcomes seem to be most important, as patients do not see the long-term effects of nutrition and exercise changes. Patients indicated wanting to 'feel fit' and 'control their blood glucose levels properly', which again refers to the direct diabetes outcomes. In the interviews it appears that patients do want to improve their diabetes, but on the other hand accept their current diabetes outcomes and therefore lack discipline in making the lifestyle changes to benefit future diabetes outcomes.

On this subject of motivation into lifestyle changes, patients mentioned the need for improvement in their diabetes outcomes, in which they want to exercise more and eat healthier. They mention to have proper knowledge to do so and do not need any type of coaching by their diabetes doctor or nurse, while this knowledge part is actually insufficient. Patients want to keep their autonomy regarding their illness, which is clearly noticed during the interviews. It seems that the idea of coaching of diabetes type 2 patients involves a doctor telling them what to do and when. This might have been caused by the interview questions regarding coaching, in which coaching is introduced as support or additional help regarding a patient's exercise and nutritional choices, hereby following the description used in literature. This description of coaching may have put the idea of coaching as a replacement of their autonomy, which is exactly what diabetes type 2 patients did not want.

The SDT distinguishes the core concepts of intrinsic and extrinsic motivation, which determines if a patients is motivated from the inside or by external influences[24]. The diabetes type 2 patients interviewed in this research mainly mention wanting to have a sense of control over their diabetes, in which they want to set their own goals according to their own knowledge. This seems as an intrinsic way of motivation. But, as their knowledge appeared to be insufficient, the question remains if patients currently recognize the necessity of motivating themselves intrinsically in improving their diabetes outcomes. Extrinsic motivation comes forward whenever patients mention to perform a certain behaviour on the advice of the doctor. Previous research concluded that intrinsic motivation in diabetes type 2 patients is stronger than extrinsic motivation and also more important for actual behaviour change[43]. As it turns out that the intrinsic motivation of diabetes type 2

patients is questionable, this might be a point that needs intervening. An article on intrinsic motivation states that it can be increased by creating a challenge, curiosity, control, competition or recognition for the patients[44]. For instance the idea of a challenge can motivate patients with goals that have a personal meaning, in which performance feedback is provided by a diabetes doctor or nurse that leads them to a certain goal. Hereby, patients keep their feeling of autonomy, but are provided with supporting feedback and motivated into reaching a goal. This again refers to the importance of personalised treatment, with information adapted to the patient's preferences and needs[14]. Patients mentioned in the interviews that they want to gain information not on diabetes in general, but for their 'specific cases' and related to their 'well-being'. In diabetes patients the goals that could be set might include less fluctuations in blood glucose levels or less insulin intake.

A final remarkable fact is that though earlier research stated that peer motivation is a proposed solution to the lack of self-management support in diabetes care, the patients in this research all reject the idea of other patients supporting them[45,46]. Again, patients want to remain autonomous and act only upon their own knowledge on their diabetes.

Coaching by technology

The final item discussed in the interviews were the possibilities of a coaching technology regarding diabetes. The majority of the patients noted to be capable of using technologies and think that a technology could motivate them if it would provide support in their lifestyle choices and improve their diabetes outcomes. Patients mentioned many possible functionalities to be included in the coaching technology. It seems that patients mainly want direct feedback on their behaviour and see detailed information on for instance blood glucose levels, number of steps and healthy nutrition. Patients mentioned to like the idea of extra information on healthy lifestyle choices, so that they can make decisions based on this information. This might seem contradictory to the statement of the patients on not needing any type of extra coaching, though the idea of a technology coaching them appears to be different than a diabetes doctor or nurse telling them what to do. This technology for coaching is also introduced as additional support on exercise and nutritional choices.

So, if patients would have the appropriate knowledge and motivation, a coaching technology could support them into healthy lifestyle choices. Though, this research pointed out that the awareness of diabetes type 2 patients is insufficient, a fact that keeps returning as an important factor for patient motivation and behaviour change[7]. It is therefore questionable if the functionalities mentioned by the patients are the actual functionalities needed in this future coaching technology. Based on the functionalities mentioned by the patients and the information they provided during the interviews a set of requirements is developed in order to determine the actual possibilities of a coaching technology for this specific patient group. In Appendix VII these requirements are linked to the possible functionalities of the proposed coaching technology.

As the lack of awareness of diabetes type 2 patients keeps emerging, this is a starting point for a first requirement. Diabetes type 2 patients lack knowledge on the subject of

healthy nutrition and exercise and are therefore unable to understand the effect of lifestyle changes on their diabetes, both direct and long-term effects. A reason for failure of previous coaching technologies might be the lack of awareness of the diabetes type 2 patients on their illness. If patients do not have the appropriate knowledge to create an awareness about the lifestyle effects on their diabetes, they will not be able to self-manage their illness properly and cannot use a technology to support this. Patients need additional support on the creation of knowledge regarding both exercise and nutritional choices, in which the diabetes doctor or nurse should be the first to participate. Technology can only be used as an addition to the usual care and not as a substitution[12]. Therefore, to create knowledge the patients should be able to use a technology as an addition to the information provided to them by their diabetes doctor or nurse. This information provision of the diabetes doctor or nurse should not be replaced by a technology, but only supported. The technology should therefore start with a 'knowledge transfer', in which the patient gains knowledge on the aspects of lifestyle changes that are important to understand the possible improvements in diabetes outcomes these changes can result in. However, the diabetes doctor or nurse must keep supervision on the information that is provided and make sure that this information is in addition to the previous knowledge of the patient.

The knowledge transfer brings forward a second requirement. In this second requirement the technology must not simply provide all patients with a large amount of information regarding exercise and nutritional effects on their illness, but actually improve the patient's knowledge and eventually their self-management. Not all patients start at the same knowledge level, because some patients were better aware than others. Thereby, patients seem to think they already have the appropriate knowledge regarding their illness, so the coaching technology must make them understand that they do not and encounter at their personal needs. These personal needs need to be taken into account in order to support every patient individually, referring to the importance of personalised treatment in self-management interventions[12]. So, 'personal monitoring' is the second requirement for the proposed coaching technology for diabetes type 2 patients. Previous research pointed out that lifestyle modifications of diabetes type 2 patients should be modest and based on the patient's willingness and ability[29]. Patients should have a certain willingness to change their lifestyle and diabetes outcomes, otherwise the continuous information supply will not come through. By personalising the treatment, as stated in this requirement, and acting upon what patients really want, the attempted lifestyle changes may most likely merge into long-term lifestyle habits. In this requirement, again the diabetes doctor or nurse should keep the supervision over the technology and make sure that the technology is indeed personalised to the patient's individual needs.

As a third requirement, 'caregiver knowledge' comes forward. This research concluded that patients experience the information on lifestyle provided by caregivers to be minimal and are uncertain about the specific effects of nutrition and exercise on their diabetes. Caregivers need to adapt the information to the patient's needs and therefore need to know which information to provide to which patient. Caregivers need to intervene

at the individual level of awareness of each patient, hereby personalising the support provided by the coaching technology. This ensures that the information provided to the patient indeed interacts at their individual level.

After the creation of knowledge and the required level of patient awareness, the coaching technology can interact with the patient at a certain level at which patients know in what way to benefit from exercise and nutritional changes. The fourth requirement of 'personalised feedback' includes the ability of the technology to provide patients with feedback based on their objective data. As patients mentioned to like the idea of a continuous blood glucose measure, step counter and nutrition diary merged in a technology to support them, the technology should provide patients with feedback based on these three items. By a direct type of feedback the application should provide patients with tips concerning the amount of exercise they should perform or the nutrition that benefits their diabetes outcomes. Hereby reminding the patient to consider their exercise and nutritional choices. Patients tend to say: 'No I am fine with my current condition, I do not need additional support', which emphasizes the need for the use of objective data allowing the caregiver to really understand the patient's situation. According to the Theory of Change, all the mini-steps lead to the long-term goal and the process of change unfolding needs to be evaluated[26]. By evaluating these mini-steps, one can check if the expected outcomes are actually reached. So, in order to reach the desired diabetes outcomes, patients must carefully walk through all the mini-steps of exercise and nutritional changes required to be intrinsically motivated into lifestyle changes. Hereby understanding that also the small steps can lead to improvements. By providing feedback based at realistic goals and based on the preferences of the patient, so with small steps at a time, the patient should be able to think of the goals as achievable and not lose faith in his/her abilities.

The previous information regarding the need of personalised feedback emphasizes the need of shared decision making. Shared decision making is defined as: "a method where clinicians and patients make decisions together using the best available evidence, where patients are encouraged to consider available screening, treatment, or management options and the likely benefits and harms of each"[47]. In this shared decision making, the caregiver supports the patient in becoming well-informed on the subject of their illness and possible options for improvement[47]. This is exactly what diabetes type 2 patients need in order to increase their awareness and self-management. The caregiver first needs to establish the patient's options and provide information, after which they can together form preferences and set-up an action plan for improvement of the patient's situation. In this action plan, it is again important to set small steps as goals for the patients, in which the patient's preferences and possibilities are carefully considered and in which a coaching technology can be introduced to support the patients into reaching their goals.

