

Associations between Self-management Behavior and Sociodemographic and Disease-related Characteristics in Elderly People with Type 2 Diabetes – New Results from the Population-based KORA Studies in Germany

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Highlights

- The study highlights avenues to target and improve self-management behavior (SMB)
- An established SMB index comprising six dimensions and behavioral levels is used
- Participation in self-management education programs is associated with better SMB
- Older and obese respondents display worse SMB

Abstract

Aims:

Self-management behavior (SMB) is an important aspect in the management of diabetes. This study aimed to identify sociodemographic and disease-related factors associated with good SMB in people with type 2 diabetes (T2D).

Methods:

We used data from 405 people with T2D aged 65 or older from the population-based KORA (Cooperative Health Research in the Area of Augsburg) Health Survey 2016 in Southern Germany. We estimated Poisson and logistic regression models testing the cross-sectional relationship between individual or disease-related characteristics and an established SMB sum index comprising six SMB dimensions stratified for people with and without insulin treatment.

Results:

Mean age in the sample was 75 and diabetes duration 13 years. The overall level of SMB was low. Higher SMB index scores were associated with higher age, treatment with insulin, participation in a diabetes education program, and, for people with insulin treatment, with a BMI < 30 kg/m². Single item analyses generally supported these findings.

Conclusions:

SMB in people with T2D needs to be improved with efficient interventions. Targeting obese individuals and those at an early stage of the disease with low-barrier, regular education or self-management programs may be a preferred strategy.

Keywords: self-management, diabetes, adherence, health behavior

Introduction

Type 2 diabetes (T2D) is a widespread chronic metabolic disease affecting approximately 425 million people globally [1, 2]. In Germany, the prevalence of diabetes ranges between 7 and 10% and constitutes the fifth leading cause of death [3, 4]. T2D is associated with severe long-term micro- and macrovascular complications, an increased risk of premature mortality, lower quality of life, lower productivity, and higher health care costs [5-7].

Adequate self-management behavior (SMB) can significantly reduce the risk of diabetes-related complications, including cardiovascular complications, which are estimated to be responsible for 50% of diabetes-related deaths [2, 8-10]. Therefore, SMB is considered to be one of the most important aspects of diseases management in T2D. Furthermore, previous studies showed that diabetes self-management education (DSME) programs have a positive effect on glycemic control. [11, 12]. However, the effect disappeared with discontinuation of support indicating that a one-time participation in a DSME program may not be sufficient to yield sustainable effects [12].

Although SMB is complex and the importance of different components varies from patient to patient, the following behaviors are often referred to as the core aspects of SMB: a healthy diet, monitoring of blood glucose and weight, regular physical exercise, monitoring and management of cardiovascular disease risk factors, such as hypertension, and adherence to diabetic medication [2, 13-15].

In Germany, medication adherence and control of relevant factors, such as blood glucose, blood pressure and lipids, have both significantly improved over the last decade. However, no progress were observed in the level of patients' SMB [16, 17]. Here, besides sociodemographic factors like age and sex, research suggests that also changeable factors like emotional and practical support, as well as the occurrence of depressive symptoms, play an important role [18]. Nevertheless, evidence on factors and predictors of good SMB is quite limited.

Therefore, the aim of our study was to identify factors, which are associated with a high level of SMB in people with T2D participating in a large German population-based study. With that, we improve the understanding for patterns, barriers and facilitators for good SMB. Ultimately, this information might help to tailor strategies and interventions to improve SMB in people with T2D.

Materials and Methods

Sample

Our study is based on data from the KORA (Cooperative Health Research in the Region of Augsburg) Health Survey 2016. This survey is a population-based, cross-sectional postal follow-up study of four previous population-representative KORA cohorts and was conducted in 2016. All former participants from the MONICA S1 (1984 to 1985, n=4022), MONICA S2 (1989 to 1990, n=4940), MONICA S3 (1994 to 1995, n=4856) and KORA S4 (1999 to 2001, n=4261) study who were still alive and could be contacted were invited. In total, 9035 people responded to the Health Survey 2016. All participants aged at least 65 years were also invited to give more detailed information in computer-assisted telephone interviews.

