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Ambrož, Martina; de Vries, Sieta T; Buitenhuis, Goya; Frost, Julia; Denig, Petra

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# Willingness of people with type 2 diabetes to engage in healthy eating, physical activity and medication taking

Martina Ambrož<sup>a,1</sup>, Sieta T. de Vries<sup>a,2</sup>, Goya Buitenhuis<sup>a</sup>, Julia Frost<sup>b,3</sup>, Petra Denig<sup>a,\*,4</sup>

<sup>a</sup> Department of Clinical Pharmacy and Pharmacology, University of Groningen, University Medical Center Groningen, Groningen, the Netherlands

<sup>b</sup> Department of Health and Community Sciences, College of Medicine and Health, University of Exeter, UK

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## ABSTRACT

**Aim:** To assess the willingness of people with type 2 diabetes (T2D) to engage in healthy eating, physical activity and medication taking, and explore associated patient factors.

**Methods:** Online survey among recently diagnosed T2D patients recruited in the Netherlands and the United Kingdom (UK). Patient factors included general factors and behaviour-specific beliefs. Logistic regression analyses and explorative comparisons were conducted.

**Results:** Overall, 48% of 67 patients were willing to engage in all three management options, whereas 6% were not willing to follow any of them. 73% were willing to manage T2D with healthy eating, 73% with physical activity, and 72% with medication. Country of recruitment was significantly associated with willingness for healthy eating, with higher willingness among Dutch participants. Beliefs surrounding capability, opportunity, and motivation were significantly associated with willingness to engage in physical activity and medication taking. Many beliefs were similar regardless of willingness but those willing to engage in physical activity perceived less barriers and those willing to take medication had more positive and less negative outcome beliefs than those not willing.

**Conclusions:** Willingness to engage in all management options was limited among recently diagnosed patients, and partly associated with behaviour-specific patient beliefs.

## 1. Introduction

Type 2 diabetes (T2D) can partly be a consequence of unhealthy lifestyles, such as diets high in sugar, high alcohol consumption, smoking, and lack of physical activity. Lifestyle changes are therefore important in T2D management, and several studies have shown the efficacy of lifestyle changes in the management or even remission of T2D [1,2]. More specifically, most people with T2D are overweight and a weight loss of  $\geq 5\%$  has been shown to reduce glycated haemoglobin A1c (HbA1c) levels by 0.6–1.2% [3]. When lifestyle changes cannot provide sufficient diabetes control, guidelines recommend initiation of metformin as a first step in the medication management of T2D for most patients [4,5]. Nevertheless, T2D management should, in addition to medication, always include a healthy lifestyle.

Little is currently known about the willingness of people with T2D to engage in different options to manage their disease. Willingness is considered a prerequisite for behavioural change and can be influenced by beliefs and other patient-related factors [6]. A study conducted in France identified five clusters of T2D patients based on their beliefs, attitudes, and reported behaviour regarding lifestyle and medication [7]. Some people appeared to be committed to both lifestyle changes and medication taking, while others expressed they are no longer modifying their lifestyle because they take medication. There were also people who reported being unable to successfully implement any T2D management options [7]. Lifestyle changes can be difficult for patients [8–10] and different barriers related to lifestyle modifications have been observed, such as beliefs that they are not helpful or that taking a pill is easier, lack of knowledge, low income and lack of social support [8,

\* Correspondence to: PO Box 30.001, Groningen 9700 RB, the Netherlands.

E-mail address: [p.denig@umcg.nl](mailto:p.denig@umcg.nl) (P. Denig).

<sup>1</sup> <https://orcid.org/0000-0003-1319-4898>.

<sup>2</sup> <https://orcid.org/0000-0001-6090-2434>.

<sup>3</sup> <https://orcid.org/0000-0002-3503-5911>.

<sup>4</sup> <https://orcid.org/0000-0002-7929-4739>.

11–14]. Regarding medication, a study in the Netherlands found that 45% of people with T2D were willing to take all medication needed to reach targets for HbA1c, blood pressure and cholesterol [15]. Better insight into patients' willingness and related factors is important for developing tailored support strategies to manage T2D. Aside from general patient-related factors, this should incorporate behaviour-specific factors that have been identified as key to implementation of new behaviour. These are described in the COM-B model as perceived capability, opportunity and motivation towards the specific behaviour [16].

We aimed to assess the willingness of people recently diagnosed with T2D to engage in healthy eating, sufficient physical activity, and medication taking, and explore general and behaviour-specific patient factors associated with the willingness to manage T2D with each of these options. In addition, we aimed to deepen our understanding of factors underlying differences in willingness.

## 2. Methods

### 2.1. Study design and population

We conducted a cross-sectional survey study among people recently diagnosed with T2D in the Netherlands and the United Kingdom (UK) using an online questionnaire consisting of closed-ended and open-ended questions between December 2021 and July 2022.

In the Netherlands, participants were mainly recruited through diabetes nurses or nurse practitioners in general practices and an endocrinologist in a hospital. Patients who agreed to participate received a personalised link to the questionnaire. People who did not open it, received two reminders sent ten days apart. Additionally, an advertisement with an open questionnaire link was posted on the Dutch website for diabetes patients (Diabetes Fonds; <https://www.diabetesfonds.nl>). Participants who completed the survey could participate in a prize draw of 10 and 50€. In the UK, participants were recruited through an advertisement with an open questionnaire link on the UK website for diabetes patients (DiabetesUK; <https://www.diabetes.org.uk/>), which was additionally advertised on Twitter and the DiabetesUK forum.

People were invited to participate if they had been diagnosed with T2D in the previous two years, were 18 years or older, were able to read Dutch (in the Netherlands) or English (in the UK) and had access to an electronic device where they could fill out the questionnaire. Before starting the questionnaire, they had to provide informed consent.

We obtained an exemption letter from the University Medical Center Groningen Medical Ethics Review Board (reference number M21.286275) for this survey study using anonymous data in the Netherlands. For the UK, we obtained ethical approval from the University of Exeter Research Ethics Committee (ethics application ID 489430).

