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Meeting the needs of multimorbid patients with Type 2 diabetes mellitus – A randomized controlled trial to assess the impact of a care management intervention aiming to improve self-care

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ABSTRACT

Aims: This study explored the impact of a care management intervention aiming to improve self-care behavior in multimorbid individuals with Type 2 diabetes mellitus on health-related quality of life (HRQoL).

Methods: A patient-level randomized parallel-group superiority trial with 32 primary care practice teams, 11 care managers and 495 patients was conducted. The intervention was delivered as add-on to an already implemented disease management program and embedded in a network of primary care practices. Hierarchical linear modeling was used to analyze impacts of the care management approach on HRQoL.

Results: Small improvements of HRQoL in the intervention arm were found after nine months ($r = 0.024$; 95%CI = [0.000, 0.047]). However, compared to standard care no significant differences of HRQoL changes were observed ($r = 0.022$; 95%CI = [−0.011, 0.054]). Subgroup analyses showed effects for female participants favoring the intervention arm ($r = 0.059$; 95%CI = [0.010, 0.108]). No significant differences between intervention and control arm for several other subgroups were observed, including subgroups defined by comorbidities.

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Conclusion: Additional care management did not influence HRQoL over and above standard disease management. Improving diabetes patients' self-care behavior in the context of structured disease management programs may be difficult to achieve. Women might benefit from additional care management, but this finding needs to be confirmed in future research.

1. Introduction

In Germany, several efforts have been made to face the needs of a growing population affected by Type 2 diabetes and other common chronic conditions to prevent long-term complications, early mortality and an increase in utilization of healthcare services. Since 2002 several disease management programs (DMP) for chronic conditions, like Type 2 diabetes mellitus or coronary heart disease (CHD), have been implemented in German healthcare services. The German DMP aim to provide care according to evidence-based guidelines, a continuous and structured process of care as well as improvements in collaboration between healthcare providers and patients [1,2].

Several studies observed positive trends of DMP enrollment, especially in diabetes care, e.g. an increase in survival time or improvements in processes of care, but impact on clinical outcome parameters, self-care behavior, quality of life and financial savings are inconsistent [1,3]. Some evidence suggests that especially patients with Type 2 diabetes and several comorbid chronic conditions may benefit from improvements in health-related quality of life (HRQoL) through DMP enrollment in Germany [4].

In patients with chronic conditions like diabetes, self-care behavior seems to be one of the most important competences [5]. Individuals with chronic conditions are responsible for daily care of their condition for the rest of their lives. With strong self-care competences persons are able to actively engage in taking care of and managing their lives with their chronic conditions. Moreover, improvements in self-care behavior are linked to changes in HRQoL as it measures the impact of a chronic condition on patients daily living [5,6]. A qualitative synthesis of diabetes self-care strategies concluded that persons with Type 2 diabetes often prefer the maintenance of their current quality of life instead of further improvements in clinical outcomes [7]. In addition, there is evidence that intensive glycemic control has no additional benefit on all-cause mortality or death from cardiovascular causes in adults with Type 2 diabetes, particularly in elderly individuals, and suggest that physicians and patients should not solely rely on clinical outcomes, like HbA1c values, as treatment target [8].

The systematic review of Tricco and colleagues [9] showed that different strategies aiming to improve quality of diabetes care are successful in improving various clinical outcomes, e.g. HbA1c or blood pressure. The most promising strategy is a combination of interventions targeting the system of chronic disease management along with interventions targeting patients, in particular promoting their self-care competences.

The concept of care management is a possibility to reorganize chronic care according to individual patient needs and preferences. This concept is characterized as a set of activities which help patients and their support system in managing medical conditions more effectively. Thus, the aim of care management is to improve patients' health status and reduce the need for healthcare services [10]. Nevertheless, it may be a challenge to improve patients' self-care behaviors in the context of disease management programs, which are nationwide implemented in Germany, as these tend to provide strict structures rather than empower patients. Other studies showed that disease management programs tend to struggle in making patients proactive participants in their care delivery [11]. Changes in the patient-provider interaction away from authoritarian to more supportive and sharing interactions are recommended to close this gap [12].