Additionally, all Health Survey 2016 participants who reported to have diabetes (n=1025) received a further diabetes-specific questionnaire, which was answered by 837 participants, of which 746 reported to have T2D, whereas remaining respondents indicated to have other types of diabetes. Out of these 837 participants, 568 were aged 65 years or older and, therefore, took also part in the telephone interview. Since all three parts of survey (viz. postal survey, telephone interview, and diabetes-specific questionnaire) contained information being relevant for our research question, the present study is based on these n = 568 persons. A detailed description of the recruitment process for all KORA studies can be found elsewhere [19].

The Health Survey 2016 and telephone interview were approved by the Ethics Committee of the Bavarian Medical Association (approval number: 08064). All participants gave written informed consent before participation and all procedures performed were in coherence with the principles expressed in the Declaration of Helsinki.

Outcome

As described by Arnold-Wörner et al. (2008), SMB was measured by six dimensions [13]: (a) performing regular physical exercise (at least 60 min/week), (b) conducting regular foot care (checking for wounds at least once per week), (c) SMBG (at least once a day for patients treated with insulin and at least twice a week for others), and (d) monitoring of body weight (at least once a week) in the last 6 months prior to examination, as well as (e) currently keeping a diabetes diary and (f) currently following a diet plan. These six dimensions were summarized in an SMB index

[13]. The index reflects the sum of dimensions in which each participant achieved a high level of self-management. Previous research shows that this index is predictive for long-term all-cause mortality [6].

Explanatory Variables

Based on previous studies, several sociodemographic and disease-related characteristics were used as potential explanatory factors in our study [6, 15, 20, 21]. Sociodemographic variables included sex, age, education (≤ 10 years of school, > 10 years of school), self-perceived income (considered by the participant as sufficient or insufficient to cover monthly expenses) and family status (living alone, living with a partner). Disease-related characteristics comprised diabetes duration (in years), participation in a DSME program (yes, no), obesity status ($BMI < 30 \text{ kg/m}^2$, $BMI \geq 30 \text{ kg/m}^2$), self-reported hypertension (yes, no), anxiety/depression (Geriatric Depression Scale (GDS-15) ≥ 10 [22] or Generalized Anxiety Disorder Scale-7 ≥ 10 [23]), history of complications, including any microvascular complications (retinopathy, blindness, microalbuminuria, kidney insufficiency, dialysis, polyneuropathy, diabetic foot syndrome and amputation) or macrovascular complications (stroke, myocardial infarction, peripheral arterial occlusive disease), and treatment regimen (insulin, other than insulin).

Statistical Analysis

Out of the 568 participants in our sample, 89 were excluded due to more than three missing answers within the six self-management dimensions. Therefore, the final analysis sample included $n=479$ participants. For those with three or less missing answers in the self-management variables, missing answers were decoded as 'no', because we conservatively assumed that a missing value is coherent with non-performance in the respective dimension. Finally, missing values in the other covariates were imputed using variable dependent imputation techniques [24]. Further information are provided in Table A1.

In a first step, following Arnold-Wörner et al. (2008) we calculated inter-dimensional correlations (Person's r) and tested if the single SMB dimensions are sufficiently independent from each other to verify the calculation and usage of the index in our sample [13]. Next, to identify factors associated with self-management, we used a Poisson regression model and regressed socio-demographic and disease-related factors on the SMB index. Furthermore, we stratified this main regression model by treatment, as we identified major differences between individuals not treated

with insulin (A) and individuals treated with insulin (B). Additionally, we fitted logistic regression models and regressed the same set of socio-demographic and disease-related factors on each of the binary categorized single SMB dimensions to explore whether the covariates were differently associated with distinct dimensions of SMB. Again, we stratified the different models by insulin treatment.

Finally, in a sensitivity analysis, we repeated all analyses for participants without any missing values in the six self-management dimensions (n=442). All analyses were conducted using SAS V.9.4 (SAS Institute).

Results

Sample Characteristics

Table 1 shows the characteristics of our sample (n=479). The mean age of the participants was 75 years and 53% were male. Furthermore, 70% of the sample reported to live with a partner, 21% stated to have an income that is not sufficient to cover their monthly expenses, and 46% indicated that they have participated in a DSME program at least once. The mean diabetes duration was 13 years, about 37% were obese ($BMI \geq 30 \text{kg/m}^2$), 80% reported to have hypertension, and 6% stated to suffer from anxiety and/or depression. Additionally, 54% of the participants reported a history of diabetes-related complications and about 25% were treated with insulin. Individuals, who were not treated with insulin, received oral anti-diabetic medication or lived without a specific treatment. About 57% of the sample regularly monitored their body weight, 56% steadily checked their feet, 48% indicated to be physically active, 46% regularly checked their blood glucose levels, 30% managed to keep a diabetes diary, and 8% of the sample followed a Diabetes-specific diet plan.

