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A simple to implement and low-cost supervised walking programme in highly motivated individuals with or at risk for type 2 diabetes: An observational study with a pre-post design

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ABSTRACT

This observational study with a pre-post design, conducted in two Dutch primary healthcare centres, aimed to evaluate the effect of a supervised walking programme in highly motivated individuals with or at risk for type 2 diabetes mellitus (T2DM). Those able and willing to walk at least 6 km, were invited for a 28-week walking programme (February to August 2017), in which participants walked in groups, once weekly under supervision of volunteer healthcare professionals. Changes in bodyweight, BMI, waist circumference, HbA1c, blood pressure, well-being, health status and patient activation were analysed using paired *t*-tests and the Wilcoxon signed-rank test. Fifty-six people were included (30 T2DM; 26 at risk), of whom 60.7% were female. Mean age was 60.6 years, median BMI 30.8 kg/m² and mean systolic blood pressure 146.9 mm Hg. Participants with T2DM had median HbA1c of 50.0 mmol/mol. Post-challenge, BMI had decreased to 29.7 kg/m², and waist circumference decreased 3.4 cm (95% CI 2.1–4.8), both *p* < 0.01. Systolic and diastolic blood pressure decreased significantly (mean difference 6.5 mm Hg (95% CI 1.6–11.3, *p* = 0.01) and 3.5 mm Hg (95% CI 1.0–6.0, *p* < 0.01), respectively). Participants with HbA1c > 53 mmol/mol at baseline (*n* = 8), had median decrease in HbA1c of 6.5 mmol/mol (*p* = 0.03). Well-being, but not health status and patient activation, improved significantly. In conclusion, in highly motivated individuals with or at risk for T2DM, this simple to implement and low-cost, but intensive, volunteer-based supervised walking programme is favourable, and therefore, can be seen as an option for clinical programs to implement to support highly motivated patients.

1. Introduction

The global prevalence of type 2 diabetes mellitus (T2DM) is rising due to an aging population and the increasing prevalence of obesity and physical inactivity, the latter two being major risk factors of T2DM (World Health Organization, 2016; Statistics Netherlands (CBS), 2016). Multiple randomised controlled trials (RCTs) of intensive interventions have shown that T2DM can be prevented by changes in lifestyle (Diabetes Prevention Program Research Group et al., 2002; Tuomilehto et al., 2001), which in people with T2DM, can prevent or delay the onset of macrovascular and microvascular complications (UK Prospective Diabetes Study (UKPDS) Group, 1998; Coutinho et al.,

1999). In addition, a recent study in people with T2DM, delivered in the primary care setting, showed that intensive weight management can achieve remission of T2DM (Lean et al., 2017). Indeed, more intensive programmes used in RCTs have great outcomes and therefore are highly relevant for both people with and at risk for T2DM, but translation into practical, affordable interventions delivered in a real-life setting has shown to be less effective (Cardona-Morrell et al., 2010; Dunkley et al., 2014). Besides, there does not seem to be an effective ‘one size fits all’ approach to engage people in lifestyle or self-management interventions.

We developed a low-cost, volunteer-based, intervention as an option to offer to people with multiple cardiovascular risk factors who were

Abbreviations: T2DM, type 2 diabetes mellitus; RCTs, randomised controlled trials; BMI, body mass index; HbA1c, glycosylated haemoglobin A1c; DBP, diastolic blood pressure; SBP, systolic blood pressure; NC, Nijkerk Challenge; EMR, electronic medical record; WHO-5, World Health Organization five well-being index; EQ-VAS, EuroQol-visual analogue scale; PAM-13, 13-item patient activation measure

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close to the top end of the full range of patient motivations and capacities. Previous meta-analyses that studied the impact of walking programmes noted that walking could improve glycaemic control, body mass index (BMI), and diastolic blood pressure (DBP) in people with T2DM (Qiu et al., 2014). In sedentary but healthy adults, it also improved systolic blood pressure (SBP) (Murtagh et al., 2015). The length and the frequency of the walking sessions in included studies varied from 20 to 120 min and 2 to 7 times per week, respectively. Although intensive lifestyle interventions to prevent and control diabetes have shown to be cost-effective ($\leq \$50,000$ /quality-adjusted life year) (Jacobs-van der Bruggen et al., 2009; Li et al., 2010), our programme likely reduces total costs due to the voluntary contribution of the healthcare providers.

