Research article

Determinants of glycaemic control among patients with type 2 diabetes: testing a process model based on self-determination theory

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A B S T R A C T

Aims: To investigate a hypothesised process model based on self-determination theory (SDT) in a population of people with type 2 diabetes. The model suggests that autonomy support from healthcare professionals is an important determinant of autonomous motivation and perceived competence in diabetes, which correlate positively in turn with wellbeing and negatively with HbA1c.
Methods: This cross-sectional study used baseline questionnaire data and HbA1c levels from a randomised controlled trial investigating the effects of a person-centred consultation program. The questionnaire used validated scales and items assessing autonomy support, wellbeing, motivation, self-care activities, diabetes distress and perceived competence. Pearson correlations were calculated, and mediation analysis was conducted by multivariate linear regression analysis.
Results: 116 participants completed the questionnaire. Autonomy support was significantly correlated with perceived competence and controlled motivation. Perceived competence correlated negatively with diabetes distress and positively with self-care activities. Diabetes distress correlated negatively with wellbeing. Controlled motivation correlated positively with autonomous motivation, which correlated positively with both wellbeing and self-care activities. Self-care activities correlated negatively with HbA1c.
Conclusion: As suggested by the hypothesised SDT process model, autonomy support, autonomous motivation and perceived competence are associated with better wellbeing and improved HbA1c.

1. Introduction

Maintaining blood glucose at recommended levels is essential for people with type 2 diabetes to reduce the risk of developing long-term diabetes complications, such as cardiovascular disease, retinopathy, neuropathy and nephropathy [1, 2, 3]. Self-management of type 2 diabetes comprises several activities, including taking medications correctly, self-monitoring blood glucose, eating a healthy diet and being physically active [3]. Implementing these activities often necessitates substantial behaviour change, effort and the acquisition of skills, which has been shown to be difficult for many people with type 2 diabetes to achieve [4, 5]. In response, a range of diabetes self-management education programmes have been developed and tested, and guidelines for diabetes self-management education and support (DSMES) have been established [6]. When delivering DSMES, a person-centred approach is generally recommended [2, 7], defined as "providing care that is

respectful of and responsive to individual patient preferences, needs, and values and ensuring that patient values guide all clinical decisions" [2]. Although guidelines promote person-centred care, it is unclear how to implement this in routine practice, when interventions designed to deliver person-centred care generates mixed results [8, 9, 10, 11]. However, effective theory-based, person-centred methodologies for achieving sustained improvements in glycaemic control and quality of life among people with type 2 diabetes are still scarce [8, 9, 10, 11].

Self-Determination Theory (SDT) is a general model of human motivation theory that provides a framework for healthcare professionals to support patients in adopting and maintaining certain behaviours, such as a healthy lifestyle [3]. SDT has been used in many studies aiming to understand how the behaviour of healthcare professionals influences patients' motivation for self-care [12]. SDT distinguishes between amotivation, extrinsic motivation and intrinsic motivation and posits that extrinsic motivation includes both externally and internally regulated

behaviours. Together with intrinsic motivation, internally regulated behaviour constitutes autonomous self-regulation, which is assumed to be a higher quality motivation than controlled regulation, or externally regulated behaviour in terms of sustaining behaviour over time. Moreover, whereas externally regulation would be negatively correlated with wellbeing and positively related to diabetes distress, autonomous self-regulation would have positive relations [13]. Autonomous self-regulation, also known as autonomous motivation, is enhanced when people experience autonomy, competence and relatedness [13, 14]. Thus, patients' motivation for self-care can be enhanced when healthcare professionals provide autonomy support and support the development of competence. Prior research based on SDT has supported the model proposed by Williams et al. [12, 15, 16], depicted in Figure 1. It suggests that perceived autonomy support from healthcare professionals is an important determinant of autonomous motivation and perceived competence in diabetes self-management, which is a predictor of wellbeing through its impact on diabetes distress. Perceived competence in diabetes furthermore is a predictor of lowered haemoglobin A1c (HbA1c) through improved self-care activities [12, 16, 17]. Further validation of this model will provide: 1) verification of the importance of autonomy support in relation to health outcomes of DSMES and 2) guidance for professional development of healthcare professionals, i.e. a focus on providing autonomy support.

The aim of this study was to investigate the validity of the SDT process model by examining associations between autonomy support, wellbeing, perceived competence, diabetes distress, motivation, self-care activities and glycaemic control in a Danish population of people with poorly controlled type 2 diabetes.