[Table 1 about here]

Inter-dimensional Correlations

The correlations between the six self-management dimensions were generally low. This verifies the use of the index in our study. Details are given in Tables A2 to A4 of the Appendix.

Associations with Self-management Index

The results of the Poisson regression analysis are presented in Table 2. An Incidence Rate Ratio (IRR)-estimate > 1 indicates that the factor is positively associated with a higher SMB index.

[Table 2 about here]

In the overall model, a lower age, participation in a DSME program, and treatment with insulin were associated with a higher SMB index. When stratified by insulin treatment status, further differences between the two groups were observed. For participants not treated with insulin, results were similar to those of the overall model: the participation in a DSME program and a lower age were associated with a higher SMB index. Additionally, obese participants had a lower SMB index. In contrast, in participants treated with insulin, none of the demographic or disease-related characteristics was associated with the SMB index.

Dimension-specific Analyses

Table 3 shows the estimated Odds Ratios (OR) only if the factor was associated with compliance in the corresponding SMB dimension in the logistic regression models (for full results see Table A5 in the Appendix). Again, we focus only on the direction and significance level of the effect. An $OR > 1$ indicates a positive correlation. In general, treatment with insulin is associated with five of the six SMB dimensions, highlighting the need of stratification by insulin treatment status.

[Table 3 about here]

Among participants treated with insulin, men are more often physically active. In addition, respondents who also have a history of complications more regularly check their feet or their blood glucose level. Furthermore, participants who perceived their income as adequate are more likely to have an updated diabetes diary.

Among participants without an insulin treatment, older and obese respondents were less often physically active or controlled their feet. Furthermore, respondents with a history of complications were less likely to be physically active, but more likely to measure their blood glucose level regularly. Finally, a more frequent self-monitoring of blood glucose can be observed for participants with a higher level of education, for individuals with a longer duration of diabetes and for those who have participated in a DSME program.

In a sensitivity analysis, we included only participants who answered all self-management questions. However, this did not alter the described results of our main analysis.

Discussion

SMB is crucial for diabetes management and the prevention of long-term micro- and macrovascular complications. However, several studies have reported that patients with T2D show poor SMB. In this study, we have explored which sociodemographic and disease-related factors are associated with “good” self-management in people with T2D. Thereby, we have aimed to identify avenues for more stratified education and training approaches. The main findings of our study are that treatment with insulin and participation in a DSME program were associated with better SMB whereas older or obese respondents displayed worse SMB.

One conceptual challenge of studying patient’s SMB is that relevant SMB dimensions depend on the clinical needs of the patient. Furthermore, the educational efforts and strategies of physicians and the capacities of patients to understand and implement the behavior recommended influence the level of engagement in each dimension. Hence, to operationalize SMB in this study, we used a previously developed SMB index comprising six SMB dimensions and levels of behaviors which have generally been proven to be important and beneficial for patients with T2D [13] and predictive for all-cause mortality [6]. However, to pay attention to specific clinical needs we also analyzed single SMB dimensions. Corresponding results further revealed a more differentiated picture with different demographic and disease-related characteristics being associated with single self-management dimensions.

One important result of our study is the association between participation in a DSME program and SMB measured either by the SMB index or the single SMB dimensions. Although our observational study design describes associations rather than causal relationships, this finding is in line with previous studies utilizing randomized designs. For example, the DESMOND study found that diabetes education for people with a newly diagnosed diabetes leads to greater improvements in smoking cessation and weight loss compared to participants with standard care [11]. Interestingly, a follow-up study showed that after three years the effect of the intervention did not sustain without continuous support and education [11, 12]. Other reported positive effects of DSME on health and economic outcomes include improved knowledge [25], lower HbA1c values [26], lower self-reported weight [27], improved quality of life [28], and reduced health care costs [29, 30]. The American Diabetes Association suggests that patients should participate in DSME programs annually and at critical time points, e.g. at diagnosis, when new complicating

factors occur and at a transition in care [31]. Similarly, in Germany, guidelines recommend participation in a DSME program at diagnosis and regularly over the course of the disease [32]. In practice, access in Germany is limited to patients enrolled in a Disease Management Program (DMP) for T2D. Furthermore, reimbursement for repeated participation in DSME programs is only possible under certain circumstances. Consequently, only 50% of all German patients with T2D are currently enrolled in such programs [33]. Likewise, only about 53% of the individuals in our study have participated in a DSME. Therefore, lowering the barriers to access DSME programs could potentially improve SMB in all dimensions considered and, thereby, lead to better long-term health outcomes.