### 2.2. Questionnaire

The questionnaire was developed in English and translated to Dutch by an official translator. For assessing patient factors, we used items from existing validated questionnaires where possible (see Section 2.4). We developed additional items for assessing willingness based on previous literature and frameworks related to behavioural change [16–18]. We pilot-tested the questionnaire among eleven people with T2D in the Netherlands and the UK (Supplementary material 1). These patients were asked to complete the questionnaire, which was followed by an online interview conducted by MA, GB and/or SdV to identify unclear or ambiguous questions or answer options. Several items and answer options, in both languages, were adapted, added, or removed based on the pilot participants' comments.

The final version of the questionnaire (Supplementary material 2) included questions about the patient's demographics, current lifestyle and T2D management, experiences, beliefs, and willingness to manage

T2D with healthy eating, sufficient physical activity and medication taking, as well as their considerations related to this willingness. Study data were collected using the Research Electronic Data Capture software [19,20].

### 2.3. Willingness to engage in different management options

To assess the main outcome, that is, the patients' willingness to manage T2D with [1] healthy eating, [2] sufficient physical activity and [3] medication taking, a short description of healthy eating and physical activity recommendations based on guidelines in the Netherlands and the UK [21–24] was provided in the questionnaire. For medication taking, information about dosing and potential side effects was provided based on the summary of product characteristics of metformin [25]. Patients were asked: "How willing are you to follow these recommendations every day to manage your diabetes?" for healthy eating, "How willing are you to engage in this amount of physical activity every week to manage your diabetes?" for physical activity, and "How willing are you to take diabetes medication like metformin once or twice a day to manage your diabetes?" for medication. Willingness was measured on a Visual Analogue Scale (VAS) ranging from *not willing at all* (0) to *very willing* (100). Patients were categorised based on their willingness into those willing (VAS score > 50) and not willing (VAS score ≤ 50).

### 2.4. Patient factors associated with willingness

We assessed the association of both general patient factors and behaviour-specific patient factors with the willingness to manage T2D with each of the three management options.

As general patient factors, we included demographics (i.e., country of recruitment, sex, age, education, income, living and work situation), diabetes-related information (i.e., diabetes duration, relative with T2D, level of worry about negative consequences of having diabetes, and current management of T2D), lifestyle-related information (i.e., smoking, alcohol consumption, body mass index (BMI), current healthy and unhealthy diet choices, level of physical activity and days of sitting), past experiences with weight loss and each of the management options, and general medication beliefs (Supplementary Table 2). The majority of the items had a binary or categorical scoring. Level of worry about negative consequences of having diabetes was measured on a VAS ranging from *not worried at all* (0) to *very worried* (100). Eating pattern in the last month was based on the shortened version of the United Kingdom Diabetes and Diet Questionnaire (UKDDQ) [26], level of physical activity in the last week was measured using the International Physical Activity Questionnaire – Short Form (IPAQ-SF) [27], and general medication beliefs were measured using the Beliefs about Medicines Questionnaire (BMQ-general) [28]. The BMQ-general questionnaire consists of three subscales with statements related to overuse, harm and benefit scored on a five-point Likert scale. Cronbach's alpha of the subscales in our study was 0.722, 0.725 and 0.736, respectively. The mean score of items per subscale was calculated.

As behaviour-specific patient factors, we included a sum score for patient beliefs regarding their capabilities, opportunities and motivation (i.e., the COM-B components) towards each of the three presented management options. For assessing the capabilities, opportunities and motivation, the participants were asked about their agreement with statements regarding healthy eating (20 statements, see Supplementary Table 3), sufficient physical activity (21 statements, see Supplementary Table 4) and medication taking (17 statements, see Supplementary Table 5). Participants were asked to rate these COM-B statements on a five-point Likert scale ranging from *not at all/strongly disagree* [1] to *absolutely yes/strongly agree* [5]. A "not applicable option" was offered, which we counted as a missing value. Mean COM-B scores were calculated by summarising all statements per management option, for which negatively presented statements were reversed before summarising.

### 2.5. Deepening of understanding differences

To further explore why participants were or were not willing to engage in healthy eating, sufficient physical activity and medication taking, we compared their answers to individual COM-B statements as well as their answers to six open-ended questions. In these open-ended questions, participants were asked to briefly describe why they would and why they would not be willing to follow each of the presented management options (i.e., “Please briefly describe why you would be willing to (a) follow these eating recommendations/(b) engage in this amount of physical activity/(c) take diabetes medicines like metformin to manage your diabetes.” and “Please briefly describe why you would not be willing to (a) follow these eating recommendations/(b) engage in this amount of physical activity/(c) take diabetes medicines like metformin to manage your diabetes.”).

**Table 1**  
Participant characteristics.

		N = 67
Females; N (%) <sup>†</sup>		30 (45)
Age in years; mean ± SD		57 ± 11
Diabetes duration; N (%)		
	< 6 months	25 (37)
	6 up to 12 months	18 (27)
	12 up to 18 months	13 (19)
	18 up to 24 months	11 (16)
Country of recruitment	The Netherlands	44 (66)
	United Kingdom	23 (34)
BMI in kg/m <sup>2</sup> ; mean ± SD <sup>‡</sup>		31.4 ± 8.0
Lives alone; N (%)		11 (16)
Yearly household income < £50,270 (UK) or < 68,507€ (NL) <sup>‡</sup> ; N (%)		44 (71)
Education level; N (%) <sup>∞</sup>	Middle	35 (52)
	High	32 (48)
Hours of work per week; N (%)	0 h	27 (40)
	1 up to 20 h	7 (10)
	20 up to 40 h	17 (25)
	≥ 40 h	16 (24)
Hours of volunteering and/or caring for others per week; N (%) <sup>§</sup> 0 h		26 (39)
	1 up to 20 h	32 (48)
	20 up to 40 h	9 (13)
Having a relative with T2D; N (%) <sup>*</sup>		37 (55)
Current T2D management	No management	6 (9)
	Lifestyle	31 (46)
Metformin (monotherapy or in combinations)		36 (54)
Other drugs (oral, other injections)		9 (12)
Worried about diabetes consequences; mean ± SD <sup>‡</sup>		55 ± 26
Negative past experience with; N (%)	Weight loss	23 (34)
	Changing eating pattern	15 (22)
	Increasing physical activity	21 (31)
	Side effects of metformin	13 (19)
Eating pattern in the last month based on the shortened UKDDQ; mean ± SD		
	% of healthy choices;	54 ± 20
	% of unhealthy choices	13 ± 12
Smoking <sup>¶</sup>		8 (12)
Alcohol consumption; N (%) <sup>α</sup>	No alcohol	30 (48)
	1 up to 10 drinks per week	29 (47)
	≥ 10 drinks per week	3 (5)
Physical activity level in the last week based on the IPAQ-SF score; N (%)		
	Low (< 600 MET min/week)	26 (39)
	Moderate (≥ 600–3000 MET min/week)	32 (48)
	High (≥ 3000 MET min/week)	9 (13)
Days of sitting > 8 h per week; median [IQR]		3 [1–5]
BMQ - general; mean ± SD	Overuse <sup>‡</sup>	3.3 ± 0.8
	Harm	2.6 ± 0.5
	Benefit	3.7 ± 0.6
COM-B sum score; mean ± SD	Healthy eating	3.7 ± 0.5
	Sufficient physical activity	3.7 ± 0.6
	Medication taking	3.9 ± 0.6

