RESEARCH ARTICLE

Factors associated with participation in a diabetes prevention program in Austria: a prospective cohort study

Yvonne Teuschl[1], Karl Matz[1], Alexandra Dachenhausen[1], Jaakko Tuomilehto[1,2,3,4] & Michael Brainin*[1]

Summary Points

Background

- Lifestyle modifications can successfully decrease diabetes risk in people at high risk of this condition.
- Participation in lifestyle interventions is often low therefore, factors associated with recruitment and adherence have to be identified.

Methods

- In this study, 644 subjects aged between 40 and 75 years who had no previously diagnosed diabetes and were at an intermediate to high risk for developing diabetes were recruited in five districts in lower Austria.
- Lifestyle interventions aimed at motivating subjects to: reduce weight; moderate dietary fat intake; lower dietary saturated fat intake; increase dietary fiber intake; and partake in regular physical activity.

Results

- Completion of baseline questionnaires was related to a family history of diabetes.
- Attendance to baseline medical examinations was associated with higher diabetes risk, anxiety and being unsatisfied with one's own weight.
- Workshop participation was more likely in older persons with lower low-density lipoprotein cholesterol and fewer complaints regarding sexual activity.
- Attendance to final medical examination was associated with fewer signs of depression, better education, lower diastolic blood pressure, better self-assessed fitness and self-estimated insufficient level of physical activity.

Conclusion & future perspective

- Diabetes information during recruitment should address the risk of elevated blood sugar levels and the necessity to start lifestyle changes in the prediabetic stage.
- Interventions should be adapted for less educated individuals, take into account emotional factors, such as depressive symptoms, and provide the most support to the least less fit and healthy participants.

[1]Department for Clinical Neurosciences and Preventive Medicine, Danube University, Karl Dorrekstrasse 30, A-3500 Krems, Austria
[2]Department of Public Health, University of Helsinki, Finland
[3]South Ostrobothnia Central Hospital, Finland
[4]Red RECAVA Grupo RD06/0014/0015, Hospital Universitario La Paz, Spain
*Author for correspondence: Fax: +43 2732 893 4810; michael.brainin@donau-uni.ac.at

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SUMMARY **Aims:** This study aims to identify factors associated with participation in and adherence to a low-intensity diabetes prevention program. **Methods:** A total of 644 subjects who were at an intermediate-to-high risk for developing diabetes were enrolled in this study, aiming to acheive weight reduction, diet changes and regular physical activity. **Results:** Attendance at the baseline medical examination (n = 198) was associated with higher diabetes risk, being more anxious, lower fat intake and being unsatisfied more often with bodyweight compared with nonattendance. Workshops were attended by 142 individuals who were older and had lower levels of low-density lipoprotein cholesterol than nonattendees. Participants at the final medical examinations (n = 80) had a higher level of education, better self-rated fitness, fewer signs of depression and lower diastolic blood pressure than nonparticipants. **Conclusion:** Self-perceived diabetes risk can thus motivate people to participate in a diabetes prevention program. Adherence could be improved by adapting interventions to the education, possible depressive symptoms, fitness and health of participants.

Leading risk factors for loss of healthy life in developed countries are tobacco (13%), high blood pressure (9%), overweight and obesity (7%), high blood cholesterol (6%) and excessive alcohol consumption (4%) [1]. Cardio- and cerebro-vascular diseases, diabetes, hypertension, dementia and some forms of cancer share this cluster of modifiable risk factors [2]. Lifestyle modification offers an effective therapy with sustained long-term benefit to prevent or delay these diseases. In particular, they have been successful in decreasing diabetes risk in individuals at high risk [3–6].