The second robust finding of our study is that treatment with insulin is positively associated with four SMB dimensions (i.e. practicing foot care, self-monitoring of blood glucose, keeping a diabetes diary, following a diet plan), while we observe a negative association with physical exercise. This finding might be explained by the fact that certain dimensions of SMB become more important when the treatment regimen is changed to insulin intake, which might be a consequence of disease progression [34, 35]. For example, frequent self-monitoring of blood glucose is more critical for patients who take insulin compared to those who take oral anti-diabetics.

However, as all of the six SMB dimensions are in general relevant for both groups, with and without insulin treatment, and since the threshold-levels defined to indicate good SMB within each of these six dimensions were quite low we believe that the mere change in treatment regimen is not the full explanation for these findings. An alternative reason might be that due to the lack of immediate health benefits of successful SMB, patients often postpone their adaptation of relevant but burdensome SMB until the disease progresses and initiation of insulin therapy is necessary [15]. Hence, it is also not surprising that a history of complications and diabetes duration were correlated with regular self-monitoring of blood glucose in our study. Previous work has already shown that external shocks, such as the diabetes diagnosis of a partner, might open the window for effective lifestyle changes [36]. Therefore, future research should consider how less-harmful contextual factors and events could also be exploited to support the process of SMB adaptations. Furthermore, patients' behavior might be driven by present-biased preferences, i.e. a (strong) preference for smaller but immediate over larger but future gains, as potential barriers for behavioral change [37, 38]. Thus, methods like incentives or deposit contracts, which have been

successfully applied in other fields, should be tested to improve SMB before disease progression and complications occur [39, 40].

Apart from self-management training and regimen status, only age and weight status in patients without insulin treatment were associated with the SMB index, and especially with physical exercise and foot care. This indicates that in particular the elderly and obese might be target groups, which could benefit the most. Other factors such as education, income or living alone were not associated with overall SMB, and only occasionally for single SMB dimensions. Further important barriers to successful SMB discovered in previous work, including lack of knowledge regarding the disease and respective recommendations [25], underestimation of one's own susceptibility [15, 41], and lack of social support [42], could not be considered in the present study as this information was not assessed in the underlying questionnaires and telephone interviews.

Besides the non-comprehensiveness of potential determinants or factors, other limitations are worth to be mentioned. First, the study focused on people with T2D aged 65 and older. It is unknown if the same associations are observed in a younger sample. Second, similar to alternative indexes available the reliability and validity of the questions comprising our SMB remains unknown and the operationalization of SMB is conceptually difficult [18, 43, 44]. Finally, due to the observational nature of this study all results describe associations rather than causal effects and should be interpreted as those. Despite these limitations, by describing the SMB and its predictors in a concurrent large population-based sample the study adds valuable information to the literature and highlights several avenues to target and improve SMB in people with T2D.

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Declarations of interest

None.

Tables

Table 1: Sample characteristics (total sample: n=479)

Variables	Total	Sub-groups
<i>Demographic characteristics</i>		
Age (years), 25% / 50% / 75% quartiles	70 / 75 / 79	
Sex, n (% of total)	479 (100.0)	
Men		256 (53.4)
Women		223 (46.6)
Education, n (% of total)	478 (98.8)	
≤ 10 years		297 (62.1)
> 10 years		181 (37.9)
Income, n (% of total)	478 (98.8)	
Not sufficient		102 (21.3)
Sufficient		376 (78.7)
Living with partner, n (% of total)	479 (100.0)	
No		145 (30.3)
Yes		334 (69.7)
<i>Disease-related characteristics</i>		
Diabetes duration (years), means (SD)	12.9 (9.9)	
Participation in DSME, n (% of total)	474 (99.0)	
No		222 (46.8)
Yes		252 (53.2)
Weight status, n (% of total)	474 (99.0)	
Not Obese		296 (62.4)
Obese		178 (37.6)
Hypertension, n (% of total)	479 (100.0)	
No		94 (19.6)
Yes		385 (80.4)
Anxiety / Depression, n (% of total)	463 (96.7)	
No		433 (93.5)
Yes		30 (6.5)
Microvascular complication, n (% of total)	472 (98.5)	
No		262 (55.5)
Yes		210 (44.5)
Macrovascular complication, n (% of total)	479 (100.0)	
No		356 (74.3)
Yes		123 (25.7)
History of any complication, n (% of total)	473 (98.8)	
No		216 (45.7)
Yes		257 (54.3)
Treatment with insulin, n (% of total)	479 (100.0)	
No		359 (74.9)