BMI = Body Mass Index; UK = United Kingdom; NL = The Netherlands; T2D = Type 2 diabetes; UKDDQ = United Kingdom Diabetes and Diet Questionnaire; IPAQ-SF = International Physical Activity Questionnaire – Short Form; MET = Metabolic Equivalent of Task; BMQ = Beliefs about Medicines Questionnaire; COM-B = Capabilities, Opportunities, and Motivation of Behaviour. † No patients answered other. ‡ Three missing values. α Five missing values. ∞ Low: no education, primary school; Middle: secondary education; High: higher vocational education, university. ‡ No included patients had low education. § Includes volunteering and care for others. \* Excluding partners. ‡ Four missing values. ¶ Regular or occasional, also including other tobacco products. ‡ One missing value. BMQ – general is copyrighted (© Professor Robert Horne).

### 2.6. Analyses

Descriptive statistics were used to present the patient factors and the patients’ willingness to manage their T2D with healthy eating, sufficient physical activity, and medication. The associations of patient factors with the willingness to manage T2D with [1] healthy eating, [2] sufficient physical activity and [3] medication were first assessed using univariable logistic regression analyses. Variables with a P-value < 0.2 were subsequently included in complete case multivariable models for each management option. Differences in agreement with the COM-B statements were compared between those willing and not willing to follow each of the management options by presenting medians with Interquartile Ranges (IQR) and Wilcoxon rank-sum tests. Thematic coding was used to analyse the open-ended data related to the patients’ willingness to engage in each of the management options. After reading all answers, initial themes with subthemes were suggested by MA and

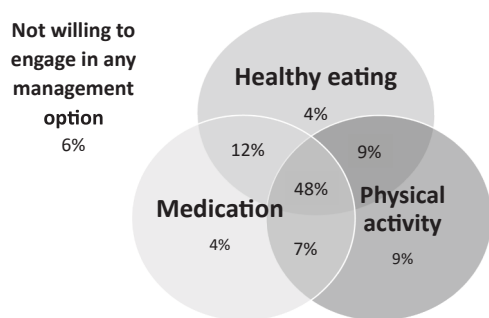


Fig. 1. Proportion of participants willing to manage type 2 diabetes with different management options, defined as more than 50 on a Visual Analogue Scale ranging from 0 to 100.

SdV, resulting in a coding scheme which was discussed and adapted in two rounds of coding by MA, SdV and PD. The final coding of the answers was conducted independently by MA and SdV and discrepancies were resolved by consensus. The results are presented separately for those willing and not willing to manage their T2D with a specific management option.

All statistical analyses were conducted in Stata version 14 (Stata Corp., College Station, TX), whereas Microsoft Excel for Microsoft 365 was used for the thematic analysis of the open-ended data.

### 3. Results

One hundred and forty-three persons opened the questionnaire, of which 67 (47%) fulfilled the inclusion criteria and were included in the analyses (Supplementary Fig. 1). Participants needed a mean of 32 minutes to complete the questionnaire, had a mean age of 57 years, more

than half were males, all had a middle or high education, 54% received metformin as a type of treatment for T2D, and two thirds came from the Netherlands (Table 1).

#### 3.1. Willingness to engage in different management options

The proportion of participants willing to manage T2D with a specific management option was 73% for healthy eating, 73% for sufficient physical activity and 72% for medication. Almost half of the participants were willing to follow all three management options (48%), whereas 6% of the participants were not willing to follow any of the management options (Fig. 1).

#### 3.2. Patient factors associated with willingness

Based on the univariable analyses with willingness to engage in healthy eating, country of recruitment, diabetes duration, BMI, education, percentage of healthy dietary choices, and percentage of unhealthy dietary choices were included in the multivariable analysis (Supplementary Table 6). Only country of recruitment remained statistically significant, indicating that participants recruited in the UK were less willing to manage T2D with the proposed healthy eating recommendations than those recruited in the Netherlands (Table 2).

In the univariable analyses for physical activity, diabetes duration, education, negative past experiences with weight loss and increasing physical activity, current physical activity level and the COM-B sum score for sufficient physical activity were associated with willingness to engage in this management option (Supplementary Table 7). Only the COM-B sum score remained statistically significant in the multivariable analysis, indicating that participants who had a higher sum score on capabilities, opportunities and motivation towards sufficient physical activity were more willing to manage T2D with this management option

Table 2  
Patient factors associated with willingness to engage.

			OR	95% CI	p-value
Healthy eating (N = 61)	Country of recruitment	The Netherlands	reference group		
		United Kingdom	0.05	0.01–0.37	<b>0.004</b>
	Diabetes duration	< 6 months	reference group		
		6 up to 12 months	2.84	0.26–31.41	0.395
		12 up to 18 months	0.55	0.07–4.06	0.557
		18 up to 24 months	0.65	0.07–6.15	0.705
	BMI in kg/m <sup>2</sup>	< 24.9	reference group		
		25–29.9	0.56	0.05–6.86	0.653
		≥ 30	2.27	0.24–21.73	0.476
	High education		0.44	0.08–2.37	0.338
% of healthy dietary choices		42.99	0.22–8368.13	0.162	
% of unhealthy dietary choices		0.00	0.00–7.98	0.155	
Sufficient physical activity (N = 64)	Diabetes duration	< 6 months	reference group		
		6 up to 12 months	1.22	0.19–7.91	0.837
		12 up to 18 months	0.72	0.10–5.38	0.747
		18 up to 24 months	5.57	0.41–74.92	0.196
	High education		2.40	0.50–11.58	0.275
	Negative experience with weight loss		0.78	0.11–5.40	0.801
	Negative experience with increasing physical activity		0.48	0.09–2.64	0.398
	Physical activity level	Low	reference group		
		Moderate	1.36	0.23–8.07	0.737
		High	0.53	0.05–5.27	0.585
COM-B sum score sufficient physical activity		7.58	1.50–38.35	<b>0.014</b>	
Medication taking (N = 64)	Country of recruitment	The Netherlands	reference group		
		United Kingdom	0.66	0.11–4.03	0.650
	Hours of work per week	0 h	reference group		
		Less than 20 h	19.95	0.23–1715.45	0.188
		20 up to 40 h	1.44	0.29–7.04	0.652
		40 h or more	11.13	0.62–200.90	0.103
	BMQ - general	Overuse	0.46	0.12–1.67	0.236
		Harm	1.22	0.21–7.16	0.823
	COM-B sum score medication		3.97	1.01–15.66	<b>0.049</b>