In Appendix VIII 4 images of the proposed coaching technology are included, hereby providing ideas for the design of the coaching technology. These 4 design ideas are developed based on the functionalities most mentioned by the patients, namely: a blood glucose level measure, a step counter and a nutrition diary. Of all of these functionalities an

example is given, together with a home screen displaying all functionalities in short. The technology idea proposed in this Appendix is not designed to increase the patients' awareness on the subject of their diabetes, but can be introduced at a later stage of coaching the diabetes type 2 patients into healthy lifestyle choices. When patients have the proper knowledge about the lifestyle effects on their diabetes, they are most likely to act upon healthy lifestyle choices and use a technology to support them into these healthy lifestyle choices. This might be the reason why all of the previous coaching eHealth interventions, as referred to in the Introduction and showed in Appendix II, failed to lead to long-term use. The interventions mainly coach the patient directly into a healthy lifestyle and forget the first step of creating awareness. The eHealth interventions showing most improvement in for instance patients' blood glucose levels or self-management used personalised feedback messages and real-time feedback on patients' objective data. This again emphasizes the need for personalised feedback and an adequate patient awareness, as proposed in this research.

Proposed coaching technology scenario

In order to introduce the proposed coaching technology in a real-life setting, a scenario is developed according to the People-Activities-Context-Technology (PACT) framework[48]. The PACT framework is used to describe a new technology within a user context. Within the PACT framework the typical users, activities to be performed by the users, health care context of the technology and features of the technology are described. Table 3 displays the scenario for a diabetes type 2 patient using the proposed coaching technology.

Table 3. Proposed coaching technology scenario

Henk is 64 years old. He worked his entire life as a mechanic engineer at a large company and mainly performed heavy outdoor work. Henk retired 2 years ago and is now enjoying his retirement together with his wife. Henk has been diagnosed with diabetes type 2 about 14 years ago. In the first 9 years he had regular visits to his general practitioner, but for 5 years he is under the supervision of a diabetes doctor and diabetes nurse at the ZGT in Almelo. He has planned visits to either the diabetes doctor or the diabetes nurse every 3 months. During these visits, his blood glucose level, HbA1c and renal function are checked with the use of a blood test. The diabetes nurse also provides information to Henk about his lifestyle. However, Henk is determined to live his life to the fullest and to enjoy his retirement days together with his wife. Henk's blood glucose levels therefore tend to fluctuate a lot during the day, for which he uses large amounts of insulin. In order to improve Henk's diabetes regulation, the diabetes doctor introduced a new coaching technology to Henk. This coaching technology gives Henk access to information on healthy nutrition and exercise related to his diabetes and information about the diabetes itself. The aim of the coaching technology is to improve Henk's diabetes outcomes and increase his awareness on the lifestyle choices related to his diabetes. The technology is available on the laptop of Henk, which he mainly uses at home. Henk's diabetes doctor and diabetes nurse also have access to the technology from their computer and together with Henk they discuss the possibilities of the technology. Henk can for instance look up information about healthy nutrition, including a variety of healthy recipes. The diabetes doctor and diabetes nurse support Henk into using the technology, so that in the future Henk can use the technology more extensively. Some future options of the coaching technology are a linkage to the continuous blood glucose measure of Henk, a nutrition diary in which Henk can write down

his nutrition and check the carbohydrates he receives and a step counter linked to the FitBit of Henk. The diabetes doctor and diabetes nurse supervise the coaching technology and the progress of Henk on the subject of healthy nutrition and exercise. In the future, when Henk has expanded his knowledge on diabetes, the diabetes doctor and nurse will allow Henk to use the other functions of the technology as well, which will be explained to him one step at a time. Due to this, Henk will gain more and more awareness on the subject of his diabetes, improve his self-management capabilities and will be able to adjust his lifestyle to improve his diabetes outcomes.

Strengths and limitations

The strength of this research is that it includes an in-depth view of the patient's preferences and uses previous research and relevant theories to determine the possibilities for motivation of diabetes type 2 patients. Hereby reasoning beyond the failures of past technologies and considering opportunities for successful lifestyle changes. Limitations of this research can be found in the fact that it did not reveal the psychological factors underlying the behaviour of diabetes type 2 patients regarding lifestyle changes. Patients tend to use socially desirable behaviour when questioned about their lifestyle, thereby causing desirability bias in the results[19]. The strength of this research is that it looked beyond these socially desirable answers and compared the answers with previous literature. Another limitation of this research is that the questionnaire used was not validated, but based on previous literature and other questionnaires regarding diabetes self-management. Thereby, the interviews were coded and evaluated by a single researcher, which enlarges the possibility of bias. Finally, the patients included in this research had an average age of 64 years old and had multiple complications. When younger and less severe patients would have been included, the answers might have been different. Also, the illness history of the diabetes type 2 patients needs to be considered. Patients with a different illness history might have other ideas regarding healthy exercise and nutrition, depending on for instance previous attempts into changing their lifestyle and how this worked out.

Future research

Subsequent research could aim at establishing the psychological factors underlying the patients in their choices regarding healthy exercise and nutrition. Hereby, a possible coaching technology could be tested with a small group of diabetes type 2 patients. It is important to determine how patients act upon the presumed coaching opportunities and how this affects their motivation. Besides this, the creation of awareness must be carefully considered. Not only to determine if the awareness of the patients is indeed increased by the supposed knowledge transfer, but also to determine other possibilities to increase awareness. It is important to always take the patient into account and personalise the information and coaching they receive. Finally, in order to decrease the desirability bias, it is important to also involve patient information from an objective source in the coaching into lifestyle changes.

CONCLUSION

In this research the possibilities for development of a coaching technology for diabetes type 2 patients were examined. To this end, the awareness, self-management and motivation of diabetes type 2 patients and the requirements of a supposed future technology aiming at lifestyle coaching were investigated.

First, it was found that overall, a minority of the patients has an adequate awareness on exercise and nutritional effects on their diabetes. Therefore, patients are not as aware as might be expected from patients with an illness as severe as diabetes type 2.

Secondly, the majority of diabetes patients tend to be relatively positive regarding their ability to self-manage their illness. Patients are positive about their competences to act upon their diabetes and are motivated to change their nutrition and exercise if these could benefit the direct outcomes of their diabetes.

Thirdly, patients are motivated in changing their lifestyle habits, but primarily because they want to improve their immediate well-being, quality of life and diabetes outcomes on the short-term. Patients want to achieve a healthy lifestyle using their own preferences and knowledge about the effects of exercise and nutrition linked to their diabetes, so seem to use intrinsic motivation. However, they note to need information about making, and maintaining, these healthy lifestyle choices, as they state to have issues with keeping up these lifestyle habits.

Finally, on the subject of a future technology, patients are willing to use a technology that supports their diabetes care, though some patients did not see direct possibilities and remained thoughtful. The following functionalities were prioritized by the patients: the technology must contain (continuous) blood glucose measurements, the technology must contain information about exercise, nutrition and diabetes, the technology must be linked to the mobile device of the patient, the technology must provide a warning when blood glucose levels are too low or too high and the technology must be linked to the step counter of the patient.

In conclusion, diabetes type 2 patients are motivated to use a technology if it improves their direct diabetes outcomes, self-management and support a healthy lifestyle. This technology should not only provide information about the exercise and nutrition of the patient, but also provide feedback on the patient's choices and collected (objective) patient data and motivate them to act upon healthy lifestyle choices with positive influence on their diabetes. It is important that the technology uses a knowledge transfer to increase the patient's awareness on the aspects of exercise and nutritional changes in order to improve their diabetes outcomes. Secondly, the technology must intervene at the patient's awareness level, lifestyle habits, willingness and ability to change. Thirdly, the caregivers should adapt the provided information to the needs of the patient in order to intervene with their support at the patient's individual situation. Finally, the technology must provide patients with personalised feedback on their objective data. This feedback should be based on the patient's preferences and aim at small steps of improvement at a time.

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APPENDIX

APPENDIX I. THEORETICAL FRAMEWORK

This appendix gives an overview of the relevant theories on motivation and coaching of diabetes patients. In order to discuss all relevant literature, not only theories on diabetes patients' motivation and coaching are mentioned, but also theories on motivation and coaching of other chronic ill patients. This theoretical framework is the basis of this research, by describing and explaining the theories that are of importance.

Behavioural Regulation in Exercise Questionnaire (BREQ-2) - Markland and Tobin (2004)[49]
The Behavioural Regulation in Exercise Questionnaire (BREQ-2) is a measurement for exercise motivation. It contains 19 items relating to five motivation types, based on the Self-Determination Theory of Deci and Ryan. The conception of extrinsic and intrinsic motivation forms the basis of this questionnaire. The lowest motivation type is the 'amotivation', with a patient lacking motivation to adopt exercise, and the highest type the 'intrinsic motivation', representing a greater exercise participation with motivation from within the patient itself.

Diabetes Self-Management Education and Support (DSME/S) – Powers et al. (2015)[50]
The diabetes self-management education and support (DSME/S) provides the foundation to help patients with diabetes to navigate their self-management decisions and perform complex care activities. DSME/S has been shown to improve health outcomes. The theory aims to address the patient's health beliefs, cultural needs, current knowledge, physical limitations, emotional concerns, family support, financial status, medical history, health literacy, numeracy and other factors that influence each person's ability to meet the challenges of self-management.