Since 2015, two primary healthcare centres in Nijkerk, in the middle of the Netherlands, organise an annual supervised walking programme for highly motivated individuals with T2DM and those at risk for it, able to walk for 6 km once weekly as starting level. This six months walking programme called the Nijkerk challenge (NC), ends with a challenge week in which people walk six consecutive days. The present study aims to evaluate the effect of this challenge on bodyweight, BMI, waist circumference, blood pressure, HbA1c, well-being, health status and patient activation.

2. Methods

2.1. Study design and participants

This is an observational study with a pre-post study design with 28 weeks follow-up. Subjects were recruited from two primary healthcare centres in Nijkerk, providing care to about 1500 people with T2DM. People with a T2DM diagnosis confirmed by International Classification of Primary Care code T90.02 in the patient's electronic medical record (EMR), and those considered at risk for T2DM by their general practitioner (e.g. overweight, obesity, physical inactivity), were assessed for eligibility. People with exercise-limiting co-morbidities not able to walk 6 km at the start of the programme (e.g. old age, musculoskeletal impairment or vascular disease of the lower extremities, visual impairment) were excluded from participation. All eligible people were informed about the walking programme by letter and were invited for an information session. People highly motivated, wanting to do a significant walking challenge, and willing to participate in the NC received a second letter in which they were informed about and asked to participate in this particular study. Written informed consent was obtained prior to participation from each participant. Ethical approval was obtained by the Medical Ethical committee of the University Medical Center Utrecht.

2.2. Nijkerk challenge programme

The Nijkerk challenge consists of a walking programme, in which participants walked in groups, once weekly, under the supervision of different volunteer healthcare professionals (physiotherapists, medical practice assistants, podiatrists, dietitians, general practitioners and sports coaches). Depending on their prior level of activity participants started walking 6, 8 or 10 km. During the NC, participants could increase their walking distance and intensity; and by the end of the study all participants walked 10 km during each walking session. The walking programme started on 18 February 2017. It ended with the challenge week from 21 to 26 August 2017, in which the participants walked approximately 15 km for six consecutive days. Participants walked for a total of 28 weeks.

Although participants were encouraged to do more physical activity outside of the one-time per week supervised walking, there were no expectations for the participants to attain certain levels.

Apart from the walking programme, participants were able to attend a diabetes education session and a cooking class. In addition,

individuals with T2DM were offered blood glucose self-monitoring during one week at home two times, to obtain more insight into the effects of their food choices, physical activity, and medication use on glycaemic control.

2.3. Measurements

Prior to the Nijkerk challenge, on 13 February 2017, a measurement session was organised for measuring bodyweight, length, waist circumference and blood pressure. Bodyweight, length and waist circumference were measured according to standardised procedures (Nederlands Huisartsen Genootschap, 2012) using a digital balance, a standard stadiometer and a measuring tape, respectively. Blood pressure was measured using the Omron 6 comfort. After the Nijkerk challenge, on 29 August 2017, the same aforementioned measurements were taken. If a participant did not attend the measurement session, last available measurements before the start and the end of the NC (with a range of 2 months prior or after), were extracted from the EMR; see below.

Data extracted from the EMR were as followed: age, gender, diabetes duration, blood pressure, bodyweight, BMI, HbA1c, and prescribed antihypertensive and blood glucose-lowering medication. Blood pressure, BMI, HbA1c, and prescribed medication were extracted between two months before the start and two months after the NC. Measurements closest to the start and end of the NC were used. Each individual has his own HbA1c target value, based on the Dutch diabetes guidelines (Rutten et al., 2013), which depends on age, medication use and diabetes duration.

2.4. Patient reported outcome measures

Participants received online questionnaires before and after the NC. Three validated questionnaires were used to assess well-being, health status and patient activation. In addition, participants were asked for their estimated attendance rate at the walking sessions and for their attendance at the education session, cooking class and blood glucose monitoring.