Adherence to prescribed risk management is a key factor for successful lifestyle changes [7]. However, adherence to behavioral changes and long-term maintenance of such changes is often low and people must be encouraged to participate in health programs in the first place [101]. A number of predictors for adherence to dietary and physical activity interventions have been identified by different theories of health behavior [7,8]. However, predictors for drop-out are not sufficiently understood; drop-out rates are often high and vary considerably. The majority of studies have focused on predictors for behavioral changes or for compliance with lifestyle interventions. It is, however, important to identify factors related to recruitment and participation to understand the motivation of the target population and be able to adapt lifestyle modification programs accordingly [9]. Here, we use data from the Diabetes in Europe – Prevention Using Lifestyle, Physical Activity and Nutritional Intervention Project (DE-PLAN) to analyze individual, lifestyle and health-related factors, and their effects on participation and adherence. In particular, we focus on factors related to the transtheoretical theory [10] and the health belief model [11]. The DE-PLAN was started, building on the success of the Finnish Diabetes Prevention study [6], to test the feasibility and effectiveness of community lifestyle intervention programs to prevent Type 2 diabetes in high-risk individuals in Europe [12]. We analyzed data of individuals recruited by the DE-PLAN in lower Austria to identify factors associated with the decision to participate in this study and to attend medical examinations and workshops offered as part of the study. We expect different motivations driving participation at different stages of the study and hope to thereby gain insight into factors influencing the readiness for lifestyle changes in this high-risk population.

Methods

■ Subjects & setting

At inclusion, subjects were 45–75 years of age, had no previously diagnosed diabetes mellitus, but a medium-to-high risk of developing diabetes according to a Finnish Diabetes Risk Score (FINDRISC) ≥12 [13]. Detailed study methods of the DE-PLAN have been published elsewhere [12]. Study participants were recruited from May 2006 to January 2007 in five of the 25 administrative districts of lower Austria (total population of the five districts: 367,240 inhabitants; 35% aged 45–75 years). People were sensibilized through local media (TV, radio and newspapers). FINDRISC questionnaires were attached to local newspapers and distributed through local structures (e.g., pharmacies, blood donation buses, work places and adult education centers) and personally by promoters presenting the study during local health information events, fairs or at regional clubs and societies. A homepage provided information on the project and the possibility to complete the FINDRISC online. Individuals with a medium-to-high diabetes risk on the FINDRISC

were encouraged to return the questionnaire and invited to participate in the study. Eligible individuals were invited to an information event to complete baseline questionnaires and undergo a medical examination.

Data collection

Medical examinations were performed by general practitioners in all five districts, freely selectable from a list by the participants. Medical examinations included recording of medical history, current medication, weight, height, waist circumference and blood pressure measurements. Blood pressure was measured from the right arm of the subject, who was seated for 5 min before the measurement. Blood pressure was measured with electronic devices; twice, if possible. Weight was measured in light clothing. Height was measured to the nearest 0.5 cm. An oral glucose tolerance test was performed according to the WHO recommendations to exclude pre-existing diabetes. Blood samples were collected during the medical examination and analyzed in a central laboratory for glucose, total high-density lipoprotein and low-density lipoprotein cholesterol, triglycerides, alanine aminotransferase, γ-glutamyltransferase, creatinine, uric acid and high-sensitivity C-reactive protein. Participants were asked to complete self-administered questionnaires about sociodemographic factors (age, marital status, years of education and working status), medical history of major vascular events and health behavior. Questionnaires contained detailed questions on vascular risk factors, smoking and drinking habits, amount and quality of physical activity habits and dietary style (including information on healthy products [i.e., fish, fruits and vegetables], as well as quantity and quality of meals, sweets, drinks and lipids). Additional questions were asked about indiviuals' stage of change for lipids, fruit and vegetables, alcohol, physical activity and weight (**Supplementary Table 1**, see online www.futuremedicine.com/doi/suppl/10.2217/DMT.12.46). Additionally, the health-related quality of life (HRQoL) questionnaire 15D asked about 15 dimensions of health: mobility, vision, hearing, breathing, sleeping, eating, speech (communication), elimination, usual activities, mental function, discomfort and symptoms, depression, distress, vitality and sexual activity (each dimension is divided into five levels) [14]. Questionnaires could be returned after the information event or by mail. Questionnaires and medical examinations were performed at baseline and after the last workshop at the end of the study in October/November 2007.