The overall objectives of DSME/S are to support informed decision making, self-care behaviours, problem solving, and active collaboration to improve clinical outcomes, health status and quality of life.

Diabetes Self-Management Questionnaire (DSMQ) – Research Institute of the Diabetes Academy in Mergentheim[51,52]
The Diabetes Self-Management Questionnaire (DSMQ) is developed as a sequel of the Summary of Diabetes Self-Care Activities (SDSCA), to be explained later. Where the SDSCA aimed at self-care activities, it lacked a correlation to the glycaemic outcomes, the HbA_{1C}, of diabetes patients. The DSMQ was designed to assess self-care behaviours which can be related to the measure of HbA_{1C}, so that the outcomes can be used to predict glycaemic control of the patients.

The DSMQ is a questionnaire with 16 items in four categories, concerning: glucose management, dietary control, physical activity, and health-care use.

Four-Step Process model – Tinker et al. (1994)[53]

In 1994 Tinker et al. developed the four-step process model for medical nutrition therapy for diabetes. The four steps are: thorough assessment of the patient, goal setting with patient participation, selecting appropriate intervention strategies, and follow-up including evaluation and problem-solving.

Integrative Health Coaching[54,55]

In Integrative Health Coaching a holistic approach is used to optimize mental, physical and social well-being rather than focusing on symptoms and disease complications. It empowers patients to make healthy behaviour changes that support well-being. It bridges the gap between medical recommendations and a patient's abilities to implement these medical recommendations into their life.

Integrative Health Coaching uses health coaches to personally identify a patient's obstacles to change and create strategies to create behaviour changes.

Integrative Medicine Wheel of Health[55,56]

The coaches that use Integrative Health Coaching use the Integrative Medicine Wheel of Health. This Wheel of Health exists of three layers. The inner layer represent the patient itself, with its awareness of physical, mental, social, and spiritual well-being as a start of positive change. The middle layer is the self-care layer, which reflects a patient's lifestyle, priorities, motivation, and habits. The outer layer represents the professional care, with therapies that are aimed at prevention as well as intervention.

Figure 2. The Wheel of Health

Motivational Interviewing – Miller (1998)[57–63]

Motivational interviewing is based on improving patients' self-efficacy, activation, lifestyle changes and health status. William R Miller developed the theory of Motivational

Interviewing, with the notion that motivation to change should not be provided by coaches, so from without, but from within the patient. The coaches should use empathic listening to minimize resistance of patients, and increase motivation for change.

Motivational Interviewing includes three central concepts: readiness, ambivalence and resistance. Readiness is about the patient being ready to change, for which the coach must always walk beside the client to be in step with his/her readiness to change their behaviour. The concept of ambivalence involves the inter-relationship between the patient's goals and values and motivation to change. Resistance is the final concept and describes a patient resisting the change, also called denial, in which the coach must proceed with encouraging a patient's self-esteem, values and opinions.

Multiple studies use Motivational Interviewing to motivate patients. It is known that Motivational Interviewing improves patients' understanding of their chronic illness, their beliefs regarding treatment aspects, and their contemplation on and motivation for behaviour change. In motivational interviewing not the physician, but the patient, examines the pros and cons of certain decisions for themselves.

Social Cognitive Theory – Bandura – 1989[11,42,64]

The Social Cognitive Theory of Bandura is developed with the notion that human behaviour is caused by three core concepts: personal, behavioural and environmental influences. The first concept of personal influence refers to a person's self-efficacy towards a behaviour. So, if the person beliefs he/she could correctly complete the behaviour. The second concept of behavioural influence states whether the person receives a positive response after performing a certain behaviour, which provides the person with the chance to learn from it. The final concept of environmental influences refers to the aspects of the environment that allow the person to complete the behaviour successfully. Hereby, the appropriate support and materials improve a person's self-efficacy.

Self-efficacy determines people's decisions and how they behave. This self-efficacy is an important factor for motivation and can thereby determine the way that goals, tasks, and challenges are completed. The proper motivation can increase self-efficacy and improve outcomes.

Self-Determination Theory – Deci and Ryan – 1985[23,24,65]

The Self-Determination Theory (SDT) of Deci and Ryan is a theory of human motivation and personality in social contexts. The SDT assumes three basic needs: competence, relatedness and autonomy. Competence includes the feeling of effectiveness of a person, and the ability of using one's capacities. Relatedness concerns the feeling of connectedness to other persons, and the feeling of being cared of. The final need of autonomy includes the perception of people to determine their own behaviour.

The SDT determines the motivation of people. People can be motivated in both an intrinsic and extrinsic way. Intrinsic motivation is motivation from the inside, in which the satisfaction lies in the behaviour itself. Extrinsic motivation is motivation from the outside, in

which the behaviour is aimed at a reward. Motivation is seen as the 'product' of the interaction between an individual's internal need and environmental elements which stimulate this. Figure 3 depicts the internal and external factors influencing a patient's motivation.

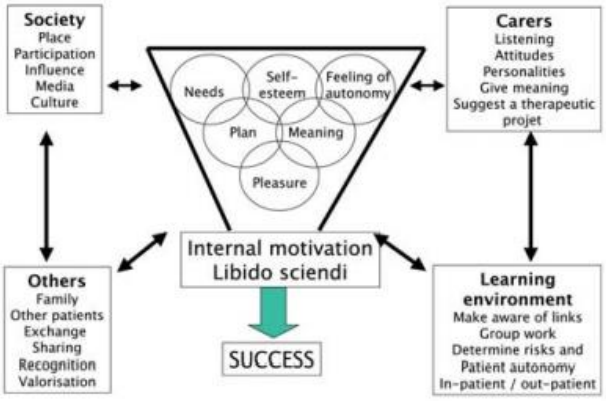

Figure 3. Internal and external factors influencing the motivation of a patient

All of these different factors have influence on a patient's willingness to change their behaviour, the so-called 'desire to change'. As there are so many factors, it emerges that change is never an easy task and its maintenance over time is of even greater complexity.

Summary of Diabetes Self-Care Activities (SDSCA) – Toobert, Hampson and Glasgow – 2000[33,66]

The Summary of Diabetes Self-Care Activities (SDSCA) is a self-report instrument for measuring the self-management in diabetes patients. The instrument has the form of a questionnaire. The items included in this questionnaire are: general diet, specific diet, exercise, medication taking, blood glucose testing, smoking, and foot care. Patients are questioned about for instance the extent to which they measure their blood glucose, or choose a healthy diet.

The SDSCA is a reliable self-report instrument for studies of diabetes self-management. It has gained the status of a standard measure since its development in 1993 and revision in 2000. Though, an instrument like this is always influenced by types of bias, as for instance desirability bias. Patients are likely to choose the answer most desired by others. Also, the SDSCA is a subjective instrument and the information included cannot be provided by an objective source.

Patient Activation Measure[67,68]

The Patient Activation Measure (PAM) measure a patient's knowledge, skills, and trust in the self-management of their illness. The PAM is used to gain insight into how and in what extent a patient thinks to be able to improve his/her own health status. The PAM contains 13 statements to be scaled by the patient. The outcome of the PAM is a score with which the patient is categorized into 4 levels of activity. PAM1 contains patients unable to experience

any form of self-management and PAM1 contains active patients willing to self-manage their illness optimally.

By using the PAM as a measure to categorize patients into their level of activity, the provided care can be tailored to the patient's level and thereby be more personalised.

Peer Health Coaching[45,69]

Peer Health Coaching is developed as a proposed solution to the lack of self-management support in diabetes care, mainly due to time and resources shortages. Peer Health Coaching makes use of patients trained to provide diabetes education and support to other patients. Hereby, coaches share similar experiences about living with diabetes. This supports patients within and beyond their normal health care setting.

Theory of Change – Weiss et al. – 1995[26,70]

The Theory of Change is a way to describe a set of assumptions that explain both the mini-steps that lead to the long-term goal and the connections between program activities and outcomes that occur at each step of the way. Weiss et al. developed this theory based on a hypothesis that complex goals are difficult to evaluate because the process of change unfolding is given too little attention. There is unclarity about the 'mini-steps' that need to be taken to reach a long term outcome, so this theory aims at evaluating these steps and tracking whether the expected outcomes are actually produced.

APPENDIX II. PREVIOUS STUDIES ON COACHING AND MOTIVATION

Previous research pointed out the potential effects of coaching interventions, also including technologies, of both exercise and nutritional changes on the health outcomes of diabetes type 2 patients. In Table 4 below the different studies are analysed on their findings, in order to gain information on the effects of the coaching interventions.

The analysis was based on: the type of intervention used for coaching, the theory behind the coaching intervention, the type of coaching, the frequency of the coaching, and the effects on the patients' health outcomes. Besides studies on diabetes coaching, also studies on coaching in case of other chronic illnesses are described. This, because of the common effects the illnesses and the interventions have on the patients' life [46].