Well-being was measured using the 5-item WHO questionnaire (WHO-5) covering items related to positive mood, vitality and general interests (Topp et al., 2015; Psychiatric Center North Zealand, 2007). Each item is rated on a 6-point Likert scale ranging from 0 'not present' to 5 'constantly present'. The total score was multiplied by four to give a final score ranging from 0 to 100, with lower scores indicating less well-being.

Health status was measured with the EuroQol-visual analogue scale (EQ-VAS) developed by The EuroQol Group (The EuroQol Group, 1990; van Reenen & Janssen, 2015). It measures self-rated health on a vertical, visual analogue scale, with 0 representing the worst health one can imagine and 100 representing the best imaginable health.

The level of patient activation was measured by the 13-item patient activation measure (PAM-13) (Hibbard et al., 2005; Rademakers et al., 2012). It assesses an individual's knowledge, skills, and confidence for managing one's health and healthcare. It uses a 5-point Likert scale ranging from 1 'strongly disagree' to 4 'strongly agree' and 0 'not applicable'. A total score ranging from 0 to 100 was calculated, with higher scores representing higher activation. Participants who answered four or more questions with 'not applicable', as well as those who answered all 13 questions with 'strongly disagree' or 'strongly agree', were excluded. Subsequently, all participants with a valid PAM-13 score were categorized into one of the four patient activation levels, based on the Insignia Health guidelines, with level 1 being least activated and level 4 being most activated (Hibbard et al., 2005).

2.5. Statistical analyses

Descriptive statistics were used to describe the study population at

baseline. Binary and categorical data are presented as frequencies and percentages. Continuous variables are presented as means with standard deviations (SD) or as medians with interquartile range (IQR) for skewed data. Paired *t*-tests were used to analyse pre-post challenge differences for each variable. The Wilcoxon signed-rank test was used for skewed paired data or small numbers. Analyses of weight, BMI, waist circumference, blood pressure, well-being, health status and patient activation were performed in all participants. In addition, those of weight, BMI, waist circumference, and blood pressure, were performed in each group separately (at risk and T2DM). Analyses of blood pressure and HbA1c were initially done for all participants. Subsequently, sensitivity analyses were performed after excluding participants whose antihypertensive medication or blood glucose-lowering medication were changed during the NC. Analyses of HbA1c were also performed after dividing participants in groups based on their HbA1c level at baseline (HbA1c ≤ 53 or > 53 mmol/mol). SPSS Analytical Software version 21.0 (SPSS INC, Chicago, IL, USA) was used. A *p*-value below 0.05 was considered statistically significant.

3. Results

3.1. Participation and baseline characteristics

Of all invited people, only 75 participated in the NC, of whom 63 gave informed consent to participate in this study. A total of 56 participants were included in this study, of whom 30 had T2DM and 26 were at risk for it. During the NC six participants dropped out; five in the T2DM group, one in the at-risk group (Fig. 1). The mean self-reported attendance rate for the walking sessions was 79.5%. Of all participants

Table 1

Self-reported attendance rate for the walking sessions, education session, cooking class and blood glucose monitoring.

	All participants (n = 36)	At risk (n = 17)	T2DM (n = 19)
Distance starting level, n (%)			
6 km	8 (22.2)	6 (35.3)	2 (10.5)
8 km	9 (25.0)	4 (23.5)	5 (26.3)
10 km	19 (52.8)	7 (41.2)	12 (63.2)
Proportions of walking sessions attended, mean %	79.5	79.1	79.9
Education session, n (%)	20 (55.6)	8 (47.1)	12 (63.2)
Cooking class, n (%)	18 (50.0)	6 (35.3)	12 (63.2)
Glucose monitoring, n (%)	N/A	N/A	9 (47.4)

Continuous variables presented as means, dichotomous variables presented as count (percentage). N, number of subjects. T2DM, type 2 diabetes mellitus. N/A, not applicable.

that filled in the questionnaires, 50% attended the cooking class, 55.6% attended the education session and 47.4% of the participants with T2DM monitored their glucose (Table 1).