2. Materials and methods

2.1. Study design and population

This study used baseline questionnaire data from a randomised controlled trial (RCT) investigating the impact on HbA1c levels and behavioural and psychosocial measures among individuals with type 2 diabetes of a person-centred consultation program using dialogue tools [18]. The study was approved by the Data Protection Agency and the Research Ethics Committees of The Capital Region of Denmark (H-1-2014-FSP-046).

Participants were recruited from a specialist diabetes clinic in the Capital Region of Denmark from October 2014 to June 2016. Inclusion criteria were at least 18 years of age, duration of type 2 diabetes for at least one year, and HbA1c ≥ 64 mmol/mol (≥8%) measured at each of the three most recent routine diabetes consultations. Moreover, participants were included if they were in treatment for their diabetes with oral or injection medications and able to speak, read and understand Danish. Participants were excluded if they were participating in other research or clinical projects, in psychological or psychiatric treatment or had severely impaired vision or blindness. Some participants' HbA1c decreased to <64 mmol/mol in the interval between the invitation to participate and enrolment; however, they were still included in the study.

Patients meeting inclusion criteria (n = 509) received a letter with an invitation to participate in the RCT and information about the study. Some patients declined to participate (n = 201), were excluded (n = 100), did not sign and forward the informed consent form (n = 21), or could not be reached by mail (n = 71). After committing to participation,

patients signed a consent form and filled out the baseline questionnaire electronically or on paper. A total of 116 participants completed the questionnaire and had HbA1c measured in the required period.

2.2. Measured variables

The questionnaire measured demographics, disease duration and treatment, and included Danish translations of six validated questionnaires [19, 20], see Supplementary material – 2). The WHO-5 wellbeing index contains five items assessing general wellbeing on a scale of 0 (not present) to 5 (constantly present) [21, 22]. Scores range from 0 to 25 with higher scores indicative of high emotional wellbeing. To obtain a mean item score total score was multiplied by 4 (scores now ranging from 0-100) and divided by number of items in the scale. The five-item Health Care Climate Questionnaire (HCCQ) assesses perceptions of the degree of autonomy support from healthcare professionals on a scale of 1 (strongly disagree) to 7 (strongly agree); total score is the sum of item scores [17]. Scores range from 5 to 35 with higher scores indicative of patients experiencing full autonomy support from health care professionals. The Perceived Competence for Diabetes scale (PCD) contains five items and the scale ranges from 1 (strongly disagree) to 7 (strongly agree); total score is the sum of item scores [17]. Scores range from 5 to 35 with higher scores indicative of patients experiencing high competence in managing their diabetes. The Problem Areas In Diabetes scale (PAID-5) assesses perceptions of the current emotional burden of diabetes related issues with five items on a scale from 0 (not a problem) to 4 (serious problem); total score is the sum of item scores [23]. Scores range from 0 to 20 with higher scores indicating high degree of current emotional burden of diabetes-related issues. The Summary of Diabetes Self-Care Activities measure (SDSCA) assesses the number of days on which participants practiced self-care activities during the last seven days, with item and total (mean of item) scores ranging from 0 to 7. A six-item version of the SDSCA assessing blood glucose measurements, foot examination, diet, physical activity and medical adherence was used [24]. Scores range from 0 to 42 with higher scores indicative of performing self-care activities as recommended by health care professionals every day. The Treatment Self-Regulation Questionnaire (TSRQ) assesses the degree to which patients' behaviours regarding taking medication and measuring blood glucose (9 items) and eating a healthy diet and performing physical activity (12 items) were based on autonomous motivation, controlled motivation or amotivation on a scale ranging from 1 (strongly disagree) to 7 (strongly agree) [12]. Factor analyses were applied to the TSRQ scores to establish the scale factor structure and internal reliability of the translated Danish version of the scales. Two separate exploratory factor analyses were applied. One included 12 items measuring diet and physical activity, a second included 9 items measuring medication taking and blood glucose testing. The participants per item, 9.7 and 12.9 respectively, and participants in total (>100) were satisfactory [25]. Based on the factor analyses two scales were calculated and used for further analyses; a four-item scale measuring autonomous motivation and a four-item scale measuring controlled motivation were used. The scales were internally consistent and generated a simple factor structure (see Supplementary material – 1).