Variables	Total	Sub-groups
Yes		120 (25.1)
<i>Dimensions of self-management, number of compliant cases (% of total)</i>		
(a) Physical exercise	231	(48.2)
(b) Foot care	269	(56.2)
(c) Weight monitoring	271	(56.6)
(d) Self-monitoring of blood glucose	219	(45.7)
(e) Diabetes diary	143	(29.9)
(f) Diet plan	38	(7.9)

Note: Weight status: obesity is based on objectively measured values and refers to a Body Mass Index ≥ 30 kg/m². Hypertension: Answers are derived from the question “Has a doctor ever told you that you have a high blood pressure (hypertension)?” Anxiety/depression: Respondents are said to suffer from anxiety or depression if the Geriatric Depression Scale (GDS-15) ≥ 10 [22] or if the Generalized Anxiety Disorder Scale-7 ≥ 10 [23].

Table 2: Main model (Poisson regression) - Factors associated with higher level of SMB for the whole sample and stratified by treatment

Variables	Main model (MM) (n=479)		Without insulin (A) (n=359)		With insulin (B) (n=120)	
	IRR (p-values)	95% CI	IRR (p-values)	95% CI	IRR (p-values)	95% CI
<u>Demographic characteristics</u>						
Age (metric)	0.99 (.02)*	0.98 - 1.00	0.98 (.01)*	0.97 - 1.00	1.00 (.66)	0.98 - 1.01
Men ^{a)}	0.96 (.57)	0.85 - 1.09	0.96 (.58)	0.82 - 1.12	0.99 (.92)	0.78 - 1.25
High level of education ^{b)}	0.94 (.35)	0.83 - 1.07	0.92 (.27)	0.79 - 1.07	0.96 (.75)	0.76 - 1.22
Sufficient income ^{c)}	1.09 (.28)	0.94 - 1.26	1.03 (.73)	0.86 - 1.24	1.13 (.36)	0.87 - 1.47
Living with partner ^{d)}	0.97 (.66)	0.85 - 1.11	0.99 (.95)	0.84 - 1.17	0.89 (.35)	0.71 - 1.13
<u>Disease-related characteristics</u>						
Diabetes duration (metric)	1.01 (.14)	1.00 - 1.01	1.01 (.13)	1.00 - 1.02	1.00 (.69)	0.99 - 1.01
Participation in self-management program ^{e)}	1.17 (.02)*	1.03 - 1.33	1.22 (.01)*	1.06 - 1.41	1.03 (.87)	0.78 - 1.37
Obesity ^{f)}	0.90 (.10)	0.80 - 1.02	0.84 (.03)*	0.72 - 0.98	1.02 (.84)	0.83 - 1.26
Hypertension ^{g)}	1.03 (.74)	0.88 - 1.19	1.00 (.97)	0.84 - 1.20	1.02 (.90)	0.77 - 1.34
Anxiety/depression ^{h)}	0.85 (.21)	0.66 - 1.09	0.90 (.54)	0.65 - 1.26	0.81 (.32)	0.54 - 1.22
History of complication ⁱ⁾	1.08 (.20)	0.96 - 1.23	1.02 (.78)	0.88 - 1.18	1.22 (.11)	0.96 - 1.55
Treatment with insulin ^{j)}	1.38 (.00)**	1.19 - 1.59	/	/	/	/

Note: IRR: Incidence Rate Ratio. CI: Confidence Interval. Level of significance: * ≤ 0.05 ** ≤ 0.01 . Reference groups: a) women; b) 10 years of education or less; c) income described as not sufficient for monthly expenses; d) living alone; e) no participation in self-management program; f) BMI below 30; g) no hypertension; h) no anxiety or depression; i) no complication since diabetes diagnosis, j) treatment with medication (metformin), diet plan, or no treatment.