Participants had a mean age of 60.6 (10.0) years and 60.7% were female. Those with T2DM were older and more often male. Overall, participants were typically obese and blood pressure was suboptimal at baseline, despite an overall use of antihypertensive medication in 55.4% of the participants. Compared to participants in the at-risk group, those with T2DM used antihypertensive medication more often. With respect to BMI, waist circumference and blood pressure, both groups were comparable at the start of the NC. Participants with T2DM

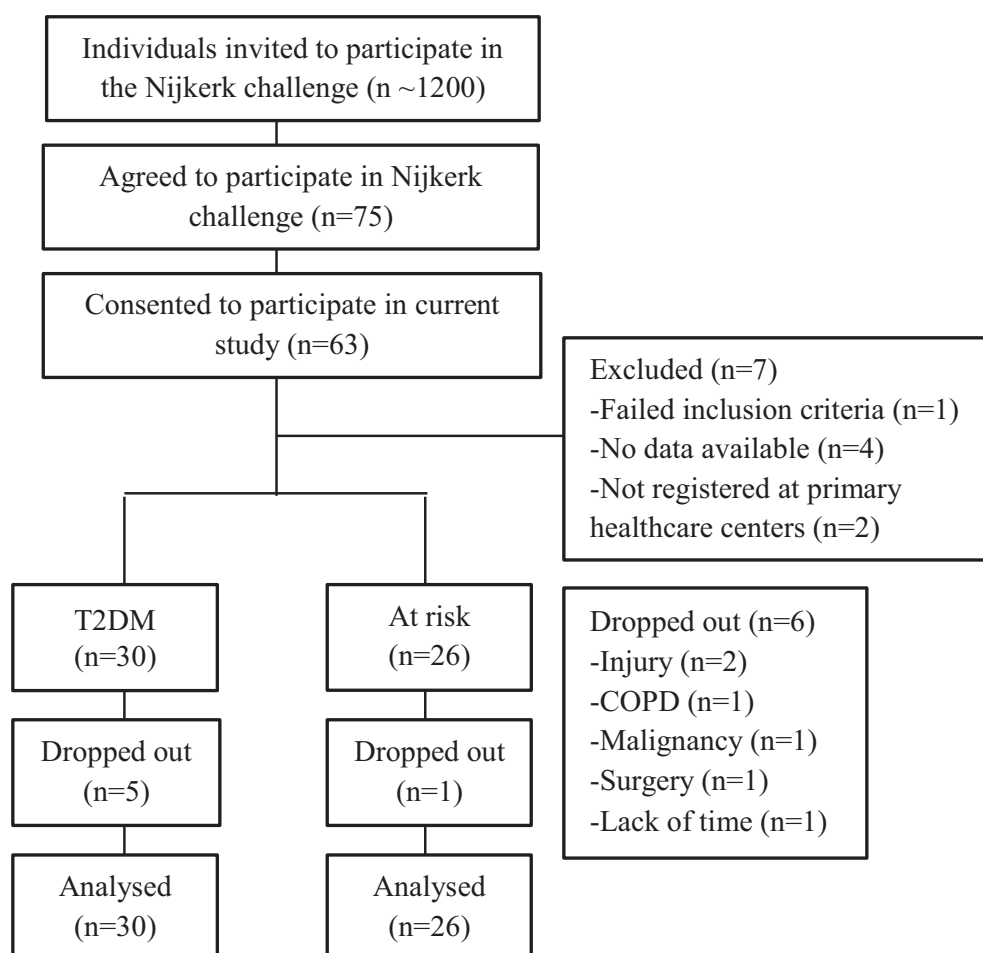


Fig. 1. Participant enrolment flow chart of the Nijkerk challenge (Nijkerk, the Netherlands, February to August 2017).

Table 2
Baseline characteristics of people participating in the Nijkerk challenge (February 2017).