Included variables had a  $p < 0.2$  in the univariate models. \*Reference group: the Netherlands. Bold:  $p < 0.05$ . BMI = Body Mass Index; COM-B = Capabilities, Opportunities and Motivation of Behaviour; BMQ-general = General Beliefs about Medicines Questionnaire.

**Table 3**  
Themes and subthemes related to healthy eating in those willing and not willing.

	Theme	Subtheme	Example	
Willing	Health beliefs	Blood sugar control	<i>Because it lowers my blood sugar. (Patient 40)</i>	
		Diabetes control	<i>Know it's needed to manage diabetes. (Patient 32)</i>	
		Prevent (additional) complications	<i>... also, because it could prevent multiple complaints. (Patient 67)</i>	
		Prevent (additional) medication	<i>I now do not have any medication for diabetes (yet). By following the diet, I try to keep it that way. (Patient 35)</i>	
		It works	<i>Because I believe this works... (Patient 64)</i>	
		Stay healthy	<i>I want to get older in the best possible health... (Patient 59)</i>	
		Diabetes remission	<i>To reverse my diabetes and put it into remission. (Patient 23)</i>	
		(To) Feel better	<i>Feel much better. (Patient 66)</i>	
		Weight control	<i>... maintain a healthy weight. (Patient 20)</i>	
		Diet beliefs	Got conflicting recommendations	<i>... I find it very annoying that I get different guidelines... (Patient 61)</i>
	Partly disagrees/only adjusted diet		<i>I do not agree with the advice on low-fat or plant-based milk products (Patient 28)</i>	
	Barriers		Does not like (some of) this food	<i>I do not like whole grain pasta. (Patient 49)</i>
			No time	<i>Difficulty in preparing, time and effort to eat healthier... (Patient 54)</i>
		Difficult to find	<i>Healthy is not always available... (Patient 41)</i>	
Expensive		<i>It is expensive... (Patient 64)</i>		
Not willing	Facilitators	Already doing this/Likes it	<i>Because I have done this and I have my blood sugars under control. (Patient 55)</i>	
		Health beliefs	<i>Because it would stabilise my blood sugars. (Patient 8)</i>	
	Need beliefs	Diabetes control	<i>...because I know it helps to keep diabetes in check. (Patient 12)</i>	
		Prevent (additional) complications	<i>To prevent problems in the future. (Patient 9)</i>	
	Diet beliefs	Weight control	<i>... and lose some kilos. (Patient 6)</i>	
		Feel good already	<i>... and feeling good now. (Patient 3)</i>	
	Barriers	Partly disagrees/only adjusted diet	<i>I'd follow the ones that make sense, some dark chocolate can be positive to eat, and some vegetables are way too high in carbs for me. (Patient 4)</i>	
		Low-carb diet is the way	<i>I believe low carb, high fat, high protein is the way to go. (Patient 13)</i>	
		Completely disagrees	<i>I wouldn't. I would think that this plan had been developed by someone clueless. (Patient 15)</i>	
		Does not like (some of) this food	<i>Do not like fatty fish. (Patient 16)</i>	
Temptations/cravings		<i>All wrong food is tastier. (Patient 6)</i>		
Recommendations do not fit them		<i>... I'm a lacto-ovo vegetarian, so eating oily fish isn't ever going to happen... (Patient 17)</i>		
	Lack of motivation	<i>Insufficiently motivated. (Patient 12)</i>		

than those with lower scores (Table 2).

In the univariable analyses for medication taking, country of recruitment, hours of work per week, BMQ subscales overuse and harm, and the COM-B sum score for medication taking were associated with willingness to engage in this management option (Supplementary Table 8). Only the COM-B sum score remained statistically significant in the multivariable analysis, indicating that participants with higher capabilities, opportunities, and motivation towards taking medication were more willing to manage T2D with this option than those with lower scores (Table 2).

### 3.3. Deepening of understanding differences

#### 3.3.1. Healthy eating

Agreement with most of the COM-B statements was similar for participants willing or not willing to engage in healthy eating, with only one of the 20 statements showing some difference (Supplementary Table 3). Those willing to engage in healthy eating more often indicated that they were advised to eat healthy by their healthcare professional (median 4, IQR 4–5) than those not willing (median 3, IQR 2–4).

Also from the open-ended questions, similar themes and subthemes were identified among both groups (Table 3). They mentioned similar health beliefs regarding improved diabetes control, prevention of (additional) complications and weight control. They also mentioned similar barriers, including not fully agreeing with the recommendations or recommendations not being suitable due to comorbidities, having struggles with cravings or temptations, or not liking (some of) the

recommended food. Some beliefs were only mentioned by participants willing to eat healthily, such as the belief that the proposed advice works and/or they were already following it. Some barriers were also only mentioned by those willing, such as receiving conflicting recommendations, lack of time or money, and needing more support. Not agreeing with the recommendations at all or believing a low-carbohydrate and/or high-fat diet was the most appropriate diet were only mentioned by those not willing to manage T2D with the suggested recommendations for healthy eating. Lack of motivation or feeling good already were other barriers identified among a few participants.