Table 3: Logistic regression models for the six single dimensions - Factors associated with a higher level of self-management behavior (SMB)

	Physical exercise			Foot care			Self-monitoring of blood glucose			Weight monitoring			Diabetes diary			Diet plan		
	MM	A	B	MM	A	B	MM	A	B	MM	A	B	MM	A	B	MM	A	B
<i>Demographic characteristics</i>																		
Age (metric)	0.94**	0.94**	-	-	0.96*	-	-	-	-	-	-	-	-	-	-	-	-	-
Men ^{a)}	-	-	3.92**	0.63*	0.60*	-	-	-	-	-	-	-	-	-	-	-	-	-
High level of education ^{b)}	-	-	-	-	-	-	0.59*	0.55*	-	-	-	-	-	-	-	-	-	-
Sufficient income ^{c)}	-	-	-	-	-	-	-	-	-	1.72*	1.74*	-	-	-	4.79**	-	-	-
Living with partner ^{d)}	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Disease-related characteristics</i>																		
Diabetes duration (metric)	-	-	-	-	-	-	1.03*	1.04*	-	-	-	-	-	-	-	-	-	-
Participation in self-management program ^{e)}	-	-	-	-	-	-	2.06**	2.40**	-	-	-	0.24*	-	-	-	-	-	-
Obesity ^{f)}	0.59*	0.49**	-	-	0.59*	-	-	-	-	-	-	-	-	-	-	-	-	-
Hypertension ^{g)}	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.33*	-
Anxiety/depression ^{h)}	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
History of complication ⁱ⁾	0.59**	0.55*	-	-	-	3.46*	2.03**	1.76*	3.32*	-	-	-	-	-	-	-	-	-
Treatment with Insulin ^{j)}	0.47**	/	/	2.63**	/	/	3.60**	/	/	-	/	/	7.35**	/	/	2.79*	/	/

Note: Models: MM: Main model, A: Treatment without insulin; B: Treatment with insulin. Given are odds ratios (OR) only for statistically significant factors. Level of significance: * ≤ 0.05 ** ≤ 0.01 . Reference groups: a) women; b) 10 years of education or less; c) income described as not sufficient for monthly expenses; d) living alone; e) no participation in self-management program; f) BMI below 30; g) no hypertension; h) no anxiety or depression; i) no complication since diabetes diagnosis, j) treatment with medication (metformin), diet plan, or no treatment.

Appendix

Table A1: Treatment of cases with missing values

Number of cases	Treatment of cases in analysis
374	No missing values: included
89	More than 3 missing values in self-management variables: excluded
205	Less than 3 missing values in self-management variables: missing values decoded as 'no' (Assumption: for participants who answered at least three self-management variables a missing value is assumed to be coherent with non-performance)
74	Three (2 participants) or less (72 participants) missing values in other covariates: Markov chain Monte Carlo (MCMC) method

Table A2: Correlations between the different dimensions of self-management behavior (SMB)

n	r	Physical exercise	Foot care	Body weight	Self-monitoring of blood glucose	Diabetes diary	Diet plan
Physical exercise			-0.01	0.14**	-0.04	-0.01	-0.04
Foot care		469		0.25**	0.24**	0.19**	0.03
Body weight		476	469		0.18**	0.11*	0.02
Blood glucose		468	462	468		0.49**	0.12*
Diabetes diary		468	461	467	459		0.10*
Diet plan		467	460	466	459	459	

Note: Stated values are Pearson's *r*. Level of significance: * ≤ 0.05 ** ≤ 0.01 .

Table A3: Correlations between the different dimensions of self-management behavior (SMB) stratified by treatment without insulin

n	r	Physical exercise	Foot care	Body weight	Self-monitoring of blood glucose	Diabetes diary	Diet plan
Physical exercise			0.03	0.17**	0.01	0.09	0.02
Foot care		353		0.29**	0.17**	0.10	-0.02
Body weight		358	353		0.24**	0.10	0.04
Blood glucose		349	345	349		0.44**	0.11*
Diabetes diary		352	347	351	342		0.03
Diet plan		352	347	351	343	346	

Note: Stated values are Pearson's *r*. Level of significance: * ≤ 0.05 ** ≤ 0.01 .