To obtain a mean item score for each scale, the total scale scores were divided by the number of items in the respective scale.

HbA1c levels were obtained from the electronic health record at the clinic. If possible, the most recent HbA1c measurement recorded between three months before and the day of questionnaire completion was used. If HbA1c was not recorded during that period, a result within 30 days after the day of questionnaire completion was used.

2.3. Statistical analysis

Mean values, standard deviations, and Cronbach's alpha were calculated on questionnaire scores and HbA1c. Pearson's correlations were used to measure bivariate correlations between all key variables.
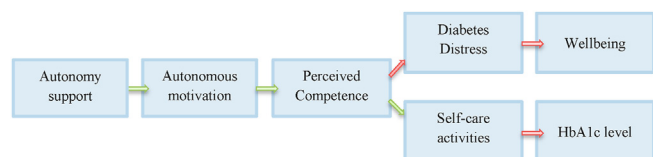

Figure 1. The self-determination process model.

Regression analysis (Table 3) was conducted to investigate the role of mediating variables. Based on our hypothesis and the bivariate correlation matrix we estimated a model of all the variables with significant correlations. Variables that correlated with more than one other were entered in the regression analyses in pairs to test for potential mediation. Wellbeing and self-care activities were entered as dependent variables in the regression analyses in accordance with the hypotheses. The combined results of the analyses (Figure 2) suggested that the correlation between perceived competence and wellbeing was mediated by diabetes distress as this was not a significant predictor in the model. Level of significance was $p < 0.05$ for all correlations. SPSS version 22 was used for the data analysis.

3. Results

3.1. Sample description

Demographic characteristics of the study population are presented in Table 1. More than half 66% (77) of participants were men, and 56% (65) were ≥66 years of age. Their educational level was generally low; 19% (22) had no education or only primary education and 51% (59) had lower education. Furthermore, 68% (79) of participants were unemployed or retired. Only 14% (16) of participants did not use insulin; 44% (51) had two or more diabetes complications and mean duration of type 2 diabetes were 17.1 years SD ± 7.7.

3.2. Bivariate correlation analysis

Results of the bivariate correlation analyses, descriptive statistics, and reliability analyses are presented in Table 2. Wellbeing was significantly correlated to both diabetes distress, perceived competence, self-care activities, and autonomous motivation. Diabetes distress was associated with perceived competence. Autonomy support was not associated with autonomous motivation but was associated with controlled motivation and perceived competence. Perceived competence was associated with self-care activities which in turn correlated to both autonomous motivation, controlled motivation, and HbA1 level. Autonomous motivation was significantly associated with controlled motivation. Mean HbA1C was 75 mmol/ml (9.0%), SD ± 12.2. All associations are approximately linear. Reliability, as measured by Cronbach's alpha, was ≥0.81 in all scales except SDSCA, which was 0.66.

3.3. Regression analysis

Regression analysis was conducted to investigate the role of mediating variables. Based on our hypothesis and the bivariate correlation matrix we estimated a model of all the variables with significant correlations. Variables that correlated with more than one other were entered in the regression analyses. Wellbeing and self-care activities were entered as dependent variables in the regression analyses (Table 3).

Results of the regression analyses (Figure 2) suggested that the correlation between perceived competence and wellbeing was mediated by diabetes distress as this was not a significant predictor in the model. The correlation between self-care activities and wellbeing was mediated by autonomous motivation, and the correlation between controlled motivation and self-care activities was mediated by autonomous motivation. Autonomous motivation remained an independent predictor for wellbeing after adjusting for diabetes distress. Likewise, both perceived competence and autonomous motivation were significant predictors of self-care activities.

All residual errors of the regression lines were approximately normally distributed.

4. Discussion

This study investigated the validity of an SDT process model when applied to a study population consisting of patients with poor glycaemic control, diabetes complications and long diabetes duration. Our findings support the hypothesised SDT process model [15, 16] suggesting that people who felt autonomy support from healthcare professionals had more autonomous motivation and perceived competence in diabetes, lower HbA1c levels and higher general wellbeing. Autonomy support correlated with controlled motivation, which correlated in turn with autonomous motivation. Acknowledging that controlled motivation is not a positive target in promotion of health behaviour change [26], it might still be useful to measure explicitly in investigating the processes of SDT. Doing that enables identifying interventions which promote autonomous motivation including the impact on processes of "taking in" and integrating an external regulation [13]. Integration refers to further transformation of the regulation into an internal regulation; it subsequently emanates from one's sense of self [13]. Taking medication and measuring blood glucose may not be innate activities for many people with T2D, and they might have (reasonable) worries in this regard, even in the presence of autonomy support. Interventions seeking to support understanding and handling of illness and medication might facilitate going from more external to more internal regulation and thus from controlled to autonomous motivation. Interestingly, a recent meta-analysis investigating mediators for promoting motivation from an SDT perspective, showed that use of non-controlling language appeared to be important for promoting autonomy satisfaction and the provision of a rationale for behavior change to be important for promoting autonomous motivation [26]. However, they also found that individual