#### 3.3.2. Sufficient physical activity

We observed several differences based on the COM-B statements between those willing and not willing to manage their T2D with sufficient physical activity (Supplementary Table 4). Those not willing more often found it difficult to incorporate physical activity into their daily lives, to be physically active in their environment and when being away from home or in bad weather, felt they were less capable of being physically active, had more negative feelings towards physical activity, were more often not motivated or did not feel like doing physical activities, and found it difficult to do without a detailed plan. In contrast, those willing more often had people joining them, found being physically active easy and expressed they felt better and that their blood sugar levels were lower when being physically active.

From the open-ended questions, some similar themes, and subthemes in those willing and not willing were identified (Table 4). Regardless of their willingness, participants had similar beliefs that physical activity

**Table 4**  
Themes and subthemes related to sufficient physical activity in those willing and not willing.

	Theme	Subtheme	Example	
Willing	Health beliefs	Blood sugar control	<i>I do this after meals to keep blood glucose low. (Patient 45)</i>	
		Diabetes control	<i>It is such a simple way to manage my diabetes... (Patient 11)</i>	
		Prevent (additional) complications	<i>I want to do everything to prevent complications. (Patient 61)</i>	
		Prevent (additional) medication	<i>I would like to be able to do without medication... (Patient 39)</i>	
		Stay healthy	<i>To live healthier. (Patient 40)</i>	
		Diabetes remission	<i>Because it gives a chance to become diabetes free. (Patient 7)</i>	
		(To) Feel better	<i>... I feel very much fitter than I did before my diagnosis. (Patient 11)</i>	
		Weight control	<i>It has helped me lose weight... (Patient 11)</i>	
		Barriers	Has comorbidities/Problems when exercising	<i>This would have to do with other complaints that make it impossible to move (back problems, painful feet. (Patient 67)</i>
			No energy	<i>No energy... (Patient 64)</i>
	No time		<i>Time! (Patient 2)</i>	
	Depends on the weather		<i>... During the winter it is usually a bit more difficult. (Patient 41)</i>	
	No money		<i>If I had to pay to go to the gym, I couldn't afford it. (Patient 4)</i>	
	Needs more support		<i>... I have no training scheme. (Patient 25)</i>	
	Does not like sports		<i>I do not like gym and running. (Patient 49)</i>	
	Facilitators	Not motivated (enough)	<i>No motivation... (Patient 25)</i>	
		Enjoys it	<i>... because moving and sports are fun and healthy. (Patient 34)</i>	
Has time		<i>Because I have a lot of time. (Patient 44)</i>		
Already doing this		<i>Was doing it anyway. (Patient 50)</i>		
Prevent (additional) medication		<i>Prefer not to be on take medication. (Patient 58)</i>		
Stay healthy		<i>I know it would be good for my overall health. (Patient 8)</i>		
Weight control		<i>Try to lose about 8 kilos. (Patient 33)</i>		
Not willing	Health beliefs	Only if needed	<i>If I would experience problems due to diabetes. (Patient 3)</i>	
		Has comorbidities/Problems when exercising	<i>Too painful. (Patient 10)</i>	
	Barriers	No time	<i>No time for. (Patient 31)</i>	
		Cannot get to the sports facilities	<i>If I could get to a pool, I could do some activity. (Patient 32)</i>	
		Needs more support	<i>Only with a medically discussed plan would I start exercise at this level. (Patient 21)</i>	
		Does not like sports	<i>I've always hated sport, and lots of activity is sporty... (Patient 17)</i>	
		Not motivated (enough)	<i>No motivation to do so. (Patient 17)</i>	

**Table 5**  
Themes and subthemes related to medication taking in those willing and not willing.

	Theme	Subtheme	Example
Willing	Health beliefs	Blood sugar control	<i>To prevent high sugar. (Patient 49)</i>
		Diabetes control	<i>To have better diabetes control. (Patient 22)</i>
		Prevent (additional) complications	<i>It helps my body and internal organs. (Patient 23)</i>
		Prevent (additional) medication	<i>Do not want to have to inject insulin. (Patient 60)</i>
		Stay healthy	<i>Because you want to stay 'healthy' as long as possible. (Patient 27)</i>
		It works/helps	<i>I was told it would help. (Patient 5)</i>
		(To) Feel better	<i>I have noticed that I feel better with medication... (Patient 64)</i>
		It is good for you	<i>Because it is better. (Patient 44)</i>
		Weight control	<i>... and have lost some weight since I take medication. (Patient 64)</i>
		Medication beliefs	Prefers lifestyle changes/does not want medication
	Doubts about the proposed medication dose		<i>... I'm also not sure 500 mg has much of an effect. (Patient 45)</i>
	Need beliefs		<i>If I can control, it with diet and physical activity than rather no medication. (Patient 24)</i> <i>If it is needed, if it helps, then I will do it. (Patient 51)</i>
	Barriers	Past experience with side effects	<i>I stopped with that on the advice of the general practitioner because I got too low blood glucose values and muscle pain. (Patient 28)</i> <i>If side effects become/are heftier than the positive result of the medicines, I think. (Patient 51)</i>
		Facilitators	Fear of side effects
	Trust in doctor		<i>Because it is prescribed. (Patient 62)</i>
	Is prescribed		<i>I only take a small dose and have no side effects. (Patient 45)</i>
	Not Willing	Health beliefs	Blood sugar control
Diabetes control			<i>If it controls my diabetes, I'd be happy. (Patient 54)</i>
(To) Feel better		Weight control	<i>Feel better. (Patient 18)</i> <i>They did help to lose weight... (Patient 61)</i>
		Prefers lifestyle changes/does not want medication	<i>I wouldn't... As a type 2 diabetic I believe that diet, exercise, and weight loss can push diabetes into remission. I am an example of this and take no diabetic medicines. (Patient 13)</i>
Need beliefs		Only if needed	<i>If I was very ill and felt, I had no other option. (Patient 4)</i>
		Barriers	Past experience with side effects
Fear of side effects			<i>If it gave my side effects, then I'd reconsider it. (Patient 54)</i>
Facilitators		(If) contraindicated/ interactions	<i>If it is not possible with my heart medication. (Patient 34)</i>
		Trust in doctor	<i>I use 2x per day medicines on recommendation of general practitioner. (Patient 38)</i>
		Is prescribed	<i>They are prescribed medication. (Patient 6)</i>
Already using it	<i>I now take one Metformin slow release at breakfast and feel it is safe... (Patient 21)</i>		

can prevent (additional) medication and can help them stay healthy and control weight. Barriers mentioned by both groups included not liking sports, lack of time or motivation, needing more support, and having problems with physical activity due to comorbidities. Some health beliefs were only mentioned by those willing, including beliefs that physical activity is good for diabetes control, prevention of (additional) complications, feeling better and to achieve T2D remission. Facilitators mentioned only by those willing included time to do so or already doing it. Also, some barriers were mentioned only by those willing, including lack of money or energy and difficulties being physically active in bad weather. Issues mentioned by patients not willing included difficulties getting to a sports facility or only willing to become physically active if this would be needed due to having problems with diabetes.