To date, several care management concepts for persons with depression [13], osteoarthritis [14], chronic heart failure [15], and multimorbidity at high-risk for future hospitalization [16] have been investigated in primary care in Germany. These concepts have shown varying benefits in outcome measures, like depressive symptoms [13], processes of care [13], self-care activities [15], specialist consultation rates [14] and quality of life [14,16]. But still, evidence regarding the impact of care management on quality of life in individuals with chronic conditions is inconsistent [13–16] and strategies as add-on to DMP that aim to support self-care activities remain scarce.

Thus, the aim was to examine the additional impact of a care management intervention as add-on to chronic care within a disease management program on HRQoL. The conducted care management intervention focused on improving self-care activities in multimorbid persons with Type 2 diabetes.

2. Materials and methods

This study was conducted as part of the research project 'INFOPAT' (Information technologies for patient-centered healthcare, 2012–2016), aiming to strengthen cross-sectoral care for people with multiple chronic conditions, and develop structures and processes which improve patient-tailored healthcare.

The primary aim of the GEDIMAplus trial ('GEsundheitsbegleitung DIabetes MAnnheim plus') described here was to

improve self-care behavior among multimorbid patients with Type 2 diabetes through a care management intervention as add-on to the German DMP for Type 2 diabetes. The focus of analyses and findings described here was to assess the further impact of this care management intervention on changes of HRQoL.

2.1. Study design

A two-armed, open-label, superiority trial (RCT) with patients as units of randomization was conducted. Full details of the study design and detailed description of primary and secondary outcomes have been published elsewhere [17].

2.2. Setting, participants and randomization

The trial aimed at improving chronic care for multimorbid patients with Type 2 diabetes within the primary care setting. Especially, in patients with diabetes mellitus comorbid conditions are common [18] and patients suffering from several chronic conditions demonstrate worse health outcomes, more complex clinical management, more complex self-care activities, and increased utilization of healthcare services [19–21]. Thus, it was assumed that particularly persons with Type 2 diabetes and at least two additional comorbidities would benefit from an additional chronic care support that aims to enhance self-care activities. Physicians specialized in family medicine or internal medicine, who function as primary care physician were eligible for study participation. Both single and group primary care practices (PCPs) needed to be enrolled in the regional network of PCPs 'Genossenschaft Gesundheitsprojekt Mannheim' (GGM) in Germany. Patients aged 18 years or above with diagnosed Type 2 diabetes mellitus (ICD 10: E11-E14) from participating PCPs were recruited for study participation. A full list of inclusion and exclusion criteria for patients is provided in Table 1.

2.2.1. Recruitment

Participating PCPs were responsible for recruitment of study participants. Each PCP-team (physician plus medical assistant) created a list of all potentially eligible patients registered in their practice software based on the above-mentioned criteria. These patients were selected according to the sequence indicated by a previously provided list with random numbers, contacted and asked for participation in the trial. All patients willing to participate gave their written informed consent.

2.2.2. Randomization

Participating patients were randomly allocated to intervention or control arm at individual-level in a 1:1 ratio by block randomization with variable block lengths. The randomization was stratified by type of medical treatment (insulin vs. oral medication/no medication) and physician. Randomization lists were provided by the responsible statistician using computer generated numbers. A clinical monitor, who acted as the sole randomization authority performed the central randomization. This clinical monitor was not involved in data analyses.

Blinding of physicians, medical assistants, and patients was not possible due to the nature of the intervention.

2.3. Intervention design

The intervention was delivered as add-on to standard care in the German DMP for Type 2 diabetes. The German DMP for Type 2 diabetes consist of regular follow-up visits every three months including clinical examinations and laboratory test (e.g. HbA1c), patient education, and referrals to specialists (ophthalmologist, cardiologist, nephrologist, neurologist) on regular basis and according to acute needs [2,22].