	All participants (n = 56)	At risk (n = 26)	T2DM (n = 30)
Age, mean (SD), years	60.6 (10.0)	56.2 (9.2)	64.3 (9.2)
Women, n (%)	34 (60.7)	20 (76.9)	14 (46.7)
Anthropometric measures			
Weight, median (IQR), kg	88.1 (20.3)	88.8 (26.6)	87.8 (18.4)
BMI, median (IQR), kg/m ²	30.8 (5.4)	31.9 (6.2)	30.1 (5.0)
Waist circumference, mean (SD), cm	108.7 (10.2) ^a	108.8 (10.7)	108.6 (9.9) ^b
Blood pressure, mean (SD), mm Hg			
Systolic	146.9 (19.1)	146.5 (21.0)	147.2 (17.6)
Diastolic	89.9 (9.9)	91.3 (7.2)	88.8 (11.7)
Antihypertensive medication use, n (%)	31 (55.4)	10 (38.5)	21 (70.0)
Diabetes factors	N/A	N/A	
Duration of T2DM, mean (SD), years			8.9 (5.4)
HbA1c, median (IQR)			50.0 (16) ^b
Blood glucose lowering medication use, n (%)			
Lifestyle advice only			8 (26.7)
Metformin only			7 (23.3)
Sulfonylurea only			1 (3.3)
Combination of metformin and sulfonylurea			9 (30.0)
Combination of metformin/sulfonylurea and other blood glucose lowering medication			3 (10.0)
Insulin ± oral blood glucose lowering medication			2 (6.7)
Questionnaires, median (IQR)	n = 45	n = 23	n = 22
WHO-5	68.0 (22)	64.0 (20)	72.0 (21)
EQ-VAS	74.0 (21)	74.0 (23)	78.00 (18)
PAM-13	55.6 (14.2) ^c	55.6 (9.6) ^d	55.6 (19.1)
Level of patient activation, n (%)			
Level 1	9 (22.0)	3 (15.8)	6 (27.3)
Level 2	8 (19.5)	6 (31.6)	2 (9.1)
Level 3	19 (46.3)	9 (47.4)	10 (45.5)
Level 4	5 (12.2)	1 (5.3)	4 (18.2)

Continuous variables presented as means (SD) or medians (IQR), dichotomous variables presented as count (percentage). N, number of subjects. SD, standard deviation. IQR, interquartile range. T2DM, type 2 diabetes mellitus. BMI, body mass index (calculated as weight in kilograms divided by height in meters squared). N/A, not applicable. HbA1c, glycosylated haemoglobin A1c. WHO-5, World Health Organization Five Well-Being Index. EQ-VAS, EuroQol Visual Analogue scale. PAM-13, 13-item Patient Activation Measure.

^a n = 50.

^b n = 24.

^c n = 41.

^d n = 19.

had a median HbA1c of 50 (Topp et al., 2015) mmol/mol at baseline, but 33.3% had an HbA1c above their personal target value. The majority of the participants with T2DM was on metformin only (23.3%) or a combination of metformin and sulfonylurea (30.0%), and 26.7% received lifestyle advice only. At the start of the NC, participants with T2DM experienced more well-being and a slightly better health status compared to those at risk for it. About half of the participants had a patient activation level 3 pre-challenge (Table 2).

3.2. Pre-post challenge differences

Pre- and post-challenge anthropometric measures and blood pressure in the overall study population and in both groups separately are presented in Table 3 and Table 4, respectively. The overall study population showed significant improvements in body weight (median decrease from 88 to 84 kg), BMI (median decrease from 30.7 to 29.7 kg/m²), and waist circumference (mean difference 3.4 cm). Improvements

were larger in the at-risk group. Both SBP and DBP decreased significantly (mean difference 6.5 mm Hg and 3.5 mm Hg, respectively), although decrease in DBP was more pronounced in the T2DM group. During the NC antihypertensive medication prescription was added in four participants in the at-risk group and reduced in one participant in the T2DM group. If these changes in antihypertensive medication were taken into account, decreases in SBP and DBP became less pronounced in the at-risk group (5.3 mm Hg ($p = 0.10$) and 1.8 mm Hg ($p = 0.37$), respectively). In the T2DM group differences became more pronounced, with a decrease of 7.4 mm Hg in SBP ($p = 0.06$) and 5.0 mm Hg in DBP ($p = 0.01$).