*p < 0.05
**p < 0.01
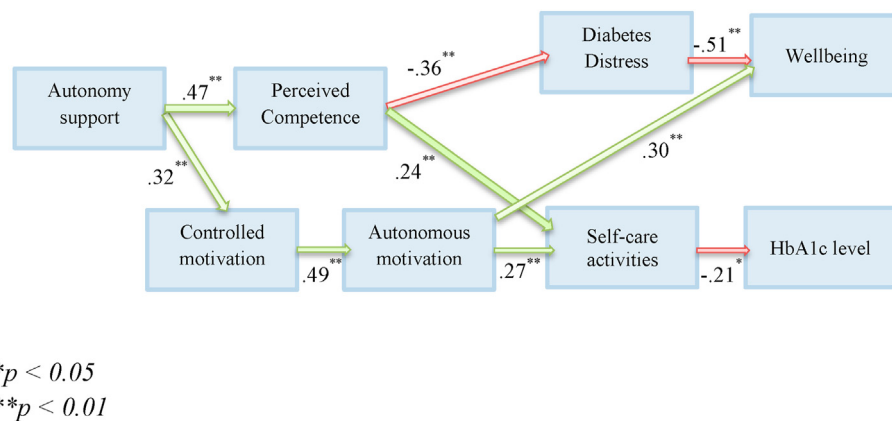
Figure 2. Standardised coefficients for the regression model. Green arrows indicate a positive correlation between the two variables (e.g., autonomy support increase perceived competence) and red arrows indicate a negative correlation between variables (e.g., maintaining self-care activities decrease HbA1c levels).

Table 1. Participant characteristics.

	n = 116	%
Sex		
Men	77	66.4
Women	39	33.6
Age (years)		
28-49	10	8.6
50-65	41	35.3
66-93	65	56.0
Marital status		
Married/cohabiting	70	60.3
Unmarried	32	27.6
Widowed	14	12.1
Education level*		
None/primary education	22	19.0
Lower education	59	50.9
Intermediate education	18	15.5
Higher education	13	11.2
Unknown	4	3.4
Principal activity		
Employed	37	31.9
Unemployed/retired	79	68.1
Diabetes medication		
Oral	16	13.8
Insulin	21	18.1
Oral and insulin	79	68.1
Diabetes complications		
No complications	24	20.7
1 complication	41	35.3
≥2 complications**	51	44.0
BMI (weigh/hight^2) (n = 115)		32.2 ± 6.1
Duration of diabetes in years		17.1 ± 7.7
HbA1c (mmol/mol) (9%)		75.1 ± 12.2

Data are mean ± SD or n (%).

*Lower education corresponding to under three years. Intermediate corresponding to a bachelor's degree (undergraduate) and higher education corresponding to a master or higher.

**No one had more than 3 complications.

techniques had limited independent effects and concluded that "a need supportive environment requires the combination of multiple co-acting techniques" [26].

Our study reinforces the importance of healthcare professionals being competent at providing autonomy support for people with type 2 diabetes as they attempt to help them change health behaviour and improve blood glucose levels. More research on how to deliver sustainable autonomy support in clinical practice is needed.

Previous studies testing SDT process models in relation to glycaemic control also found that autonomy support is correlated with increased autonomous motivation, perceived competence in diabetes management and diabetes self-care activities, which correlated in turn with decreased HbA1c [12, 15, 16, 17]. Similar to our findings, one study showed that the correlation between autonomy support and self-care activities (specifically related to physical activity) was mediated by autonomous motivation [27]. However, in contrast to our findings that autonomy support was directly correlated with perceived competence, other studies indicate that the correlation between autonomy support and perceived competence is mediated by autonomous motivation [12, 16].