In contrast to most of the already studied care management approaches this intervention was embedded in a network of healthcare professionals. In 2014, 72% of healthcare facilities in German primary care were single practices [23]. In small primary care settings, like single practices, resources might be limited and extensive collaborative models, like regular care management, may be difficult to implement in daily practice. Networks of PCPs give the possibility to share resources and reduce organizational workload for each practice [24] as well as support implementation of new care concepts [25]. Thus, the care management intervention examined here was embedded in a regional network of PCPs, which gave the possibility to share resources and employ care managers at the network. Fig. 1 illustrates the care management concept of the GEDIMAplus trial, which was already described in detail elsewhere [17].

The care management intervention was delivered by specially trained medical assistants [26], so called net-care

Table 1 – Inclusion and exclusion criteria of the GEDIMAplus trial for patients.

Inclusion criteria	Exclusion criteria
≥18 years of age; Diagnosed Type 2 diabetes mellitus (ICD-10: E11- E14); Enrollment in the German DMP for Type 2 diabetes; ≥two additional diagnosed chronic conditions	Severe acute psychiatric disorders (ICD-10: F20 - F29); Dementia (ICD-10: F00 - F03); Mental and behavioral disorders due to psychoactive substance use (ICD-10: F11 - F16, F18 and F19), except for alcohol (ICD-10: F10) and tobacco use (ICD-10: F17); Malignant neoplasms (ICD-10: C00 - C97) with current chemotherapy or radiotherapy; Transplanted organ and/or tissue status (ICD-10: Z94); Care involving dialysis (ICD-10: Z49); Insurmountable language and communication problems; Emergency cases

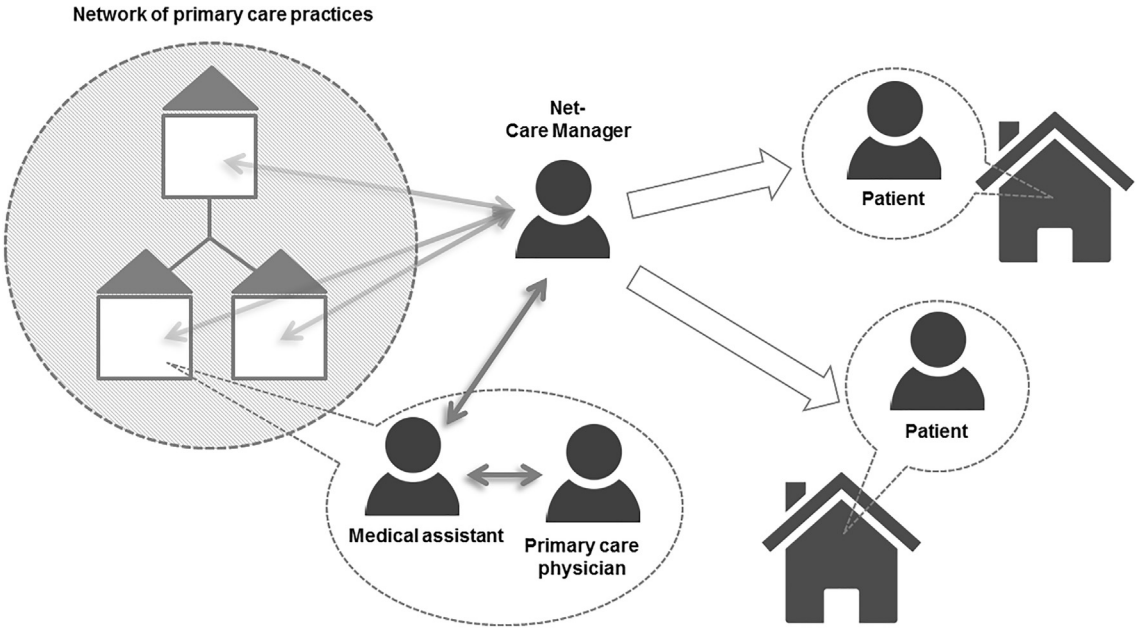

Fig. 1 – Conceptual design of the care management approach.