Complete HbA1c data were available from 21 participants with T2DM. Overall, no significant differences in median HbA1c were observed. Subanalysis shows that those with an HbA1c ≤ 53 mmol/mol at the start of the NC ($n = 13$) did not improve, whereas those with an HbA1c above 53 mmol/mol ($n = 8$) improved from 64.0 (van Reenen & Janssen, 2015) mmol/mol to 57.5 (Jacobs-van der Bruggen et al., 2009) mmol/mol post-challenge ($p = 0.03$). During the NC blood glucose-lowering medication prescription was diminished in three participants with an HbA1c ≤ 53 mmol/mol and added in one with an HbA1c above 53 mmol/mol. After excluding these participants, the decrease in median HbA1c in the group with a higher HbA1c remained significant (7.0 mmol/mol, $p = 0.04$).

Only 20 participants filled in questionnaires both at the start and post-challenge; 10 in each subgroup. Because of few data only results for the overall study population are shown (Table 5). Participants experienced statistically significant more well-being.

4. Discussion

An easy to organise and low-cost 28-weeks supervised walking programme significantly improved BMI, waist circumference, SBP and DBP in a highly motivated study population that is able to walk for 6 km once weekly as a starting level and wanting to do a significant walking challenge. Furthermore, participants experienced significantly more well-being and a better health status (non-significant) post-challenge. Participants with T2DM whose HbA1c was > 53 mmol/mol, but not those below that level, had a significant decrease in HbA1c post-challenge.

With respect to body composition, our findings are in agreement with previous studies conducted in controlled settings in terms of direction of effect. Qiu et al. (2014) and Murtagh et al. (2015) examined in their meta-analyses the effect of walking on cardiovascular risk factors in people with T2DM and sedentary but healthy participants, respectively. They found significant improvements in bodyweight and BMI, but with regard to the magnitude of the effect of a walking programme on body composition, improvements were larger in our study population. Although both meta-analyses included RCTs with a higher frequency of walks per week (ranging from 2 to 7 times a week), both supervised and non-supervised, our walking programme covered a significant volume (i.e. distance). In abovementioned meta-analyses duration of each walking session varied from 20 to 120 min; average duration is not given. Furthermore, we do not have any information about the amount of unsupervised physical activity outside of the walking programme, and neither about dietary outcomes, that both might have contributed to the favourable effect found. Differences in effect size may also be due to a lower BMI at baseline in the included studies and a shorter walking programme. Moreover, weight loss in our study population might be more since post-challenge measurements were taken three days after the challenge-week in which participants walked 15 km for six days consecutively. Maybe the highly selected sample (highly motivated and able to walk 6 km once weekly at the start) in our study population is the main trigger of our findings. If so, in our opinion this does not affect their relevance. One size does not fit all, but for those who want to walk in groups one day per week, the walking programme seems a good option.

Table 3

Pre-challenge, post-challenge and changes in anthropometric measures and blood pressure in the overall study population of the Nijkerk challenge (February–August 2017).

	N	Pre-challenge	Post-challenge	Mean difference (95% CI)	p-value
Weight, median, (IQR), kg	53	88.0 (20.0)	84.0 (22.4)	-	< 0.01
BMI, median (IQR), kg/m ²	53	30.7 (5.2)	29.7 (4.8)	-	< 0.01
Waist circumference, mean (SD), cm	44	107.3 (9.5)	103.9 (9.8)	3.4 (2.1; 4.8)	< 0.01
Blood pressure, mean (SD), mm Hg					
Systolic	54	147.3 (19.3)	140.9 (17.6)	6.5 (1.6; 11.3)	0.01
Diastolic	54	90.1 (9.9)	86.6 (9.0)	3.5 (1.0; 6.0)	< 0.01

Variables presented as means (SD) or medians (IQR). If values are reported in means, p-values are calculated using the paired t-test; if values are given in medians, p-values are calculated using the Wilcoxon Signed Rank test. N, number of subjects. SD, standard deviation. IQR, interquartile range. BMI, body mass index. CI, confidence interval.