Intervention

Intervention consisted of an initial information event and four consecutive workshops held by dieticians or sport scientists with the aim of motivating and providing subjects with the tools necessary to reach five lifestyle goals:

- Weight reduction (≥5%)
- Moderate dietary fat intake (<30% of daily energy intake)
- Low dietary saturated fat intake (<10% of daily energy intake)
- High dietary fiber intake (>15 g/1000 kcal)
- Regular physical activity (>30 min/day or >4 h/week)

Workshops were scheduled over a period of 1 year, each had a duration of 1–2 h and covered information on vascular risk factors, determination of individual goals, healthy nutrition, examples of physical exercises, and advice on how to incorporate physical activity and diet into daily life. To give all participants the opportunity to attend workshops, they were held in small groups (ten individuals or less) in all five districts, on at least two dates. Further motivational tools were regular control of weight, waist circumference and blood pressure, individual contact by phone and/or mail and provision of additional educational material (i.e., a diary containing health advice and recipes for a healthy diet, worksheets, caloric tables and a website providing more tips and information). Overall, 13 initial information sessions and 47 workshops were held.

Ethical considerations

The study was approved by the Ethics Committee of Lower Austria and participants gave written informed consent.

Data analysis

Baseline data of people attending or not attending four different stages of the study were compared:

- Completing the baseline questionnaires
- Undergoing the baseline medical examination
- Participation in at least one workshop
- Undergoing the final medical examination

We compared attendance according to sociodemographic variables, FINDRISC, to the stages of change (Transtheoretical Theory [15]), to self-perceived health (Health Belief Model [12]), and according to laboratory data, possibly more objective, reflecting lifestyle and vascular risk factors. Univariate group comparisons were made using χ^2 or the Fisher exact test for nominal data, Mann–Whitney U for non-normal distributed data and t-test for normally distributed data.

For multivariate analysis, sex and age-adjusted backward stepwise binary logistic regressions, with participation as a dependent variable, were performed:

- With sociodemographic and health-related factors
- With the answers to the HRQoL questionnaire
- With laboratory parameters as explanatory variables

Only participants with full data sets were included in the analysis.

Results

Overall, 117,000 FINDRISC questionnaires were distributed in the target communities; of those 1951 were returned, and of them, 644 (49%) fulfilled the inclusion criteria **(Figure 1)**. Of these, 297 (46%) completed the baseline questionnaires and 198 (31%) underwent medical examinations. Forty two individuals (16%) had to be excluded because of pre-existing or newly detected diabetes. A total of 186 individuals attended an initial information event and 142/602 (24%) individuals participated in at least one workshop, 80/602 (13%) individuals underwent the final medical examination and 137/602 (23%) individuals completed final questionnaires **(Figure 1)**. Individuals who were incompliant at some point were not excluded from the study, leading to participants not completing questionnaires or not being compliant at the baseline medical visits, but visiting workshops **(Figure 1)** or the final medical examination. The mean age of the 602 individuals fulfilling the inclusion criteria was 60 ± 8 years and 50% were women.

Completion of baseline questionnaires

Individuals completing at least the baseline questionnaires were younger (mean: 58.3 ± 7.6 standard deviation vs 60.5 ± 8.2 standard deviation; $p = 0.001$) and had a higher diabetes risk (median FINDRISC: 17 [IQR 15–18] vs 16 [IQR 13–18]; $p \leq 0.0001$) compared with those solely completing the FINDRISC questionnaire. There was no gender difference (51 vs 48% women; $p = 0.357$). Responses to individual FINDRISC questions differed between those completing and those not completing the baseline questionnaires for daily physical activity (62 vs 70%; $p = 0.025$), hypertensive medication (61 vs 69%; $p = 0.023$) and family history of diabetes (71 vs 54%; $p \leq 0.0001$). No differences were found for BMI, waist circumference, history of high blood glucose and daily consumption of fruits and vegetables (all univariate comparisons: $p > 0.3$).