manager (NCMs), and consisted of two main components: two home visits including a structured assessment and 15 structured telephone monitoring contacts within 9 months. A description of both components according to the Template for Intervention Description and Replication (TIDier) [27] is provided in Appendix 1 – Table S1. The home visits with individualized (re-)assessments of clinical and social needs aimed to reduce barriers to patients' accessing support systems and (healthcare) services based in their local communities in order to improve management of their disease. The design of this outreach element was based on evidence on improving diabetes care through non-physician healthcare professional-led individualized assessments, use of decision-making algorithms and bringing behavior-related task into focus – both elements were incorporated in the IT tool used by NCM [28,29]. The additional telephone monitoring contacts were delivered with a high intensity for at least six months in order to improve and sustain possible changes in self-care behavior [28]. Moreover, each monitoring contact was used to give feedback related to patients' control of diseases and current (self-care) activities to reinforce positive behavioral changes [30].

Patients allocated to the control arm continued to receive standard care within the German DMP for Type 2 diabetes.

2.4. Data collection and outcome measure

Patients willing to participate were asked to complete a pseudonymized, paper-based questionnaire. This patient questionnaire consisted of validated instruments to measure diabetes self-care activities (SDSCA-G), HRQoL (EQ-5D-3L), for example, and a range of socio-demographic aspects. A full list of measures used within the trial is published elsewhere [17]. In addition, physicians had to complete a paper-based questionnaire for each participant based on data from the patients' chart (e.g. diagnoses, medication, and hospitalizations) and an assessment of the current clinical status (e.g. latest HbA1c value, blood pressure, and weight). Both, patient questionnaire and physician reported patient information, were collected twice, before intervention start (T0, baseline; 02–10/2014) and nine months after intervention start (T1; 11/2014–07/2015).

2.4.1. Outcome measures

The outcome measures of this trial were the change in patient-reported self-care behavior and patient-reported HRQoL as the difference between baseline score and nine months after baseline. Self-care was measured with the German version of the 'Summary of diabetes self-care activities measure' (SDSCA-G). The SDSCA-G has been shown to be a reliable and valid instrument for assessing self-management activities in adults with Type 2 diabetes in Germany [31]. The EQ-5D-3L (EuroQol 5-Dimension) as a general measure of HRQoL was used to assess patient-reported HRQoL [32,33]. The EQ-5D index was calculated by applying scores from the European value set [34].

2.5. Statistical analysis

Impact of this additional care management on HRQoL was analyzed as the contrast between changes of EQ-5D index from baseline to T1 between the two study arms. Additionally, changes of HRQoL within each study arm were examined.

Hierarchical linear modeling using restricted maximum likelihood (REML) for parameter estimation was applied to assess possible treatment effects of the intervention on HRQoL. The hierarchical linear model used two levels for analyses, whereby NCMs constituted the first and patients the second level. Treatment group, insulin therapy, and EQ-5D index at baseline were included as fixed factors and NCMs as random factor. In a subsequent secondary model age (in years) and gender were added as additional fixed effects.

Results of differences in changes of EQ-5D index between intervention and control arm are presented as the fixed effect estimates of the random intercept models with corresponding standard error (SE) and 95% confidence interval (95%CI).

Differences in EQ-5D index between baseline and after nine months of intervention in each group were estimated using paired tests by least squares means of the described multilevel approach and presented as mean EQ-5D index for each group with corresponding p-value and 95%CI.

To assess changes of HRQoL in different subgroups, the primary hierarchical model was fitted with an interaction term including treatment group * subgroup variable. Subgroup analyses were conducted for several groups listed in section '3 Results' - Table 4. Changes in EQ-5D index between intervention and control arm were estimated by using the differences of least squares means in each subgroup.