When compared to other lifestyle interventions, achieved weight loss and decline in BMI were similar to results found in diabetes prevention programmes in highly controlled settings (Diabetes Prevention Program Research Group et al., 2002; Tuomilehto et al., 2001; Roumen et al., 2008). Recently, Duijzer et al. (Duijzer et al., 2017) assessed the effectiveness of the SLIMMER combined dietary and physical activity lifestyle intervention in people at risk for T2DM in Dutch primary healthcare. After 12 months, the decrease in BMI was comparable to our findings in a real-life setting. On the contrary, a one-year nurse-led lifestyle program (Hesselink et al., 2015) and a cognitive behaviour programme (Lakerveld et al., 2013), both performed in Dutch primary healthcare, resulted in smaller changes in body composition.

The NC had high clinical impact on both SBP and DBP, and the blood pressure decrease was larger than in the aforementioned meta-analyses (Qiu et al., 2014; Murtagh et al., 2015). This may be due to the higher blood pressure at baseline in our study population. Moreover, since weight loss adds to the benefits of exercise alone (Neter et al., 2003; Bacon et al., 2004; Franz et al., 2015), it is expected that the higher magnitude of weight loss in our study contributed to the observed effects. Other lifestyle intervention programmes in Dutch patients found larger decreases in DBP ranging from 2.8 mm Hg (Duijzer et al., 2017) to 5.9 mm Hg (Figueira et al., 2014), but smaller decreases in SBP ranging from 2.8 mm Hg (Hesselink et al., 2015) to 4.7 mm Hg (Duijzer et al., 2017). Principally, the large decrease in SBP in our study is favourable.

In contrast to the results of a previous meta-analysis (Qiu et al., 2014), where an overall decline in HbA1c level of 0.58% (95% CI -0.93 to -0.23%) in supervised walking programmes was found, we were not able to demonstrate such an improvement, most likely due to the fact that on average participants with T2DM were well-controlled at the start of the NC. This assumption is supported by the finding that glycaemic control did improve by 6.5 mmol/mol (~0.6%) in participants

Table 5

Pre-challenge, post-challenge and changes in questionnaire scores in the overall study population of the Nijkerk challenge.

All participants (n = 20)			
	Pre-challenge	Post-challenge	p-value
WHO-5	72.0 (20.0)	76.0 (12.0)	0.01
EQ-VAS	74.0 (23.0)	80.0 (15.8)	0.07
PAM-13 ^a	55.6 (15.3)	58.1 (18.9)	0.37

Values are expressed in medians with interquartile range. P-value is calculated using the Wilcoxon Signed Rank test. WHO-5, World Health Organization Five Well-Being Index. EQ-VAS, EuroQol Visual Analogue scale. PAM-13, 13-item Patient Activation Measure.

^a n = 18.

with insufficient glycaemic control (HbA1c > 53 mmol/mol), which is in line with existing evidence that higher baseline HbA1c levels are associated with greater reductions in HbA1c levels (Franz et al., 2015; Reid et al., 2010; Gugliani et al., 2014; König et al., 2009). Presumably, the weight loss contributed to the observed decrease in HbA1c in participants with insufficient glycaemic control, but previous studies have also indicated that physical activity decreases the risk of diabetes through mechanisms beyond weight loss alone (Hamman et al., 2006; Laaksonen et al., 2005; Pan et al., 1997).

Recently, a cross-sectional study conducted in people with T2DM in Dutch general practices, found a statistically significant, but not clinically relevant, positive association between physical activity and well-being (Hendriks et al., 2017). Although the former study is a cross-sectional study, and therefore cause and effect cannot be determined, our results showed that the NC significantly improved participant's well-being, which is in line with other (Gugliani et al., 2014; Kempf &

Table 4

Pre-challenge, post-challenge and changes in anthropometric measures and blood pressure in participants at risk for T2DM and participants with T2DM, separately.