Attendance at baseline medical examination

Attending the baseline medical examination was associated with higher FINDRISC scores and, considering the stages of change with an already low fat intake, a greater willingness to reduce alcohol consumption and more dissatisfaction with bodyweight **(Supplementary Table 1)**. Group differences for quality of life were small, as the majority of people considered themselves to be healthy on the 15D questionnaire. However, individuals who did not undergo medical examinations stated more often that they were not anxious (66.7 vs 55.6%; univariate $p = 0.03$). In the multivariate model corrected for sex and age, being more anxious (logistic regression: OR: 1.62, 95% CI: 1.09–2.41; $p = 0.017$) but having fewer complaints regarding sexuality (OR: 0.71, 95% CI: 0.51–1.00; $p = 0.048$) were the only variables associated with participation in the medical examination.

Workshop participation

In the quality of life questionnaire, the only difference found between people attending and those not attending workshops was related to problems with sexual activity (51% of workshop visitors had no complaints, compared with 71% for nonattendees, logistic regression: OR: 1.56, 95% CI: 1.08–2.24; $p = 0.017$). Older individuals with lower low-density lipoprotein cholesterol were more likely to attend workshops **(Table 1)**.

Attendance at final medical examination

In the logistic regression, people attending both medical examinations were better educated and had better self-assessed fitness, but did estimate their level of physical activity to be low compared