Analyses of the effectiveness of this intervention on self-care behavior, measured with the SDSCA-G, used a similar multilevel approach as described above. Only results of this analysis can be interpreted in a confirmatory manner.

In all multilevel analyses, it was assumed that outcome data was missing at random, meaning that missing data in the response can be explained by either the baseline or the treatment variable. Thus, no additional imputation of missing data was conducted.

Baseline characteristics of both study groups were compared using chi^2-test for categorical variables and two-sided t-test for continuous variables.

All analyses were carried out according to the intention-to-treat principle, i.e. including all randomized patients, and the statistical tests were two-sided at the significance level of $\alpha = 0.05$. Descriptive statistical analyses were conducted by using IBM SPSS statistics version 24 and multilevel analyses by using the procedure PROC MIXED in SAS version 9.4 (SAS Institute Inc., Cary, NC).

2.6. Ethics

This study was approved by the ethics committee of the Medical Faculty of the University of Heidelberg, Germany, (S-590/2013) as well as by the ethics committee of the Medical Association Baden-Wurttemberg, Germany, (B-F-2014-007). Moreover, the trial is registered with the Current Controlled Trials (ISRCTN 83908315). A completed CONSORT statement is provided in Appendix 2.

3. Results

495 eligible multimorbid patients with Type 2 diabetes among 21 participating PCPs with 32 physicians were randomly assigned to control (n = 243) and to intervention arm (n = 252). Overall, 219 (90.1%) participants in the control arm and 227 (90.1%) participants in the intervention arm completed nine months of intervention (Appendix 3 – CONSORT flow diagram). Participants in the intervention arm were allocated to one of 11 NCM. Caseload for NCMs varied between 13 and 31 patients with an average number of 23.3 (±4.5) patients per NCM. 14 (66.7%) of the 21 participating PCPs were single-handed practices. Characteristics of physicians, medical assistants and NCM are presented in Appendix 1 – Table S2. The mean age of included patients was 68.0 ± 10.9 years, 42.9% (n = 164) were female and 34.0% (n = 130) were treated with insulin. The mean EQ-5D index at baseline within the included sample was 0.697 ± 0.23. No significant differences in baseline characteristics were observed between both study arms. Table 2 illustrates the main characteristics of the patient sample included in the analyses. Only patients with complete EQ-5D data were analyzed, thus amounting to 187 participants in the control arm and 195 participants in the intervention arm.

The analyses of the effect on self-care behavior of this care management intervention showed an increase of 0.23 (±0.96) for the difference in SDSCA-G sum score between T0 and T1 in the intervention group after nine months, which was, however, not statistically significant compared with controls ($r = 0.150$; 95%CI = [−0.084, 0.384]; Cohen's d = 0.1597).

The average change in EQ-5D index for the total sample was 0.015 (±0.18) after nine months of intervention. Within the intervention arm a significant increase in EQ-5D index of 0.028 (±0.17) after nine months was observed ($r = 0.024$; 95%CI = [0.000, 0.047]). There was no significant change in EQ-5D index within the control arm. Results of the paired tests using least square means for the analyses of within-group differences are presented in Appendix 1 – Table S3. There was no significant difference in the change of EQ-5D index between intervention and control arm after nine months of intervention ($r = 0.022$; 95%CI = [−0.011, 0.054]) (Table 3).

Further analyses of different subgroups highlighted a significant increase in EQ-5D index of 0.042 (±0.18) for female participants in the intervention arm compared to controls after nine months ($r = 0.059$; 95%CI = [0.010, 0.108]). In most of the other subgroups the difference in EQ-5D index between T0 and T1 showed a small superior trend within the intervention arm. However, no significant differences in changes of EQ-5D index between intervention and control arm were found for subgroups of patients regarding insulin therapy, school education, migration background, more than two comorbidities, and comorbid disease of coronary heart disease, chronic pain, depression and chronic heart failure (Table 4).