	At risk					T2DM				
	N	Pre-challenge	Post-challenge	Mean difference (95% CI)	p-value	N	Pre-challenge	Post-challenge	Mean difference (95% CI)	p-value
Weight, median (IQR), kg	24	88.8 (24.6)	83.5 (23.3)	-	< 0.01	29	87.5 (17.3)	85.0 (21.0)	-	0.10
BMI, median (IQR), kg/m ²	24	31.9 (5.8)	30.5 (3.6)	-	< 0.01	29	30.0 (4.7)	28.7 (4.9)	-	0.15
Waist circumference, mean (SD), cm	24	108.3 (10.9)	104.4 (11.0)	3.9 (2.2; 5.6)	< 0.01	20	106.1 (7.7)	103.2 (8.4)	2.9 (0.5; 5.2)	0.02
Blood pressure, mean (SD), mm Hg										
Systolic	25	146.9 (21.3)	140.4 (16.6)	6.5 (0.6; 12.4)	0.03	29	147.7 (17.7)	141.3 (18.6)	6.4 (-1.4; 14.2)	0.10
Diastolic	25	91.2 (7.4)	88.9 (9.0)	2.3 (-1.3; 5.8)	0.20	29	89.2 (11.7)	84.7 (8.7)	4.5 (0.8; 8.2)	0.02

Variables presented as means (SD) or medians (IQR). If values are reported in means, p-values are calculated using the paired t-test; if values are given in medians, p-values are calculated using the Wilcoxon Signed Rank test. T2DM, type 2 diabetes mellitus. N, number of subjects. SD, standard deviation. IQR, interquartile range. BMI, body mass index. CI, confidence interval.

Martin, 2013; Shenoy et al., 2010), but not all (Reid et al., 2010) studies that examined the effect of exercise programmes on well-being. Improvements in health status reached significance, to a post-challenge health status comparable to the overall Dutch population (Konig et al., 2009). Significant improvements in health status, measured by EQ-VAS, were reported of a 3-year lifestyle intervention programme performed in primary healthcare (Eriksson et al., 2010). When compared to studies that used the Short Form Health Survey (SF-36) as measure of physical and mental health status, this concurs with the results of the IDEs and SLIMMER interventions (Duijzer et al., 2017; Nicolucci et al., 2011).

Well-being, physical health status and BMI are associated with patient activation and thereby influence diabetes control and self-management (Bos-Touwen et al., 2015; Hendriks et al., 2016). In the current study, no significant increase in patient activation was found. Baseline patient activation score was similar to those reported in two cross-sectional studies in people with T2DM in the Netherlands (Bos-Touwen et al., 2015; Hendriks et al., 2016). Many participants remained at patient activation level 3 post-challenge, suggesting that these individuals are taking actions to self-manage their health (Rademakers et al., 2012), although there is still room for improvement.

4.1. Study limitations and strengths

An important strength of our study is that it is conducted in a real-life primary care setting. Besides, the walking programme is simple to implement and low-cost, on the condition that a sufficient number of volunteer health care professionals is available. Moreover, it evaluates the effectiveness of supervised walking on various important outcome measures. Despite the small number of people participating in this study and a dropout rate of ~10%, both significant and clinical relevant effects were found.

But, in interpreting our findings, several limitations need to be considered. Since only a small number of people from the invited individuals agreed to participate, included participants are likely to be more motivated for lifestyle interventions. The way of selecting participants at risk for T2DM may also have caused selection bias. Because of the highly selective group of motivated participants, generalizability of the findings can be questioned. Although the outcomes are great in magnitude, it is likely not 'high impact' as it may address only a small proportion of affected or at-risk individuals and therefore its reduction in community attributable risk is likely modest.

Potential confounders to the results of this study are the baseline physical activity, the amount of physical activity people attained outside the walking programme, and the dietary habits. Since changes in levels of physical activity outside the walking sessions and changes in diet have not been assessed during the NC, it is unsure whether the reported effects are only due to the walking programme itself. Since post-challenge measurements are only taken three days after the challenge-week, we cannot provide information about long-term effects on body composition.

5. Conclusion

In conclusion, in motivated individuals with T2DM and those at risk for it, this study demonstrates that a once per week, intensive, supervised walking programme, has favourable effects on body composition, blood pressure, HbA1c and well-being, and has potential to improve health status. Such programme could hereby prevent T2DM, and prevent or delay the onset of complications or induce remission, although generalizability can be questioned because of the highly selective group of motivated participants.

Conflict of interest

The authors declare no conflict of interest.

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