Table A4: Correlations between the different dimensions of self-management behavior (SMB) stratified by treatment with insulin

n	r	Physical exercise	Foot care	Body weight	Blood glucose	Diabetes diary	Diet plan
Physical exercise			0.05	0.1	0.08	0.02	-0.09
Foot care	116			0.13	0.18	0.1	0.05
Body weight	118	116			-0.04	0.12	-0.01
Blood glucose	119	117	119			0.28	-0.01
Diabetes diary	116	114	116	117			0.01
Diet plan	115	113	115	116	116	113	

Note: Stated values are Pearson's *r*. Level of significance: * ≤ 0.05 ** ≤ 0.01 .

Table A5: Logistic regression models for the six single dimensions - Factors associated with a higher level of SMB (full version)

Variables	Physical exercise			Foot care			Self-monitoring of blood glucose			Weight monitoring			Diabetes diary			Diet plan		
	MM	A	B	MM	A	B	MM	A	B	MM	A	B	MM	A	B	MM	A	B
<i>Demographic characteristics</i>																		
Age (metric)	0.94**	0.94**	0.95	0.98	0.96*	1.02	0.97	0.98	0.93	0.97	0.97	1.00	1.01	1.00	1.01	1.03	1.03	1.05
Men ^{a)}	1.18	0.87	3.93**	0.63*	0.60*	1.00	1.22	1.30	0.83	1.02	1.06	0.61	0.70	0.97	0.40	0.89	0.88	0.68
High level of education ^{b)}	1.39	1.36	1.37	0.93	0.86	1.78	0.59*	0.55*	0.64	0.78	0.81	0.55	0.80	0.87	0.59	0.78	0.60	1.41
Sufficient income ^{c)}	1.03	1.14	0.86	1.16	1.10	1.13	1.05	0.96	1.14	1.72*	1.74*	1.26	1.22	0.65	4.79**	0.89	0.54	1.21
Living with partner ^{d)}	0.81	0.84	0.68	0.91	0.93	0.43	1.07	1.02	1.37	0.94	1.23	0.45	1.08	0.78	1.98	0.80	1.78	0.27
<i>Disease-related characteristics</i>																		
Diabetes duration (metric)	1.01	1.00	1.02	1.02	1.03	1.00	1.03*	1.04*	1.02	1.01	1.01	1.00	1.00	1.00	1.01	0.98	0.99	0.97
participation in self-management program ^{e)}	1.34	1.45	1.36	1.14	1.05	2.72	2.06**	2.40**	1.17	1.08	1.36	0.24*	1.51	1.41	1.59	1.38	1.78	1.15
Obesity ^{f)}	0.59*	0.50**	1.07	0.74	0.59*	1.67	1.01	0.93	1.28	0.78	0.86	0.62	0.92	0.76	1.12	1.06	1.10	0.92
Hypertension ^{g)}	0.98	1.01	0.86	1.43	1.58	0.87	0.94	0.85	1.25	1.10	0.88	2.04	0.91	1.23	0.36	0.70	0.33*	4.47
Anxiety/depression ^{h)}	0.56	0.51	0.59	0.71	1.07	0.31	1.71	1.55	3.18	0.69	0.95	0.30	0.51	0.43	0.99	0.29	0.73	σ
History of complication ⁱ⁾	0.59**	0.55*	0.82	1.31	1.12	3.46*	2.03**	1.75*	3.32*	1.12	1.07	1.15	1.60	1.29	2.16	1.10	0.86	1.71
Treatment with Insulin ^{j)}	0.47**	/	/	2.63**	/	/	3.60**	/	/	1.13	/	/	7.35**	/	/	2.79*	/	/

Note: Models: MM: Main model, A: Treatment without insulin; B: Treatment with insulin. σ = calculation not possible (quasi-separation). Given are odds ratios (OR) only for statistically significant factors. Level of significance: * ≤ 0.05 ** ≤ 0.01. Reference groups: a) women; b) 10 years of education or less; c) income described as not sufficient for monthly expenses; d) living alone; e) no participation in self-management program; f) BMI below 30; g) no hypertension; h) no anxiety or depression; i) no complication since diabetes diagnosis, j) treatment with medication (metformin), diet plan, or no treatment.

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