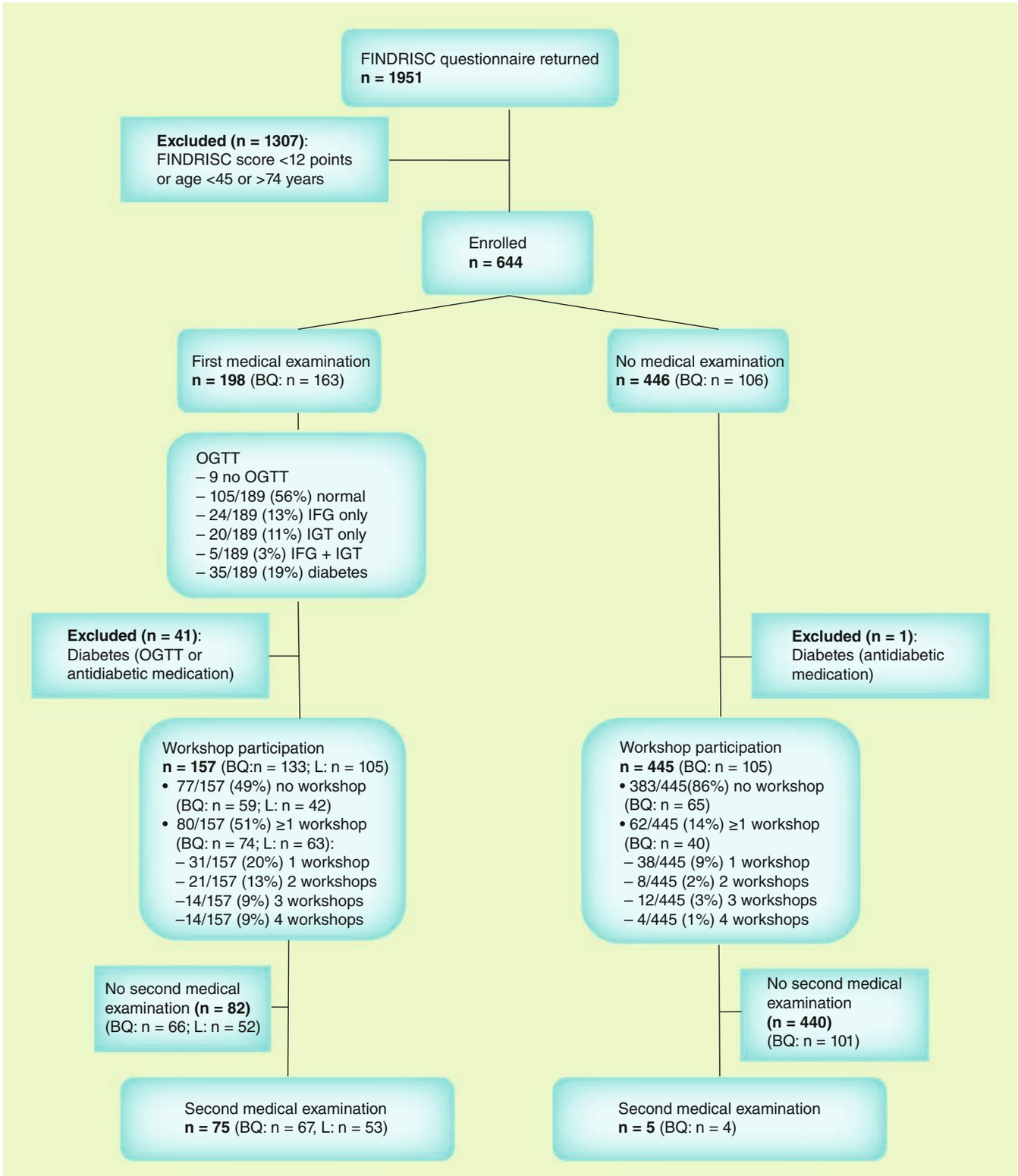

Figure 1. Flowchart of the Diabetes Prevention Project (DE-PLAN) in lower Austria.
BQ: Full data set for the baseline questionnaire; FINDRISC: Finnish Diabetes Risk Score; IFG: Impaired fasting glucose; IGT: Impaired glucose tolerance; L: Full data set for the medical examination; OGTT: Oral glucose tolerance test.

Table 1. Characteristics of the baseline medical examination of individuals with or without workshop participation, and with or without final medical examination.

Variable (mean ± SD)	At least one workshop					Final medical examination				
	Participation		Univariate	Binary logistic regression†		Participation		Univariate	Binary logistic regression†	
	No (n = 42)	Yes (n = 63)	p-value	OR (95% CI)	p-value	No (n = 52)	Yes (n = 53)	p-value	OR (95% CI)	p-value
Sex (% female)	66.7%	55.6%	0.255	1.63 (0.65–4.10)	0.297	63.5%	56.6%	0.473	1.39 (0.62–3.15)	0.428
Age	55.0 ± 6.8	59.8 ± 6.8	0.001	1.12 (1.05–1.20)	0.001	56.7 ± 7.2	59.1 ± 7.1	0.092	1.049 (0.99–1.11)	0.095
BMI	33.0 ± 5.4	31.6 ± 4.7	0.177	0.93 (0.85–1.02)	0.120	33.1 ± 4.7	31.3 ± 5.2	0.076		
Waist circumference	109.8 ± 13.9	108.8 ± 11.6	0.936			111.2 ± 11.9	107.3 ± 12.9	0.154		
Blood pressure systolic	153.2 ± 18.0	154.9 ± 21.7	0.690	0.98 (0.95–1.01)	0.138	154.9 ± 18.2	153.5 ± 22.1	0.597		
Blood pressure diastolic	93.2 ± 8.4	95.3 ± 12.5	0.549	1.06 (1.00–1.12)	0.065	96.5 ± 11.6	92.4 ± 10.1	0.049	0.96 (0.93–1.00)	0.049
Triglycerides (mmol/l)	1.7 ± 0.9	1.7 ± 0.8	0.950			1.8 ± 0.9	1.7 ± 0.8	0.800		
Cholesterol (mmol/l)	6.0 ± 1.1	5.6 ± 1.1	0.087			5.8 ± 1.1	5.8 ± 1.1	0.734		
HDL cholesterol (mmol/l)	1.35 ± 0.3	1.35 ± 0.4	0.799			1.3 ± 0.3	1.4 ± 0.4	0.642		
LDL cholesterol (mmol/l)	3.9 ± 0.9	3.5 ± 1.0	0.134	0.59 (0.35–0.98)	0.041	3.7 ± 0.9	3.6 ± 1.0	0.800		
ALT (U/l)	27.2 ± 10.7	27.8 ± 12.4	0.950			28.8 ± 12.3	26.3 ± 11.1	0.334		
GGT (U/l)	31.9 ± 16.7	33.9 ± 23.6	0.462			33.1 ± 15.8	33.1 ± 25.3	0.717		
Creatinine (µmol/l)	101.9 ± 103.7	85.9 ± 12.4	0.995			99.2 ± 93.4	85.5 ± 12.1	0.817		
Uric acid (µmol/l)	299.4 ± 81.8	307.9 ± 68.8	0.578			5.1 ± 1.2	5.1 ± 1.2	0.570		
CRP (mg/l)	5.5 ± 4.1	5.8 ± 8.0	0.206			5.9 ± 5.8	5.5 ± 7.6	0.198		
Fasting glucose (mmol/l)	5.4 ± 0.7	5.6 ± 0.5	0.120			5.5 ± 0.6	5.5 ± 0.6	0.566		
Glucose 2h (mmol/l)	6.2 ± 1.7	6.0 ± 1.9	0.377			6.1 ± 1.8	6.0 ± 1.9	0.507		