Table 4. Previous studies on coaching and motivation for patients with diabetes (and other chronic illnesses)

Researcher(s)	Type of intervention	Theory behind the intervention	Intervention provision	Frequency / duration of intervention	Outcomes
Diabetes mellitus					
Browning et al.[58,59]	The Happy Life Club. An intervention to assist patients with the management of type 2 diabetes mellitus. The intervention exists of telephone and face-to-face coaching, based on patient-centered care with use of motivational interviewing.	Based on the 'Good Life Club' intervention in Australia.	Intervention group patients received health coaching combined with usual care. Control group patients received usual care only.	Follow-up of 12 months.	The intervention group showed modest improvement in the quality of life, systolic blood pressure, HbA1c levels, and waist circumference. Further research is necessary.
Cho et al.[71]	The 'Diabetes phone' - Intervention group received the mobile phone containing a device to measure blood glucose - Control group received normal care and a web-based diabetes management system	Not mentioned	The intervention group communicated with the medical staff through the mobile phone. Glucose data was automatically transferred and they received recommendations by short messages.	Three months	No difference was found between the mobile phone and web-based intervention group. Though, HbA1C levels of both groups decreased significantly.
Clark[72]	Physical activity intervention	Not mentioned	Physical activity increasing interventions used in different studies.	Multiple studies included in this review.	Physical activity over 3-4 months lowered glycostated haemoglobin with 15-20% among people with diabetes mellitus.

Faridi et al.[73]	Mobile telephone technology for patient self-management - Intervention group received tailored daily messages via mobile phone - Control group received standard diabetes care	Not mentioned	Patients in the intervention group received messages through their mobile phone from their physician.	Not mentioned	The intervention had a positive impact on the HbA1C levels and improved patient's self-efficacy scores.
Glasgow et al.[53]	Office-based intervention to facilitate diabetes dietary self-management. Intervention group compared with a control group.	American Diabetes Association (ADA) nutrition recommendations were used. Physicians also followed the four-step process model of Tinker et al. for medical nutrition therapy for diabetes.	Intervention group patients had to complete several questionnaires, and based on their answers on these questionnaires they received personal feedback, tips, and videos from their caregiver.	One first visit with a first feedback session. After this, two phone calls in week one and three after the office visit. Finally, after three months a repetition of the intervention process with final feedback provision.	The intervention leads to reductions in saturated fat and caloric intake as well as overall percent of calories from fat. These results are promising, when eventually a dietary intervention like this would be combined with other factors of diabetes self-management.
Gonzáles-Guajardo et al.[16]	Coaching of physician performance	Not mentioned	Coaching: guiding family doctors to improve clinical abilities	Follow-up of three years	Improved diabetes control

Knowler et al.[74]	Lifestyle intervention in groups: 1: Standard lifestyle recommendation plus metformin 2: Standard lifestyle recommendation plus placebo 3: Intensive program of lifestyle modification	Not mentioned	Group: 1+2: Written lifestyle recommendations and 20-minute individual session 3: A 16-lesson curriculum by case managers, one-to-one, and individualized, aimed at weight reduction	Only once	Lifestyle interventions in diabetes type 2 patients were more effective than metformin. Incidence of diabetes was reduced by 58 percent with the lifestyle intervention compared to 31 percent with metformin.
Newton et al.[75]	Pedometers and text messaging to increase physical activity. - Intervention group received the pedometers and text messages - Control group received usual care	Not mentioned	Participants received a goal for the pedometer of 10.000 steps per day and received motivational text messages in addition to remind them to be active.	12-weeks of intervention	The intervention group did not show improved motivation and physical exercise due to the pedometers and text messages.
Norris et al.[76]	Self-management training	Based on earlier research into self-management training for diabetes.	Training on: information, lifestyle behaviours, mechanical skills, and coping skills.	72 studies included in this systematic review.	Particularly in the short term, self-management training is effective in type 2 diabetes.
Powers et al.[50]	Self-management education and support	Theory of Diabetes Self-Management Education and support (DSME/S), by the American Diabetes Association (ADA).	Not applicable. No research but a Joint Position Statement.	Not applicable.	DSME/S is critical in ongoing support for diabetes patients to maintain gains made during care.
Quinn et al.[77]	Mobile phone based diabetes management software system with	Not mentioned	The software on the mobile phone provided real-time feedback on	Three months	Patients in the intervention group showed significant

	web-based data analytics - Intervention group received the mobile phone software		patients' blood glucose levels, medication regimens, hypo- and hyperglycaemia algorithms, and requested additional data.		improvements in HbA1C levels.
Rachmani et al.[78]	Randomized controlled trial 1. Patient participation program: motivating patients to gain expertise and closely follow their risk parameters 2. Standard consultation	Not mentioned	Intervention provided by primary care physicians.	Follow-up of 7.7 years.	Levels of haemoglobin A1c were significantly lower in the intervention group. Well informed and motivated patients were more successful in obtaining and maintaining good control of their risk factors.
Sherifali et al.[79]	Health coaching	Not mentioned	Diabetes health coaching: goal setting, knowledge acquisition, individualized care, and frequent follow up.	Multiple studies included in this review.	Health coaching improved glucose control, and facilitates behaviour change
Thom et al.[45]	Randomized controlled trial. 1. Peer health coaching 2. Usual care	Based on earlier trials with use of peer health coaching. Peer coaches have the same disease as the people they assist, and experienced similar challenges of living with the chronic condition.	Intervention provided by peer coaches. These peer coaches attended 36 hours of training by a study team, aimed at providing the most optimal coaching.	Peer coaches contacted their patients either in person or by telephone. At least twice a month or more over 6 months.	Peer health coaching significantly improved diabetes control (HbA1C) in the peer health coaching group compared to the usual care group.
Tuomelitho et al.[80]	Lifestyle changes:	Not mentioned	Intervention group:	Follow-up of three	Diabetes type 2 can be

	an intervention group and a control group		individualized counselling aimed at weight reduction, fat intake, fiber intake, physical activity Control group: no counselling	years	prevented by lifestyle changes. Cumulative incidence of diabetes was 11 percent in the intervention group and 23 percent in the control group.
Van der Wulp et al.[64]	Self-management coaching intervention	Based on earlier research into peer support in diabetes patients. Bandura's Social Cognitive Theory is used for self-efficacy. Patient and expert interviews lead to an intervention.	The intervention was used during three monthly home visits of experts to patients.	Three home visits	A self-management coaching intervention for patients with diabetes type 2 only increased self-efficacy of patients with low self-efficacy shortly after diagnosis.
Wayne et al.[81]	Health coaching intervention with a 'health coach'.	Based on earlier research of Quinn et al. (2011) were four different intensity levels of internet-based support were compared.	Automated messages send to patients by their mobile phones, based on their input (meals, exercise, blood glucose, and mood).	Patients were followed up to six months.	No significance between intervention and control group was found, though improvements in HbA1c for patients with the health coaching intervention were found.
Wolever et al.[54]	Health coaching: an intervention group and a control group	Theory of integrative health coaching. Aimed at applying a holistic approach to optimize mental, physical, and social well-being rather than focusing on symptoms	Randomized patients into control group and intervention group. Integrative coaching was provided by two coaches. During a time period of 6 months, intervention group patients received	14 sessions during a research period of six months	A coaching intervention focussed on patients' values and sense of purpose may provide added benefit to diabetes education programs. In order to improve self-efficacy,

		and disease complications.	14 sessions of 30-minute telephone calls.		accountability and clinical outcomes.
(Other) chronic illnesses					
Ferrara et al.[82]	Lifestyle educational program for hypertensive patients. 1. Educational care group 2. Usual care group	Based on previous literature.	For the intervention group: small group meetings	Patients were seen at three-month intervals. Follow-up of two years.	Involving patients in a face-to-face program with doctors and dieticians is able to improve the outcome of the disease and reduce the risk of cardiovascular events.
Free et al.[83]	Mobile technologies to improve disease management and improve health behaviour.	Not mentioned	Mainly smartphone applications (mHealth).	75 trials included in this review.	Mixed evidence was found for the effectiveness of health intervention delivery to health-care consumers using mobile technology. The interventions need to be optimized.
Funnell[46]	Peer-based behavioural strategies to improve self-management.	Not mentioned. Though, not clearly described in the articles included which strategies are used for self-management support.	Different options: - face-to-face group peer support programmes - one-to-one peer programmes - web and email peer support programmes	Multiple studies included in this review.	Based on the multiple studies, it is not clear whether peer based coaching improves the long-term self-management of patients.
Gasser et al.[84]	Mobile lifestyle coaching application. - Intervention group using a smartphone application - Control group using a web interface	Not mentioned.	A smartphone application and a web interface aimed at lifestyle coaching.	28-day field study	The mobile application was used more frequently and evenly throughout the day. An application like this aimed at the health