### 3.3.3. Medication taking

There were some differences based on the COM-B statements between those willing and not willing to take medication (Supplementary Table 5). Those not willing believed they were more likely to forget taking the medication without a reminder, were more afraid of experiencing side effects or had other negative feelings towards taking medication. However, those who were willing more often believed that medication lowers their blood sugar and more often knew people who benefitted from taking diabetes medication.

Health beliefs identified from the open-ended questions in both groups included improved diabetes control, feeling better and weight control (Table 5). Barriers mentioned by both groups included past experience or fear of side effects. Facilitators mentioned by both included already taking diabetes medication or trusting the doctor's decision. Factors also shared by both groups included preferring lifestyle changes instead of taking medication, beliefs about not (yet) needing medication or wanting to take medication only if needed. Some beliefs were only mentioned by those willing, such as the belief that taking medication can prevent (additional) medications or complications, is good for you, that it works, and it can help you stay healthy.

## 4. Discussion and conclusion

### 4.1. Discussion

Although almost three quarters of the participants were willing to manage T2D with either healthy eating, sufficient physical activity or medication, only half of the participants were willing to manage it with all three management options. Participants from the UK were less willing to follow the proposed recommendations for healthy eating than those from the Netherlands. Several participants not willing to follow these recommendations disagreed with the recommendations or believed that other diets were more appropriate. For sufficient physical activity and for medication taking, patients with a higher sum score on perceived capabilities, opportunities and motivation were more often willing than those with lower scores. Other patient factors, including education, diabetes duration, BMI, smoking, alcohol consumption, eating patterns or physical activity level were not independently associated with patients' willingness. Surprisingly, participants willing and those not willing to engage in a particular management option shared many similar beliefs, including beliefs that healthy eating and medication can lower blood sugar and weight control is important. They also reported similar barriers and facilitators. Nonetheless, some differences were observed: those willing to engage in physical activity appeared to perceive less difficulties to do so, and those willing to take medication appeared to have more positive and less negative outcome beliefs than those not willing.

Patients with T2D are usually confronted with recommendations for healthy eating, physical activity as well as the need to take medication within the first years after diagnosis. Few previous studies assessed the willingness of patients to engage in each of the different management options. A study in France showed that a quarter of patients with T2D

were committed to follow both diet and physical activity recommendations as well as declared high compliance with drugs [7]. Other patients reported less motivation or more difficulties to change their lifestyle or adhere to medication, which was linked to being less concerned or to feeling bitter, overwhelmed or discouraged, partly fuelled by negative experiences [7]. It is likely that recently diagnosed patients have fewer negative experiences, which might explain that only 6% of participants in our study were not willing to follow any management option. Importantly, our study showed that most of the recently diagnosed patients not willing to manage T2D with medication were willing to engage in healthy eating or physical activity. Nonetheless, a substantial proportion was not willing to engage in both healthy eating and physical activity. These findings illustrate the importance of addressing the different aspects of lifestyle separately by exploring the patient's preferences and needs for tailored support regarding all necessary management options. A stepwise approach starting with the option most favoured by the patient could be part of a personalised management strategy.

Unexpectedly, we did not observe significant associations between a wide range of patient factors and the patients' willingness for healthy eating. Only country of recruitment appeared to influence willingness to follow the proposed healthy eating recommendations. Of note, differences in the patient populations included can be confounders for the observed association, for example, related to age, sex, BMI, lifestyle and education (Supplementary Table 9). These patient characteristics were included in the analyses but were not independently associated with willingness in the multivariable models. Since different diets can be effective in T2D management [29–32], it is possible that patients received different advice or had different perspectives regarding healthy eating. The recommendations we presented recommended high-fibre foods, low-fat dairy products, and food rich in omega-3. Particularly participants from the UK mentioned they preferred low-carbohydrate or high-fat diet to manage their T2D. This suggests that participants from the UK might not necessarily have been less willing to eat healthy but may have considered a different dietary advice as more appropriate. Besides considering different effectiveness of diets between individual patients [33,34], it is also important to clarify the perceptions a patient has about what healthy eating is when providing advice. Addressing personal diet beliefs and tailoring advice to such beliefs is needed for effective change.

The willingness to be physically active was significantly associated with perceiving the capabilities, opportunities, and motivation for sufficient physical activity. There appeared to be a difference between those willing and not willing to engage in physical activity in many of the COM-B statements. Particularly, perceived difficulties to incorporate physical activity in daily life seemed to be a relevant factor. Regardless of willingness, the presence of comorbidities or experiencing pain when being physically active were mentioned as barriers. This illustrates that support is relevant to overcome these difficulties and barriers, also in patients motivated for being physically active. This can come in many forms, such as from a physical therapist, exercise programme, personal trainer, family member or psychologist [35]. Based on the open-ended question, also differences in patients' beliefs regarding the need for physical activity were observed. In the previous study conducted in France, beliefs of not needing lifestyle changes were particularly seen in patients who were not concerned about having diabetes [7]. In our study, however, levels of worry about negative consequences of having diabetes were not found to be associated with willingness. It could be that these levels of worry change over the course of the disease.

A previous study found that around 45% of Dutch T2D patients were willing to take the medication needed to reach all treatment targets, whereas a similar percentage would be willing to take medication until side effects arise [15]. From our study it can be learned that patients' willingness for medication taking was associated with their perceived capabilities, opportunities, and motivation towards this behaviour. Although similar barriers and facilitators were mentioned by those



willing and not willing to take medication, those willing more often acknowledged the benefits of taking diabetes medication and less often feared its side effects. General medication beliefs, however, were not associated with willingness. This implies that exploring and addressing medication-specific beliefs or fears before starting medication is important. Many patients may be willing to take medication to achieve its benefits but for some this willingness appears more restricted by possible side effects than for others [15].