4. Discussion

This study examined the potential impact of a care management intervention aiming to improve self-care in multimorbid patients with Type 2 diabetes as add-on to chronic care within a disease management program (DMP). Following nine month of care management as add-on to German DMP no overall effect on HRQoL compared to standard care was observed. However, a small positive trend in HRQoL within the intervention arm was noticed. Subsequent analyses of several subgroups highlighted possible benefits from an additional care management in women. Among subgroups of participants with school education of <10 years, insulin therapy, migration background, and, defined by type and number of comorbid diseases no benefits of an additional care management were detected.

Table 2 – Sample description with observed means and standard deviations for continuous, and absolute and relative frequencies for categorical variables. Only patients with complete EQ-5D data included. SD: standard deviation.

NCM-level						
Included NCMs	11					
Patient-level	**Total**		**Intervention**		**Control**	
Included patients	274		139		135	
SDSCA-G score[#] differences (T1-T0) (SD)	0.23	(0.96)	0.04	(0.92)	0.14	(0.94)
Included patients	382		195		187	
EQ-5D Index difference (T1-T0) (SD)	0.015	(0.18)	0.028	(0.17)	0.003	(0.19)
EQ-5D Index[#] baseline (T0) (SD)	0.697	(0.23)	0.687	(0.23)	0.708	(0.24)
EQ-5D Index[#] follow-up (T1) (SD)	0.712	(0.23)	0.715	(0.22)	0.708	(0.23)
Socio-demographic aspects						
Age in years[#] (SD)	67.99	(10.88)	68.47	(10.99)	67.50	(10.77)
Gender[#] (female) (%)	164	(42.90)	81	(41.50)	83	(44.40)
Marital status[#] (single) (%)	154	(38.50)	73	(37.60)	72	(39.30)
Migration background[#] (no) (%)	307	(80.40)	156	(80.00)	151	(80.7)
Years of school education[#] (≤9 years) (%)	252	(68.70)	126	(67.00)	126	(70.40)
Medical aspects						
Additional conditions (number) (SD)	2.92	(1.04)	2.91	(1.03)	2.94	(1.06)
Insulin therapy (yes) (%)	130	(34.00)	71	(36.40)	59	(31.60)
HbA1c (%) (SD)	7.20	(1.25)	7.20	(1.32)	7.21	(1.89)
Blood pressure, systolic (SD)	134.77	(14.36)	135.80	(14.22)	133.69	(14.47)
BMI (kg/m^2) (SD)	31.37	(6.14)	31.44	(6.64)	31.30	(5.58)
Additional chronic conditions						
Coronary heart disease (ICD 10:I25) (yes) (%)	140	(36.60)	69	(35.40)	71	(38.00)
Chronic pain (ICD 10: R52) (yes) (%)	99	(25.90)	50	(25.60)	49	(26.20)
Depression (ICD 10: F32-F33) (yes) (%)	62	(16.20)	34	(17.40)	28	(15.00)
Chronic heart failure (ICD 10: I50) (yes) (%)	53	(13.90)	25	(12.80)	28	(15.00)
COPD (ICD 10: J44) (yes) (%)	50	(13.10)	23	(11.80)	27	(14.40)
Atherosclerosis (ICD 10: I70) (yes) (%)	45	(11.80)	21	(10.80)	24	(12.80)
Cerebrovascular disease (ICD 10: I60-I69) (yes) (%)	30	(7.90)	17	(8.70)	13	(7.00)

[#] Patient-reported.

Table 3 – Fixed part results of the random intercept models (primary and secondary[#]) with change of EQ-5D index as dependent variable (382 patients and 11 NCMs) for between-group comparison. Coeff.: regression coefficient, SE: standard error, CI: confidence interval.