†Final model of an age- and sex-adjusted step-wise backward binary logistic regression with participation as a dependent variable and BMI, systolic and diastolic blood pressure, HDL and LDL cholesterol, fasting blood glucose, 2-h blood glucose, ALT, GGT, creatinine, uric acid and CRP as explaining variables.
ALT: Alanine aminotransferase; CRP: C-reactive protein; GGT: γ-glutamyltransferase; HDL: High-density lipoprotein; LDL: Low-density lipoprotein; OR: Odds ratio; SD: Standard deviation.

with people only undergoing the first medical examination (Supplementary Table 1). They reported fewer signs of depression in the quality of life questionnaire (69 vs 51% had no signs of depression; univariate p = 0.040; logistic regression OR: 0.50, 95% CI: 0.29–0.87; p = 0.015). Individuals with lower diastolic blood pressure were more likely to undergo a second medical examination (Table 1).

■ Stages of changes

Overall, most participants were already in high stages of change concerning fat and fruit/vegetable consumption at baseline, but in low stages for physical activity (Supplementary Table 1). The majority of participants were not satisfied with their bodyweight (Supplementary Table 1).

Discussion

We analyzed factors related to participation at different points in time in a study targeting lifestyle modifications on a community level in individuals with a high risk of diabetes. The results indicated that willingness to participate in this study, reflected by completing baseline questionnaires and a medical examination, was related to factors implying a higher self-perceived health risk as suggested by the health belief model [11], but also to personal motivation as suggested by the transtheoretical model [10]. Adherence, reflected by workshop participation and attendance at the final examination, was associated with a higher level of education and factors related to better health and fitness.

Individual risk perception has been suggested as an important factor for behavioral change according to the health belief model [11]. Willingness to participate in this study was motivated by a family history of diabetes, but not by the individual's own history of elevated blood glucose levels, as reported in the FINDRISC. People attending the baseline medical examination described themselves more often as anxious, and participation may thus relate to an anxiety of developing diabetes. Diabetes risk measured by the FINDRISC was, however, not related to workshop participation and attendance at the final medical examination. Some people attending the baseline medical examination may have lost interest in the study and in lifestyle modifications when laboratory data confirmed that they had not yet developed diabetes. During recruitment, the study explicitly addressed individuals with medium-to-high diabetes risk. We cannot assess the effect of the FINDRISC on the recruitment and motivation of individuals with high diabetes risk. However, 18% of people completing the baseline questionnaires stated that they had been diagnosed with diabetes before. Thus, the concept of having high diabetes risk but not yet having diabetes, and the necessity to start lifestyle modifications in the prediabetic stage, seems difficult to communicate.