#### 4.2. Strengths and limitations

Our study is one of the few that investigated the willingness of recently diagnosed patients with T2D to engage in healthy eating, physical activity and medication taking. We combined quantitative and qualitative methods to explore patient factors associated with willingness. We included statements derived from the COM-B model that showed sufficient content validity in the piloting phase. In this pilot study we adapted statements to address issues regarding the clarity and understandability.

The main limitation of this study is the small number of respondents, which restricts extrapolation of the results to the general T2D population. The included population was relatively high educated and thus not fully representative for all patients with T2D. Moreover, the sample size was particularly small for those recruited in the UK and this group should not be considered representative for the country. Small numbers also limit the exploration of underlying and confounding factors. As mentioned, the observed association of the country of recruitment on the patients' willingness to engage in healthy eating can be confounded by underlying differences in the patient population at country level. Our small sample size inhibits the conduct of multilevel analyses to investigate this further. Any statistical comparison of individual COM-B statements between those willing and not willing is restricted by the large number of comparisons with a risk of false positive findings. We used a combination of recruitment strategies to enhance the number of participants but this approach prohibits calculation of response rates. Of potential participants opening the questionnaire, 24% dropped out because they had been diagnosed more than two years before and 11% because they did not give informed consent. We used open-ended questions to further explore factors underlying differences in willingness. These questions were limited by not focussing on differences in importance of these factors. This could be researched using in-depths interviews. Another limitation is that we presented specific descriptions for the management options, which might not be fitting for all participants. For example, healthy eating might not mean the same for everyone. Furthermore, since this was an online survey study, limitations related to the use of this type of method should be acknowledged, including underrepresentation of people with less computer skills [36, 37]. Last, although we included many patient factors in this study, other factors could be of relevance, such as personality, comorbidity and comedication.

#### 4.3. Conclusion

The majority of recently diagnosed patients with T2D were willing to engage in either healthy eating, sufficient physical activity or medication taking but only half of them were willing to manage T2D with all three options. Patients willing or not willing to engage in a specific management option seemed to share many similar beliefs. Nevertheless, their willingness to engage in physical activity or taking medication depended in part on their perceived capabilities, opportunities, and motivation, which implies that exploring and addressing these factors is essential when making decisions about T2D management. The willingness to follow a specific diet was not associated with such patient factors but may depend on contextual factors, including discrepancies between general recommendations for healthy eating and specific diets advocated for patients with T2D. Finally, both patients willing and not

willing to manage T2D with a certain management option experienced barriers to do so. This highlights that willingness to engage in something does not guarantee successful implementation and tailored support should be part of personalised diabetes care.

#### Author contribution

MA contributed to the development and formulation of the research question and the questionnaire, conducted the analysis, contributed to the interpretation of data, wrote the manuscript, and edited the manuscript. SdV contributed to the development and formulation of the research question and the questionnaire, conducted the analysis, contributed to the interpretation of data, and reviewed and edited the manuscript. GB contributed to the development of the questionnaire, the interpretation of data, and reviewed and edited the manuscript. JF contributed to the development and formulation of the research question and the questionnaire, the interpretation of data, and reviewed and edited the manuscript. PD contributed to the development and formulation of the research question and the questionnaire, development of the analysis, the interpretation of data, and reviewed and edited the manuscript.

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#### Declaration of Competing Interest

The authors have no conflicts of interest to disclose.

#### Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.pcd.2024.03.006](https://doi.org/10.1016/j.pcd.2024.03.006).

#### References

- [1] E.W. Gregg, H. Chen, L.E. Wagenknecht, J.M. Clark, L.M. Delahanty, J. Bantle, et al., Association of an intensive lifestyle intervention with remission of type 2 diabetes, *Jama* 308 (23) (2012) 2489–2496.
- [2] M.E.J. Lean, W.S. Leslie, A.C. Barnes, N. Brosnahan, G. Thom, L. McCombie, et al., Primary care-led weight management for remission of type 2 diabetes (DiRECT): an open-label, cluster-randomised trial, *Lancet* 391 (10120) (2018) 541–551.
- [3] M.J. Franz, J.L. Boucher, S. Rutten-Ramos, J.J. VanWormer, Lifestyle weight-loss intervention outcomes in overweight and obese adults with type 2 diabetes: a systematic review and meta-analysis of randomized clinical trials, *J. Acad. Nutr. Diet.* 115 (9) (2015) 1447–1463.
- [4] E.S.E. Barents, H.J.G. Bilo, M. Bouma, M. Dankers, A.D. Rooij, H.E. Hart, et al., NHG-standaard Diabetes mellitus type 2, NHG standaard, 2021.
- [5] National Institute for Health and Care Excellence: Guidelines, Type 2 diabetes in adults: management, National Institute for Health and Care Excellence (NICE), London. Copyright © NICE 2022, 2022.
- [6] K. Glanz, B.K. Rimer, K. Viswanath, Health Behavior: Theory, Research, and Practice, Jossey-Bass, a Wiley Brand San Francisco, CA, San Francisco, CA, 2015. Available from: (<http://www.dawsonera.com/depp/reader/protected/external/AbstractView/S9781118629055>).
- [7] H. Mosnier-Pudar, G. Hochberg, E. Eschwege, S. Halimi, M.L. Virally, P. J. Guillausseau, et al., How patients' attitudes and opinions influence self-care behaviours in type 2 diabetes. Insights from the French DIABASIS Survey, *Diabetes Metab.* 36 (6 Pt 1) (2010) 476–483.
- [8] J.B. Nielsen, A. Leppin, D.E. Gyrd-Hansen, D.E. Jarbol, J. Sondergaard, P.V. Larsen, Barriers to lifestyle changes for prevention of cardiovascular disease – a survey among 40–60-year old Danes, *BMC Cardiovasc. Disord.* 17 (1) (2017) 245.
- [9] D.J. Cegala, T. Marinelli, D. Post, The effects of patient communication skills training on compliance, *Arch. Fam. Med.* 9 (1) (2000) 57–64.
- [10] M. Wermeling, U. Thiele-Manjali, J. Koschack, G. Lucius-Hoene, W. Himmel, Type 2 diabetes patients' perspectives on lifestyle counselling and weight management in general practice: a qualitative study, *BMC Fam. Pract.* 15 (2014) 97.
- [11] J. Murray, C.L. Craigs, K.M. Hill, S. Honey, A. House, A systematic review of patient reported factors associated with uptake and completion of cardiovascular lifestyle behaviour change, *BMC Cardiovasc. Disord.* 12 (2012) 120.