					behaviour can be generally accessible.
Greist et al.[85]	Computer-guided behaviour therapy self-help system (BT STEPS).	Not mentioned	Accessible by the telephone of the patient.	10 weeks of behaviour therapy treatment	Computer-guided therapy was effective, although clinician-guided behaviour therapy was even more effective.
Griffiths et al.[86]	Web-based depression literacy and cognitive-behavioural therapy. Three intervention groups: 1. Depression information website (BluePages) 2. Behavioural skills training website (MoodGYM) 3. Attention control condition	Not mentioned	Both interventions were accessible via a website on the patient's computer. The control intervention involved weekly contact with an interviewer.	A research period of five weeks. For both intervention groups the patients could constantly look into the websites. For the control group the patients had weekly contact with an interviewer.	Both the web-based depression literacy and the behavioural intervention lead to a small reduction in attitude towards depression.
Härter et al.[87]	Telephone-based health coaching (TBHC) in chronically ill patients. Intervention group compared with a control group.	Based on earlier research. TBHC aims to enhance patients' self-management abilities by providing information for a better understanding of their condition.	Accessible by the telephone of the patient. Important components of the coaching intervention were: motivational interviewing, goal setting, and shared-decision making.	Two-year follow up period of patients.	TBHC lead to a better disease management and a higher awareness in patients.
Hibbard et al.[68]	Tailoring care to the patient's level of activation. - Intervention group in	Patient Activation Measure (PAM). A 13-item scale that predicts the range of	Telephone coaching between coaches and patients.	One year of pre-intervention period, and six months of post-intervention period.	Systematically measuring and tailoring coaching to patients' activation level would

	which coaches used the PAM scores to coach their patients. - Control group in which coaches did not have access to the PAM scores.	health behaviours.			improve the outcomes of the disease management.
Linden et al.[60]	Motivational interviewing based health coaching. Intervention group compared with a control group.	Not mentioned	Not mentioned.	8 months	Motivational interviewing-based health coaching improved patient's self-efficacy, patient activation, lifestyle change score, and perceived health status.
Yoo et al.[88]	Ubiquitous Chronic Disease Care system (UCDC) using cellular phones and the internet	Not mentioned	A cellular phone system combined with the internet to improve the quality and efficiency of chronic disease care	3 months	The UCDC system improved different metabolic parameters simultaneously in patients.

APPENDIX III. QUESTIONNAIRE

Vragenlijst

Onderzoek naar diabetes type 2 patiënten

Respondent nummer: _____

Kleur in of omcirkel het antwoord dat voor u van toepassing is.

1. Wat is uw geslacht?
   - ○ Man
   - ○ Vrouw

2. Wat is uw leeftijd?
   _____ jaar

3. Wat is uw opleidingsniveau?
   Geen / Basisonderwijs / VMBO / MBO / HAVO / HBO / VWO / WO / Post-WO

4. Wat is/was uw beroep?
   _____

5. Wat is uw sociale status?
   - ○ Alleenstaand
   - ○ Getrouwd
   - ○ Gescheiden/weduwe/weduwnaar
   - ○ Anders, namelijk _____

6. Hoe groot denkt u dat de invloed is van voeding op variaties in de suikerspiegel bij diabetes?

O	O	O	O	O
Geen invloed	Weinig invloed	Neutraal	Redelijke invloed	Veel invloed

7. Hoe groot denkt u dat de invloed is van voeding op het optreden van complicaties bij diabetes?

O	O	O	O	O
Geen invloed	Weinig invloed	Neutraal	Redelijke invloed	Veel invloed

8. Hoe groot denkt u dat de invloed is van beweging op variaties in de suikerspiegel bij diabetes?

O	O	O	O	O
Geen invloed	Weinig invloed	Neutraal	Redelijke invloed	Veel invloed

9. Hoe groot denkt u dat de invloed is van beweging op het optreden van complicaties bij diabetes?

O	O	O	O	O
Geen invloed	Weinig invloed	Neutraal	Redelijke invloed	Veel invloed

10. Onvoldoende beweging en onjuiste voeding kunnen niet de oorzaak zijn van diabetes.
- Juist
- Onjuist

11. Welke complicaties van de diabetes denkt u dat te voorkomen zijn?
- Retinopathie (oogklachten)
- Neuropathie (voetklachten)
- Nefropathie (nierproblemen)
- Hart- en vaatziekten
- Alle bovenstaande

12. Hoe groot vindt u de invloed van de diabetes op uw kwaliteit van leven?

O	O	O	O	O
Helemaal niet groot	Niet zo groot	Neutraal	Redelijk groot	Erg groot

13. Hoe goed heeft u voor uw gevoel momenteel uw diabetes onder controle?

O	O	O	O	O
Helemaal niet goed	Niet zo goed	Neutraal	Redelijk goed	Erg goed

14. In hoeverre acht u uzelf in staat om acties te ondernemen die uw diabetes zouden kunnen verbeteren?

O	O	O	O	O
Helemaal niet goed	Niet zo goed	Neutraal	Redelijk goed	Erg goed

15. Hoeveel stappen denkt u dat u gemiddeld op een dag moet zetten om ‘gezond’ bezig te zijn?
- 1000
- 5000
- 10.000

16. In welke mate voldoet u zelf aan deze richtlijn?

O	O	O	O	O
Helemaal niet goed	Niet zo goed	Neutraal	Redelijk goed	Erg goed

17. Hoeveel minuten denkt u dat u gemiddeld op een dag moet bewegen (denk hierbij aan wandelen, fietsen, zwemmen, etc.)?
- 15 min
- 30 min
- 60 min

18. In welke mate voldoet u zelf aan deze richtlijn?

O	O	O	O	O
Helemaal niet goed	Niet zo goed	Neutraal	Redelijk goed	Erg goed

19. Welke voedingsmiddelen zorgen volgens u voor een <u>verhoogd</u> risico op diabetes?

- (Suikerhoudende) frisdrank
- Groenten
- Koffie
- Vlees
- Yoghurt
- Alcohol

20. Vanaf welk percentage gewichtsverlies wordt er volgens u een verbetering in de bloedsuikerwaarden gezien?

- 5 procent van het lichaamsgewicht
- 10 procent van het lichaamsgewicht
- 20 procent van het lichaamsgewicht

APPENDIX IV. INTERVIEW SCHEME

Interview

Onderzoek naar diabetes type 2 patiënten

Respondent nummer: _____

Welkom, hartelijk bedankt dat u mee wilt werken aan dit onderzoek voor mijn afstudeeropdracht hier op het ZGT in Almelo.

Mijn naam is Michèle Lankheet en ik ben een masterstudente Gezondheidswetenschappen aan de Universiteit Twente in Enschede.

Ik doe voor mijn afstudeeropdracht een onderzoek naar diabetes type 2 patiënten, waarin ik kijk naar de mogelijkheden van coaching voor de ziekte diabetes. Ik richt mij hierbij op voeding en beweging (dus leefstijl), aangezien er over medicatie al veel bekend is.

In dit interview zal ik enkele vragen stellen met betrekking tot uw mening over coaching voor de ziekte diabetes. Alles wat u zegt gedurende dit interview zal anoniem verwerkt worden. Geeft u mij toestemming om dit interview op te nemen zodat ik deze terug kan luisteren? Heeft u verder nog vragen voordat we beginnen?

1. Heeft u het gevoel dat u zelf goed om kunt gaan met de dagelijkse zorg (ook wel: zelf-zorg) die bij de ziekte diabetes komt kijken?
Zelf-zorg, ook wel zelf-management genoemd, gaat over het omgaan met de dagelijkse bijkomstigheden van de diabetes, bijvoorbeeld: medicatie, glucosemetingen, insuline spuiten, bijwerkingen, etc.

2. Wat heeft u nodig op het gebied van ondersteuning van deze zelf-zorg van uw diabetes?

3. Heeft u het gevoel dat u uw eigen keuzes kunt maken ten opzichte van uw diabetes?
Denk hierbij aan keuzes binnen uw behandeling, medicatie, artsen, contactmomenten, etc.

4. Voelt u zich gesteund door uw naasten (familie, vrienden, buren, etc.) in het omgaan met uw diabetes?

5. U heeft ook de vragenlijst ingevuld met vragen over voeding en beweging (leefstijl) gerelateerd aan de diabetes. Heeft uw diabetes arts, verpleegkundige of diëtist u informatie verschaft over de mogelijkheden hiervan?

6. Wat zou er volgens u kunnen veranderen aan uw diabetes als u uw voeding en beweging (leefstijl) gaat veranderen?

7. Acht u uzelf in staat acties te ondernemen om uw diabetes te verbeteren?

8. Voelt u zich ook gemotiveerd om deze acties te ondernemen die uw diabetes kunnen verbeteren?

9. Welke dingen motiveren u om uw voeding en beweging (leefstijl) te verbeteren ten opzichte van uw diabetes?

10. Welke manieren van beweging zorgen voor u voor een betere kwaliteit van leven? Dus met andere woorden: van welke manieren van beweging wordt u gelukkig?

11. Welke doelen zou u voor uzelf willen stellen op het gebied van voeding en beweging (leefstijlveranderingen)?

12. Hoe zou u gemotiveerd willen worden in voeding en beweging (leefstijlveranderingen) om uw diabetes te verbeteren?

13. Op welke manier zou u begeleid (gecoacht) willen worden in het verbeteren van uw diabetes?

14. Op welke manier zou u begeleid (gecoacht) willen worden in voeding en beweging (leefstijlveranderingen)?

15. Zou u begeleiding (coaching) door medepatiënten prettig vinden om u te motiveren?

16. Bent u bekend met technologieën als: een iPad, tablet, laptop, smartphone, etc.?

17. Denkt u dat een technologie u zou kunnen motiveren om uw voeding en leefstijl aan te passen?
Denk bij een 'technologie' aan een soort ondersteuning die u kunt krijgen op uw smartphone, iPad, computer, etc.