	Primary model [#] (N = 382)			Secondary model [#] (N = 382)		
	Coeff.	(SE)	[95% CI]	Coeff.	(SE)	[95% CI]
Intercept	0.2216**	(0.0294)	[0.163; 0.279]	0.2527**	(0.0558)	[0.139; 0.367]
Patient level						
Treatment group (intervention)	0.0216	(0.0166)	[−0.011; 0.054]	0.0209	(0.0165)	[−0.012; 0.053]
Insulin therapy (no)	0.0084	(0.0176)	[−0.026; 0.043]	0.0095	(0.0175)	[−0.025; 0.044]
EQ-5D index at baseline	−0.3209**	(0.0361)	[−0.392;−0.250]	−0.3358**	(0.0368)	[−0.408;−0.264]
Gender (male)				0.0372*	(0.0170)	[0.004; 0.071]
Age				0.0006	(0.0008)	[−0.002; 0.001]

*p-value < 0.05, **p-value < 0.001; [#]The primary model includes treatment group, insulin therapy, and EQ-5D index at baseline as fixed factors and NCM as random factors. The secondary model includes age (in years) and gender as additional fixed effects.

Evidence demonstrates that a combination of interventions targeting the system of chronic care plus promoting patients' self-care activities is a promising strategy to improve quality of diabetes care [9]. In Germany, changes in the system of chronic care have been already triggered through implementation of DMP, for instance. Current literature points out that the implementation of DMP in German healthcare services might has improved quality of chronic care, especially in persons with diabetes, and decreased mortality [1,22], but patient important outcomes like self-care behavior do not seem to be affected as desired [35]. It could have been supposed that a care management as add-on to DMP might lead to improvements in self-care activities and in overall quality of life. However, the primary analyses of this trial showed only a small, non-significant positive trend in improving self-care behavior through an additional care management approach compared to standard care in German DMP.

At the moment, knowledge whether structured disease management approaches can be combined with the promo-

Table 4 – Differences of EQ-5D index in different subgroups. P-values for between-group differences using differences of least squares means. Reference: control, (SD): standard deviation, coeff.: regression coefficient, (SE): standard error, CI: confidence interval.

Subgroup		Differences in EQ-5D index					
		Intervention (SD)		Control (SD)		Coeff. (SE)	[95% CI]
Insulin (N = 382)	Yes	0.035	(0.18)	0.006	(0.18)	0.011 (0.27)	[−0.046; 0.067]
	No	0.024	(0.16)	−0.003	(0.19)	0.027 (0.02)	[−0.013; 0.067]
Gender (N = 382)	Female*	0.042	(0.18)	−0.020	(0.20)	0.059 (0.03)	[0.010; 0.108]
	Male	0.018	(0.16)	0.017	(0.18)	−0.010 (0.02)	[−0.053; 0.033]
School education (N = 367)	≤9 years	0.040	(0.18)	−0.006	(0.19)	0.039 (0.02)	[−0.001; 0.079]
	≥10 years	0.016	(0.13)	0.008	(0.18)	−0.004 (0.03)	[−0.063; 0.056]
Migration background (N = 382)	Yes, turkish	0.054	(0.26)	−0.009	(0.24)	0.030 (0.05)	[−0.071; 0.132]
	Yes, other	0.048	(0.13)	0.035	(0.17)	0.007 (0.06)	[−0.039; 0.161]
	No	0.022	(0.16)	−0.002	(0.18)	0.021 (0.02)	[−0.015; 0.058]
Number of comorbidities (N = 382)	2	0.036	(0.18)	0.000	(0.20)	0.025 (0.03)	[−0.025; 0.074]
	3	0.041	(0.19)	−0.029	(0.16)	0.056 (0.03)	[−0.003; 0.115]
	≥4	−0.003	(0.12)	0.031	(0.19)	−0.024 (0.03)	[−0.088; 0.040]
Coronary heart disease (N = 382)	Yes	0.020	(0.15)	0.003	(0.21)	0.017 (0.03)	[−0.037; 0.071]
	No	0.033	(0.17)	−0.002	(0.18)	0.024 (0.02)	[−0.017; 0.065]
Chronic pain (N = 382)	Yes	0.022	(0.15)	0.010	(0.21)	0.039 (0.03)	[−0.025; 0.102]
	No	0.030	(0.17)	−0.003	(0.17)	0.014 (0.02)	[−0.024; 0.052]
Depression (N = 382)	Yes	0.041	(0.14)	−0.005	(0.19)	0.025 (0.04)	[−0.056; 0.107]
	No	0.025	(0.17)	0.001	(0.19)	0.021 (0.02)	[−0.015; 0.057]
Chronic heart failure (N = 382)	Yes	0.030	(0.12)	0.086	(0.18)	−0.026 (0.05)	[−0.113; 0.062]
	No	0.028	(0.17)	−0.015	(0.19)	0.030 (0.02)	[−0.005; 0.065]