Another factor motivating participants was dissatisfaction with their own weight. Self-image and high bodyweight can trigger long-term weight loss [15]. People attending the medical baseline examination were more often in the preparation or action phase for weight loss (according to the transtheoretical model [10]) and more often followed a low fat diet than non-attendees. However, no group difference was identified in the stages of change for physical activity. Moreover, 19% of those recruited in this study were at baseline in the precontemplation phase (i.e., had no intention of increasing their physical activity). They were apparently more interested in diet changes. Indeed, less than 10% were in the precontemplation phase for diet (i.e., not interested in changing their fat, fruit and vegetable intake). Similarly, in the Inter99-study, individuals perceiving themselves as more susceptible to developing cardiovascular disease, having bad self-rated health, being overweight, aware of unhealthy dietary habits, having bad physical fitness and a high motivation towards changing dietary habits were more likely to accept participation in diet and exercise courses [9].

Workshop participation and attendance at final medical examinations was not related to phases of change for weight or diet. Individuals participating until the end of the study assessed their fitness at baseline as higher than nonadhering individuals. This is partly reflected by laboratory baseline parameters indicating that healthier individuals (lower low-density lipoprotein and diastolic blood pressure) were more likely to visit workshops and to participate until the final medical. In keeping with this, other studies found better adherence to physical intervention for people being fitter at baseline [8]. A web-based health program was used more frequently by individuals meeting guidelines for diet and physical activity [16], and patients at increased cardiovascular risk were more likely to participate in a nutrition counseling program when they had higher levels of

high-density lipoprotein cholesterol and lower systolic blood pressures [17]. These data suggest that those participants with a higher vascular risk are also at higher risk for drop-out.

Individuals participating in lifestyle-modification studies are often reported to be a more educated subsample of the population (e.g., [16,18]). In our study, better-educated individuals were more willing to attend the final medical examination. Unsurprisingly, people showing signs of depression seemed more likely to drop out. In view of the bidirectional relationship between sedentary lifestyle and depression, this underlines the importance of further encouraging these high-risk participants to start and maintain lifestyle changes.

Despite intensive recruitment efforts and personal contact during the distribution of the FINDRISC questionnaire, the response rate was low, and recruitment and retaining of participants turned out to be difficult in lower Austria compared with the Finnish population [6]. Recruitment was, however, also low in the other participating communities across other countries in Europe [19–21]. Thus, our sample probably reflects the situation encountered in communities during the implementation of low-level lifestyle change programs and can give insight into the motivation driving individuals to participate in such programs. Our results are, however, based on a low number of participants and a high number of variables, and therefore have to be interpreted with care. In contrast to our population, in a Greek population participating in the DE-PLAN study, neither the level of diabetes risk nor family history of diabetes influenced the decision of high-risk individuals to undergo the baseline oral glucose tolerance test [19]. On the other hand, participation in the intervention program was better in people with an increased degree of dysglycemia. We can only speculate about these differences. They may arise randomly due to the small number of participants at both study sites, but may also reflect differences in the recruited populations: the Greek population was recruited in a large city, partly in primary care settings

Finally, participation in a lifestyle modification program cannot be considered an equivalent to behavioral change. The intention to change behavior may not translate into actual changes. On the other hand, people who found themselves to be at high risk of diabetes may have started to change their lifestyle themselves without any assistance from the prevention program. Our data can thus only give a first insight into peoples' motivation to start lifestyle changes.

Conclusion

On a broad community level, it is difficult to communicate the necessity for lifestyle modification and to recruit individuals with high diabetes risk to participate in a diabetes prevention program. Participation in this study was motivated by a family history of diabetes, a higher level of anxiety and willingness to reduce weight. Participants' intention for lifestyle changes was mainly focused on changing their diet and less on increasing physical activity. Adherence until the end of the study was associated with better health, better self-rated fitness, fewer signs of depression and more years of education.

Future perspective

Self-perceived high diabetes risk can motivate people to participate in a lifestyle intervention program. However, people at risk have to become more aware that the development of diabetic complications is associated with elevated blood sugar levels even in the prediabetic stage, and that lifestyle changes should thus start before the diagnosis of diabetes. Adherence could be improved by adapting interventions to the educational level of the participants and by taking into account emotional factors, such as depression. Participants who were less fit and healthy, and thus probably at higher risk for developing diabetes, were at higher risk for drop-out. Increasing motivation and support, depending on the condition of the participants, could help to increase adherence.

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- ■■ of considerable interest

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