18. Wat zou zo'n technologie volgens u moeten kunnen doen?
Denk hierbij aan dingen in het gebruik van een technologie, hoe deze er uit zou moeten zien, wat deze technologie zou moeten kunnen, wat deze technologie zou bevatten, etc.

19. Voelt u zichzelf gemotiveerd om met een technologie als deze aan het werk te gaan in de toekomst?

Dit waren alle vragen van dit interview. Heeft u verder nog aanvullingen?

Dan wil ik u hartelijk bedanken voor uw medewerking.

APPENDIX V. CODING SCHEME

Table 5. Interview coding scheme Atlas.ti 8.0

Number	Interview question	Code
1	Heeft u het gevoel dat u zelf goed om kunt gaan met de dagelijkse zorg (ook wel: zelf-zorg) die bij de ziekte diabetes komt kijken?	Self_managing_diabetes_negative
		Self_managing_diabetes_positive
2	Wat heeft u nodig op het gebied van ondersteuning van deze zelf-zorg van uw diabetes?	Self_management_support
3	Heeft u het gevoel dat u uw eigen keuzes kunt maken ten opzichte van uw diabetes?	Autonomy_notownchoices
		Autonomy_ownchoices
		Autonomy_noidea
4	Voelt u zich gesteund door uw naasten (familie, vrienden, buren, etc.) in het omgaan met uw diabetes?	Relatedness_negative
		Relatedness_positive
5	U heeft ook de vragenlijst ingevuld met vragen over voeding en beweging (leefstijl) gerelateerd aan de diabetes. Heeft uw diabetes arts, verpleegkundige of diëtist u informatie verschaft over de mogelijkheden hiervan?	Support_caregivers
6	Wat zou er volgens u kunnen veranderen aan uw diabetes als u uw voeding en beweging (leefstijl) gaat veranderen?	Effect_lifestylechanges_on_diabetes
7	Acht u uzelf in staat acties te ondernemen om uw diabetes te verbeteren?	Competence_negative
		Competence_positive
8	Voelt u zich ook gemotiveerd om deze acties te ondernemen die uw diabetes kunnen verbeteren?	Motivation_patient_negative
		Motivation_patient_positive
9	Welke dingen motiveren u om uw voeding en beweging (leefstijl) te verbeteren ten opzichte van uw diabetes?	Motivation_intooutcomes
10	Welke manieren van beweging zorgen voor u voor een betere kwaliteit van leven? Dus met andere woorden: van welke manieren van beweging wordt u gelukkig?	Exercise/Movement_options_QOLimprovement
11	Welke doelen zou u voor uzelf willen stellen op het gebied van voeding en beweging (leefstijlveranderingen)?	Diabetes_goals
12	Hoe zou u gemotiveerd willen worden in voeding en beweging (leefstijlveranderingen) om uw diabetes te verbeteren?	Motivation_options
		Extrinsic_motivation
		Intrinsic_motivation
13	Op welke manier zou u begeleid (gecoacht) willen worden in het verbeteren van uw diabetes?	Coaching_improving_diabetes
14	Op welke manier zou u begeleid (gecoacht) willen	Coaching_lifestyle_changes

	worden in voeding en beweging (leefstijlveranderingen)?	
15	Zou u begeleiding (coaching) door medepatiënten prettig vinden om u te motiveren?	Peer_motivation_negative
		Peer_motivation_positive
16	Bent u bekend met technologieën als: een iPad, tablet, laptop, smartphone, etc.?	Technology_familiar_yes
		Technology_familiar_no
17	Denkt u dat een technologie u zou kunnen motiveren om uw voeding en leefstijl aan te passen?	Technology_motivates_to_change_no
		Technology_motivates_to_change_yes
18	Wat zou zo'n technologie volgens u moeten kunnen doen?	Technology_requirements_options
19	Voelt u zichzelf gemotiveerd om met een technologie als deze aan het werk te gaan in de toekomst?	Technology_motivation_negative
		Technology_motivation_positive

APPENDIX VI. ADDITIONAL TABLES

Influence of nutrition and exercise on the diabetes

Table 6. Influence of nutrition and exercise on the diabetes

Number (percentage)	None	Little	Neutral	Reasonable	Much
Influence of nutrition on variations in the blood glucose level	0 (0)	0 (0)	2 (11)	6 (32)	11 (58)
Influence of nutrition on the occurrence of complications related to the diabetes	0 (0)	0 (0)	3 (16)	10 (53)	6 (32)
Influence of exercise on variations in the blood glucose level	0 (0)	0 (0)	2 (11)	9 (47)	8 (42)
Influence of exercise on the occurrence of complications related to the diabetes	0 (0)	0 (0)	5 (26)	11 (58)	3 (16)

Complications of the diabetes

Table 7. Complications of the diabetes to be prevented

Complication to be prevented	Number of respondents (percentage)
Retinopathy	2 (11)
Neuropathy	3 (16)
Nephropathy	1 (5)
Cardiovascular disease	3 (16)
All of the above	13 (68)

Self-management of the respondent

Table 8. Self-management of the respondent

Number (percentage)	None	Little	Neutral	Reasonable	Much
Influence of the diabetes on the respondent's quality of life	2 (11)	3 (16)	8 (42)	5 (26)	1 (5)
Sense of control over the diabetes	0 (0)	0 (0)	4 (21)	12 (63)	3 (16)
Capability of the respondent to take actions for improvement of their diabetes	0 (0)	3 (16)	2 (11)	11 (58)	3 (16)

Desirable behaviour on exercise, food and weight

Table 9. Desired number of steps per day

	Number (percentage)
1000 steps per day	4 (21)
5000 steps per day	11 (58)
10000 steps per day	4 (21)

Table 10. Desired number of minutes of movement per day

	Number (percentage)
15 minutes per day	1 (5)
30 minutes per day	13 (68)
60 minutes per day	5 (26)

Table 11. Do the respondents think they meet the guidelines of the desired number of steps and minutes of movement per day?

Number (percentage)	**Not**	**Little**	**Neutral**	**Reasonable**	**Much**
Respondent meets the criteria of the number of steps per day	1 (5)	4 (21)	5 (26)	9 (47)	0 (0)
Respondent meets the criteria of the number of minutes movement per day	0 (0)	3 (16)	4 (21)	11 (58)	1 (5)

Table 12. Food types that can increase the risk of diabetes

Food types	Number of respondents (percentage)
Soda	15 (79)
Vegetables	0 (0)
Coffee	3 (16)
Meat	1 (5)
Yoghurt	1 (5)
Alcohol	13 (68)

Table 13. Percentage of weight loss that can improve the blood glucose levels of the respondent

	Number (percentage)
5% weight loss	7 (37)
10% weight loss	11 (58)
20% weight loss	1(5)

APPENDIX VII. FUNCTIONALITIES

In this research the possibilities of coaching for diabetes type 2 patients were examined. In the interviews patients were asked questions about their opinion regarding a coaching system using technology, a so called eHealth system. In this Appendix the requirements mentioned in the Discussion are explained with use of the functionalities of Table 2 mentioned by the patients in the interviews. By combining the requirements with the functionalities, the possible solutions of a coaching technology are established. At first each requirements is worked out in one or more goal(s), after which these goals are linked to the functionalities. Table 14 shows the possible functionalities of the future coaching technology.

Table 14. Possible functionalities of the future coaching technology

Requirement	Goal(s)	Functionalities
Knowledge transfer	Technology must improve patient's knowledge on the aspects of exercise and nutritional changes for improvement of their diabetes.	The technology should start with an information transfer regarding exercise, nutrition and the diabetes itself. Patients mentioned to need information on these three aspects and the technology could include an information point where this information is shown. The patients can look up the information themselves.
		Besides having patients looking for information themselves, the diabetes doctor or nurse should intervene in the knowledge transfer. The diabetes doctor or nurse could 'test' the patient's knowledge and provide the appropriate information so that patients keep learning new aspects linked to their illness.
Personal monitoring	Technology must show patients they do not have the appropriate knowledge regarding lifestyle choices and their illness.	The technology must have access to objective data of the patient, regarding their illness and lifestyle habits. Also, objective data regarding their knowledge on the aspects linked to their illness. Patients must understand that their knowledge needs to be increased and that they are unaware of important information regarding exercise and nutrition. Hereby, the technology can interact with patients on their individual knowledge levels.
	Technology must intervene at the patient's level of awareness.	The technology should be able to be adapted to the needs of the patient, in which each patient starts at a different level of awareness and needs different information. The diabetes doctor or nurse, who will 'test' the knowledge of the patient, should be able to adapt the technology to these patient needs.
	Technology must be adapted to the patient's willingness and ability to change.	Patients must first understand why they have to change their exercise and nutrition. After this, they have to be motivated to actually perform the healthy behaviour. In cooperation with the patient, the diabetes doctor or nurse should find small rewards for the patient. So, figure out what will drive them into these healthy lifestyle changes. This will need small steps at a time, for which the diabetes doctor or nurse must actually know the patient's illness situation and abilities. By aiming at small improvements at first, the