4.1. Strengths and limitations

Key study strengths include the combination of self-reported outcomes and clinical measures and the inclusion of participants with poorly controlled diabetes with a long history of diabetes, which is a hardly reached group. Among the limitations is the cross-sectional nature of the study, which does not support any assumptions about causality in the SDT process model; however, it does provide additional validity for these variables as important biopsychosocial markers of person-centred care for people with type 2 diabetes.

It should be emphasised that the SDSCA measure has relatively low internal consistency (α = 0.66), which might arise from its inclusion of a range of different activities that are not necessarily correlated. Combining diverse activities into a single scale may attenuate correlation and mask nuances in self-care activities. Despite suboptimal scale reliability, the correlation between self-care activities and HbA1c is evident from previous studies [12, 16, 28].

Finally, many participants were excluded or dropped out of the study which could be explained by the multi-morbidity characterising this patient group. Thus, the findings of this study are mainly generalisable to patients with particularly low glycaemic control and lower educational level. A more heterogenous study population might implicate different estimates.

5. Conclusion

This study found that autonomy support, perceived competence and autonomous motivation, which are core elements in the SDT model of health behaviour, were determinants of diabetes self-management, HbA1c and wellbeing. The study contributes with additional knowledge about the importance of autonomy support from healthcare professionals for patients with type 2 diabetes to improve diabetes self-

Table 2. Descriptive statistics, reliability estimates, and Pearson's correlation coefficients for model variables.

	Variable	Mean (SD)	Scale α	Variable							
				1	2	3	4	5	6	7	8
1	WHO-5	62.7 (21.3)	.88	1	-.560**	.121	.312**	.185*	.104	.338**	.005
2	PAID-5	1.4 (0.9)	.88		1	-.116	-.360**	.019	.034	-.070	-.045
3	HCCQ	5.9 (1.3)	.91			1	.473**	.066	.315**	.157	-.019
4	PCD	5.6 (1.4)	.92				1	.278**	.112	.131	-.145
5	SDSCA	4.2 (1.6)	.66					1	.297**	.303**	-.214*
6	Controlled motivation	5.1 (1.6)	.82						1	.494**	-.065
7	Autonomous motivation	5.9 (1.1)	.81							1	-.097
8	HbA1c^a	75 (12.2)	-								1

Abbreviations: HbA1c, haemoglobin A1c; HCCQ, Health Care Climate Questionnaire (Autonomy support); PAID-5, Problem Areas in Diabetes-5; PCD, Perceived Competence for Diabetes; SD, standard deviation; SDSCA, Summary of Diabetes Self-Care Activities; WHO-5, World Health Organization-5.

*p < 0.05.

**p < 0.01.

Table 3. Results of regression analyses.

Outcome measure	Predictors	β	t	Sig t	Equation statistics
Wellbeing	Perceived Competence	0.13	1.53	0.138	$F = 27.46$; $R^2 = 0.33$; $p < 0.001$
	Diabetes Distress	-0.51	-6.21	<0.001	
	Diabetes Distress	-0.54	-7.39	<0.001	$F = 38.08$; $R^2 = 0.40$; $p < 0.001$
	Autonomous motivation	0.30	4.12	<0.001	
	Self-care activities	0.09	0.98	0.328	$F = 7.83$; $R^2 = 0.12$; $p = 0.001$
	Autonomous motivation	0.31	3.36	0.001	
Self-care activities	Autonomous motivation	0.21	2.04	0.044	$F = 7.76$; $R^2 = 0.12$ $p = 0.001$
	Controlled motivation	0.20	1.93	0.057	
	Perceived Competence	0.24	2.77	0.007	$F = 9.93$; $R^2 = 0.15$; $p < 0.001$
	Autonomous motivation	0.27	3.10	0.002	

management and thereby improve blood glucose control especially for people with low glycaemic control. Furthermore, our findings support the value of SDT as a conceptual framework to study motivational processes and provide autonomy support for patients as they adopt and maintain new health behaviours. Additional knowledge is needed about methods to enhance autonomy support in clinical practice and how the intervention effect on blood glucose control is mediated by other factors.

Declarations

Author contribution statement

C. Grønnegaard and A. Varming: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

K. Olesen and T. Skinner: Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data.

I Willaing: Conceived and designed the experiments; Contributed reagents, materials, analysis tools or data.

Competing interest statement

The authors declare no conflict of interest.

Additional information

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