- [12] N. Eikelenboom, I. Smeele, M. Faber, A. Jacobs, F. Verhulst, J. Lacroix, et al., Validation of Self-Management Screening (SeMaS), a tool to facilitate personalised counselling and support of patients with chronic diseases, *BMC Fam. Pract.* 16 (2015) 165.
- [13] L. Penn, S.U. Dombrowski, F.F. Sniehotta, M. White, Participants' perspectives on making and maintaining behavioural changes in a lifestyle intervention for type 2 diabetes prevention: a qualitative study using the theory domain framework, *BMJ Open* 3 (6) (2013).
- [14] G. Siopis, S. Colagiuri, M. Allman-Farinelli, People with type 2 diabetes report dietitians, social support, and health literacy facilitate their dietary change, *J. Nutr. Educ. Behav.* 53 (1) (2021) 43–53.
- [15] K.J. Gorter, G.J. Tuytel, R.R. de Leeuw, J.M. Bensing, G.E. Rutten, Opinions of patients with type 2 diabetes about responsibility, setting targets and willingness to take medication. A cross-sectional survey, *Patient Educ. Couns.* 84 (1) (2011) 56–61.
- [16] S. Michie, M.M. van Stralen, R. West, The behaviour change wheel: a new method for characterising and designing behaviour change interventions, *Implement Sci.* 6 (2011) 42.
- [17] J. Cane, D. O'Connor, S. Michie, Validation of the theoretical domains framework for use in behaviour change and implementation research, *Implement Sci.* 7 (2012) 37.
- [18] S. Michie, L. Atkins, R. West, *The Behaviour Change Wheel: A Guide to Designing Interventions*, Silverback Publishing, London, 2014.
- [19] P.A. Harris, R. Taylor, B.L. Minor, V. Elliott, M. Fernandez, L. O'Neal, et al., The REDCap consortium: building an international community of software platform partners, *J. Biomed. Inform.* 95 (2019) 103208.
- [20] P.A. Harris, R. Taylor, R. Thielke, J. Payne, N. Gonzalez, J.G. Conde, Research electronic data capture (REDCap)—a metadata-driven methodology and workflow process for providing translational research informatics support, *J. Biomed. Inform.* 42 (2) (2009) 377–381.
- [21] E.S.E. Barents, H.J.G. Biló, M. Bouma, M. Dankers, A.D. Rooij, H.E. Hart, et al., Diabetes Mellitus Type 2 [NHG Standard Diabetes Mellitus Type 2], *Huisarts en Wetenschap*, 2018.
- [22] Guidelines Healthy Eating, Health Council of the Netherlands. 2015.
- [23] Physical Activity: Brief Advice for Adults in Primary Care, National Institute for Health and Care Excellence; Public health guideline. 2013.
- [24] Type 2 Diabetes in Adults: Management, National Institute for Health and Care Excellence, 2015.
- [25] Summary of product characteristics: Metformin, 2022.
- [26] C.Y. England, J.L. Thompson, R. Jago, A.R. Cooper, R.C. Andrews, Development of a brief, reliable and valid diet assessment tool for impaired glucose tolerance and diabetes: the UK Diabetes and Diet Questionnaire, *Public Health Nutr.* 20 (2) (2017) 191–199.
- [27] P.H. Lee, D.J. Macfarlane, T.H. Lam, S.M. Stewart, Validity of the international physical activity questionnaire short form (IPAQ-SF): a systematic review, *Int. J. Behav. Nutr. Phys. Act.* 8 (1) (2011) 115.
- [28] R. Horne, J. Weinman, M. Hankins, The beliefs about medicines questionnaire: the development and evaluation of a new method for assessing the cognitive representation of medication, *Psychol. Health* 14 (1) (1999) 1–24.
- [29] O. Ajala, P. English, J. Pinkney, Systematic review and meta-analysis of different dietary approaches to the management of type 2 diabetes, *Am. J. Clin. Nutr.* 97 (2) (2013) 505–516.
- [30] F. Jannasch, J. Kröger, M.B. Schulze, Dietary patterns and type 2 diabetes: a systematic literature review and meta-analysis of prospective studies, *J. Nutr.* 147 (6) (2017) 1174–1182.
- [31] D. Papamichou, D.B. Panagiotakos, C. Itsiopoulos, Dietary patterns and management of type 2 diabetes: a systematic review of randomised clinical trials, *Nutr. Metab. Cardiovasc. Dis.* 29 (6) (2019) 531–543.
- [32] A.N. Reynolds, A.P. Akerman, J. Mann, Dietary fibre and whole grains in diabetes management: systematic review and meta-analyses, *PLoS Med.* 17 (3) (2020) e1003053.
- [33] M. Rein, O. Ben-Yacov, A. Godneva, S. Shilo, N. Zmora, D. Kolobkov, et al., Effects of personalized diets by prediction of glycemic responses on glycemic control and metabolic health in newly diagnosed T2DM: a randomized dietary intervention pilot trial, *BMC Med.* 20 (1) (2022) 56.
- [34] D. Zeevi, T. Korem, N. Zmora, D. Israeli, D. Rothschild, A. Weinberger, et al., Personalized nutrition by prediction of glycemic responses, *Cell* 163 (5) (2015) 1079–1094.
- [35] S.K. Schmidt, L. Hemmestad, C.S. MacDonald, H. Langberg, L.S. Valentiner, Motivation and Barriers to Maintaining lifestyle changes in patients with type 2 diabetes after an intensive lifestyle intervention (the U-TURN trial): a longitudinal qualitative study, *Int. J. Environ. Res. Public Health* 17 (20) (2020).
- [36] H.L. Ball, Conducting online surveys, *J. Hum. Lact* 35 (3) (2019) 413–417.
- [37] S. Oliveri, L. Lanzoni, S. Petrocchi, R. Janssens, E. Schoefs, I. Huys, et al., Opportunities and challenges of web-based and remotely administered surveys for patient preference studies in a vulnerable population, *Patient Prefer. Adherence* 15 (2021) 2509–2517.