		patient will most likely be able and motivated to perform the behaviour.
Caregiver knowledge	Technology must allow caregivers to adapt the information to the need of the patient.	By continuously monitoring the patient's diabetes outcomes, exercise and nutrition the caregivers can interact with the patient at their own level and adapt the information to the situation of the patient. Caregivers hereby gain insight into the patient's specific situation and needs.
		Therefore, the technology must be available at all times, for instance linked to the mobile phone or tablet of the patient and linked to the computer of the diabetes doctor or nurse.
Personalised feedback	Technology must provide patients with feedback based on their objective data.	The technology should include a continuous blood glucose measure, step counter and nutrition diary, according to the preferences of the patients. By linking the information of these measures to feedback messages, the patient will receive direct feedback on the behaviour they perform.
		The feedback should be based on the patient's preferences, hereby aiming at small improvements at a time. The feedback should be linked to a reward, aimed at the patient's needs.
		Patients mentioned to like information on their blood glucose levels, exercise and nutrition. The technology should therefore show patients their current blood glucose levels, step count and nutrition intake. The technology should also provide warnings when the patient does not exercise enough and when their blood glucose levels are too high or too low. Besides this, the technology should allow patients to check their carbohydrates intake, based on their nutrition diary. Finally, based on the step counter, the technology should be able to show the burned calories of the patient.
		A minority of the patients mentioned to be also interested in their heart rate and blood pressure. So, the technology should have the ability to show these outcomes as well, based on the patient's preferences and input.

APPENDIX VIII. DESIGN IDEAS

Based on the preferences of the patients, four design ideas (also known as mock-ups) of the future coaching technology are developed. These mock-ups are prototype versions of the interface of the eHealth system, here called the 'Diabetes type 2 application' and are based on the functionalities mentioned by the patients. The mock-ups are based on the researcher's interpretation of these functionalities and aim to simply visualize the patient's preferences.

The first mock-up, shown in Figure 4, depicts the home screen of the future coaching technology, with an overview of the patient's blood glucose level, step counter and nutrition diary. The second mock-up, depicted in Figure 5, contains the step counter of the patient, with the number of steps shown for the past week in this example. Figure 6 contains a mock-up showing the blood glucose levels of the patient, also depicted per week. Finally, Figure 7 shows the nutrition diary of the patient, in which the patient can adjust their daily nutrition and check the food types and calories these contain.

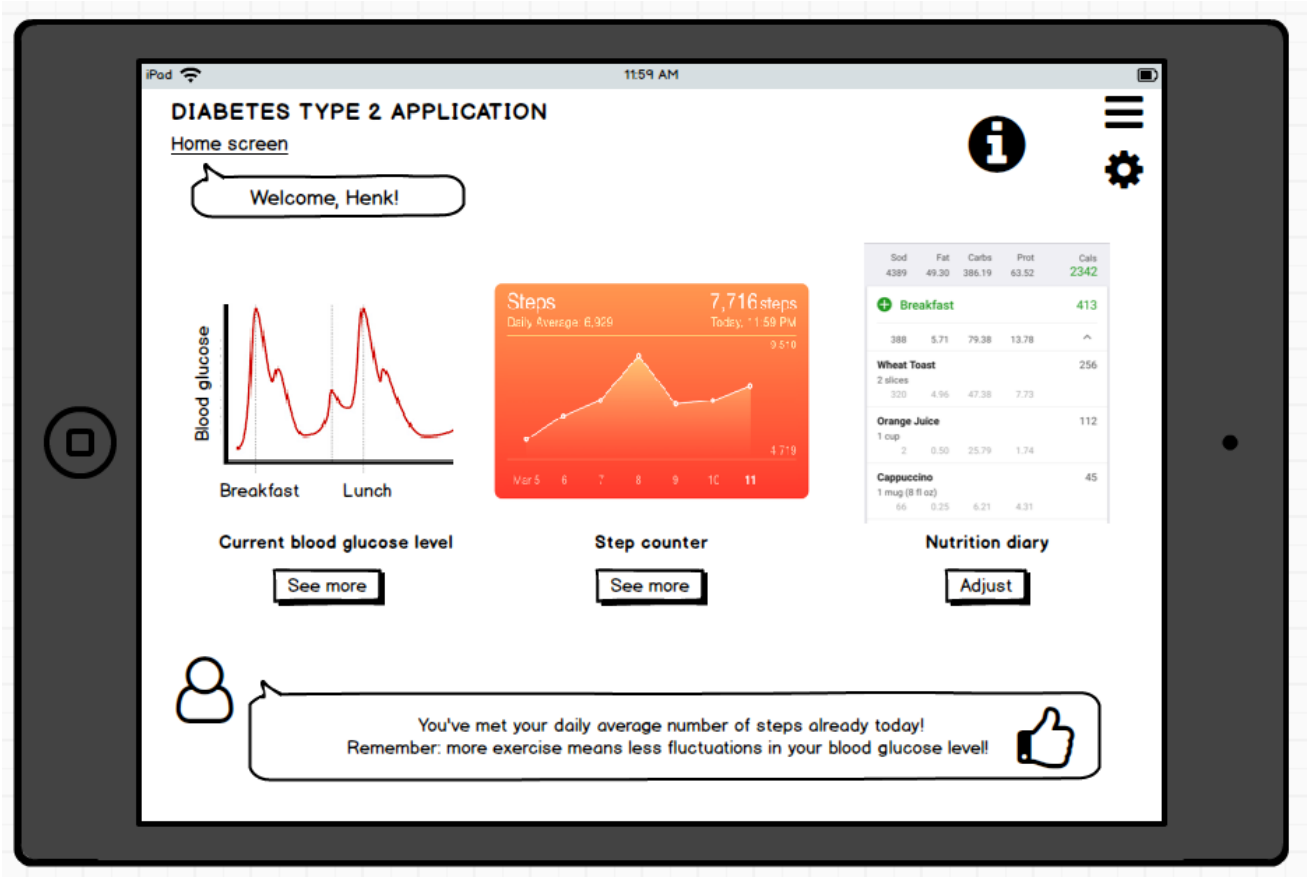

Figure 4. Home screen of the future coaching technology 'Diabetes type 2 application'

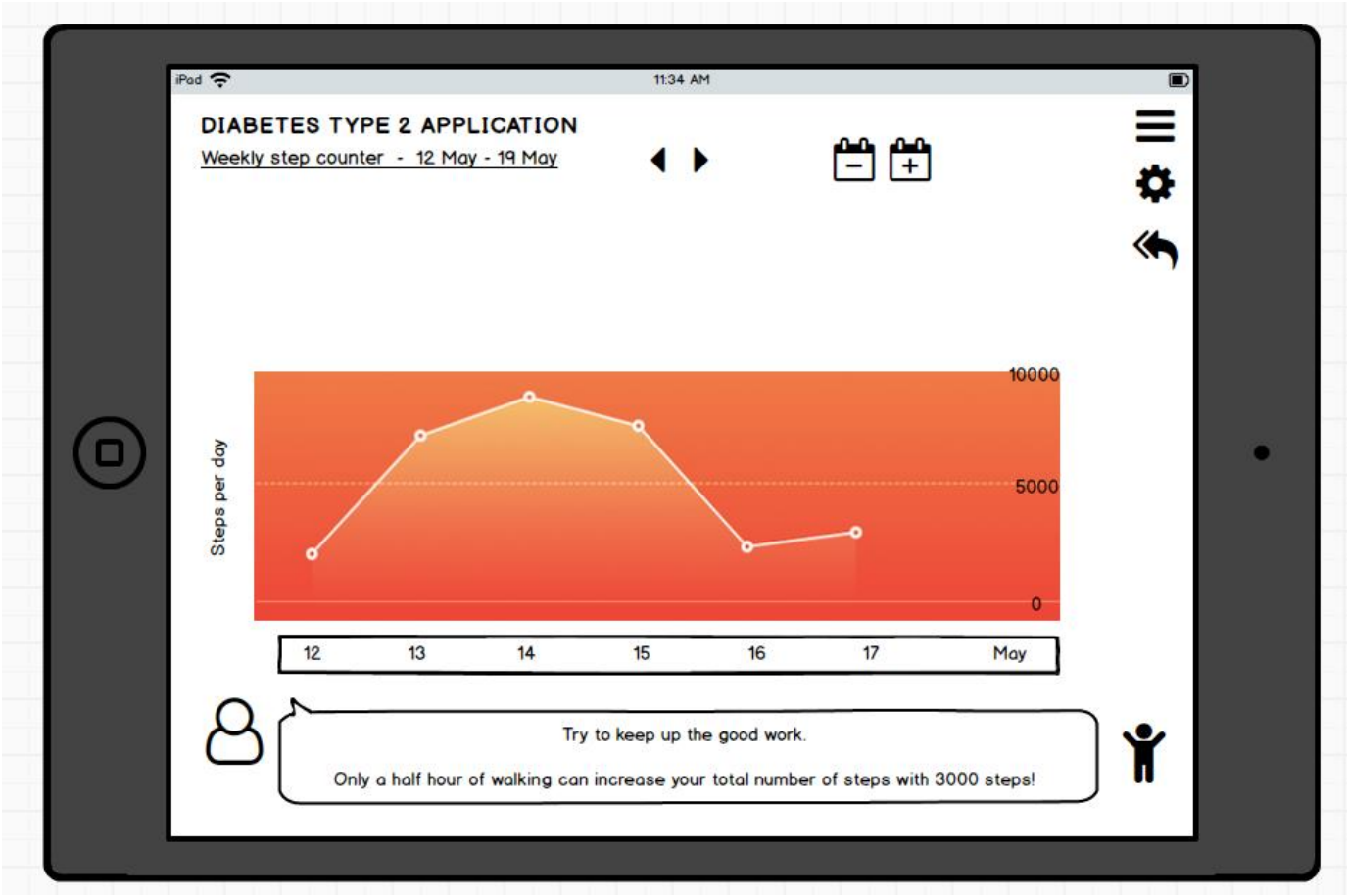

Figure 5. Screen showing step counter in the future coaching technology 'Diabetes type 2 application'

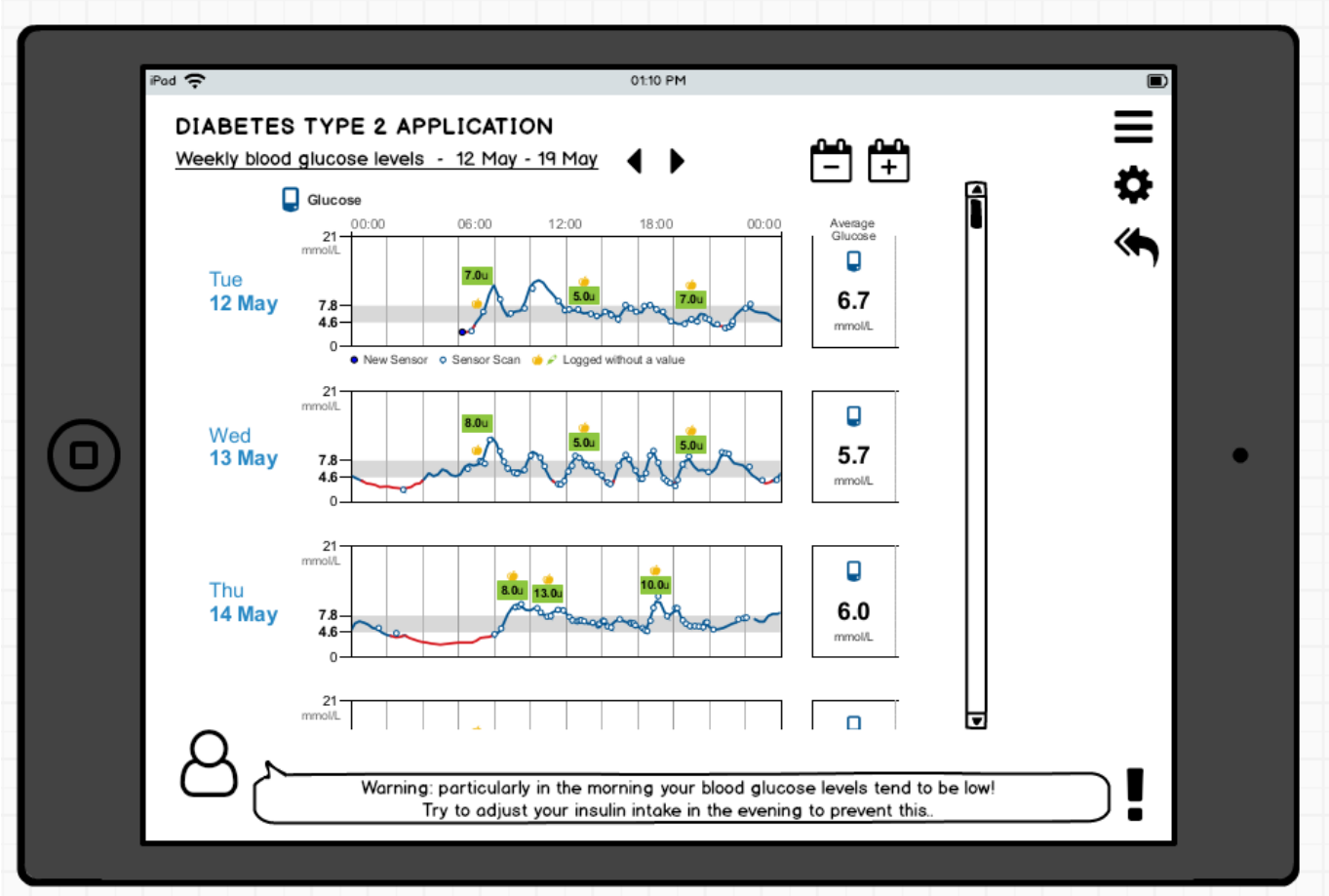

Figure 6. Screen showing blood glucose levels in the future coaching technology 'Diabetes type 2 application'

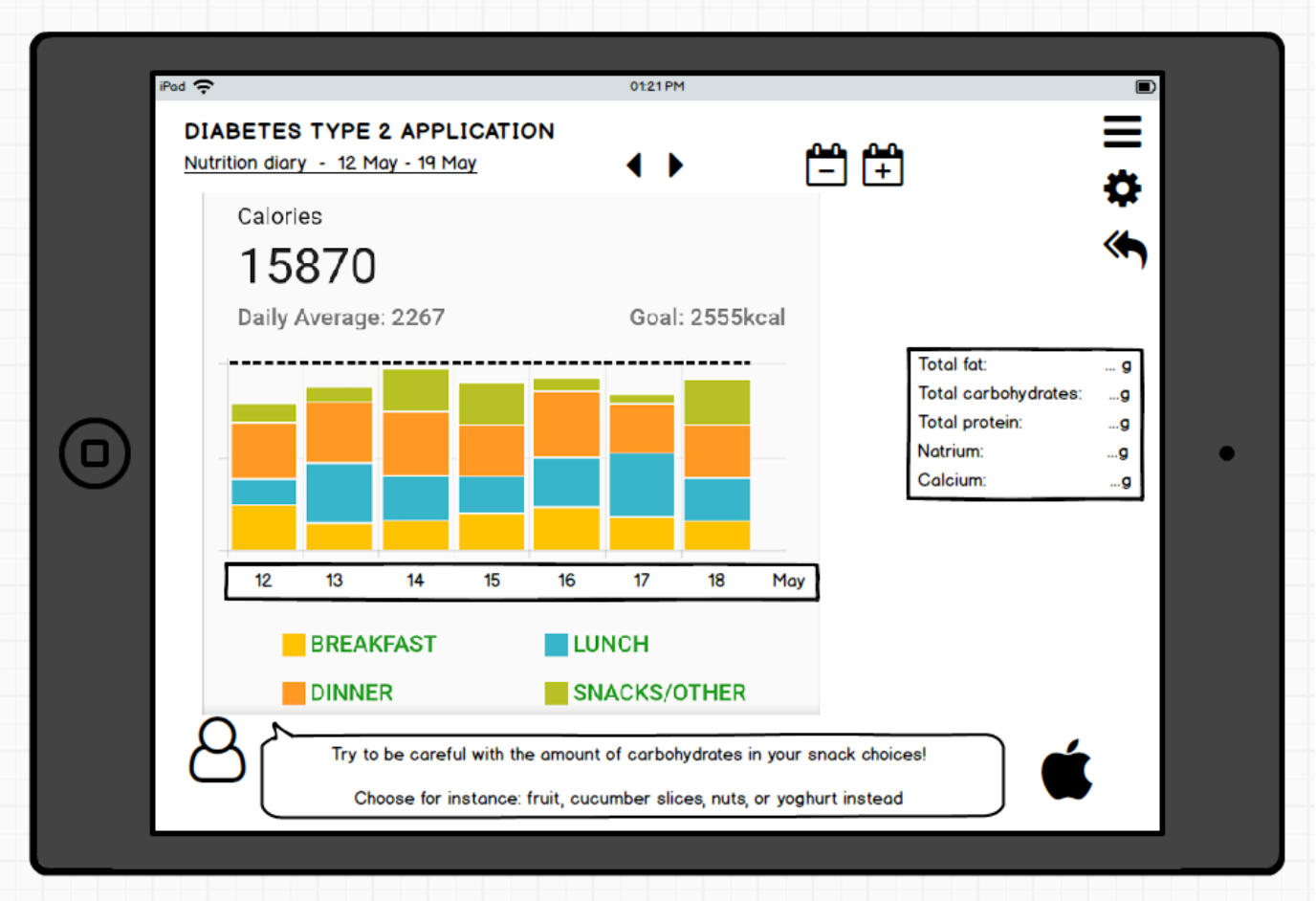

Figure 7. Screen showing the nutrition diary in the future coaching technology 'Diabetes type 2 application'