* p-value < 0.05.

tion of self-care competences is still lacking. The emphasis on pre-defined, planned activities in disease management programs may contradict with the need for tailoring to individual patient preferences, which is required for harnessing self-care competences. Disease management, like the German DMP, that is structured requires high adherence among patients, whereas promotion of self-care requires high patients' autonomy. Knowledge about this association is essential to identify strategies which effectively support individuals with chronic conditions, especially patients with diabetes, in improving their self-care behavior and maintain or even improve their health status over time. The findings of this trial suggest the assumption that it may be challenging to promote self-care competences within a structured care approach.

Moreover, it remains uncertain if gender influences the ability to actively engage in self-care activities and may need to be considered to a greater extent in strategies which aim to motivate persons to change their health behavior and life habits. Women and men differ in their behavior and attitudes towards their diabetes [36,37]. Gender-specific barriers to improvements in self-care where already examined [38] and point out that women tend to be more uncertain about their symptoms and reluctant to take action without support from a healthcare professional. Lack of available support was identified as one of the major barriers to self-care behavior in women. In addition, gender differences in social support among persons with diabetes may exist. Women seem to have less social support sources and receive less social support than men [39]. So, it might be possible that women benefit more from an additional care management that offers individual support as add-on to a structured disease management approach. The subsequent analyses in this trial seem to support this assumption, because only in women improvements in HRQoL of an additional care management were observed and suggest that it is possible that they may benefit from an additional support.

Further analyses of subgroups showed no benefits of an additional care management for multimorbid patients with Type 2 diabetes. Of note is that the findings suggest that patients with several comorbidities (three and above) seem not to improve in HRQoL. In accordance to findings demonstrating a counterbalancing effect of DMP enrollment on the impact of multimorbidity on HRQoL [4], it could have been expected that an additional care management reinforced this effect and patients with several additional chronic conditions might would have benefitted to a greater extent from an additional chronic care support. Previous analyses of baseline data within this sample [40] already did not support findings concerning an important association between the number of chronic conditions and HRQoL in general [4,41]. The results of the conducted subgroup analyses in addition to the findings of the baseline data within this sample [40] tend to contribute to the assumption that an increasing number of additional comorbidities is not a strong indicator of additional healthcare needs. In contrast, other studies already demonstrated that the presence of diabetes in multimorbid patients can be associated with better preventive treatment for other chronic conditions, like cardiovascular diseases [42].

Although additional care management did not influence HRQoL over and above standard care, a positive trend among patients in the intervention arm was examined. Patients who

received an additional care management for nine months experienced a mean improvement of 0.03 on the overall EQ-5D index. It has to be acknowledged that the mean baseline value of the quality of life index was lower in the intervention than in the control arm but did not differ significantly, which may have left more room for improvements in individuals receiving an additional care management. However, the observed improvement is comparable to other trials within a similar context [16] and might be considered as a clinically relevant change [43,44]. In patients with multiple chronic conditions and diabetes mellitus deterioration of quality of life can be expected as time progresses [45]. Therefore, even small benefits in HRQoL might be of importance when determining the quality of care offered to patients with chronic conditions [46]. However, possible benefits in HRQoL which are triggered through an additional healthcare approach should always be at reasonable cost. Further cost-effectiveness analyses are needed to examine the effect of an additional care management in relation to additional healthcare expenditures.

The point in time when to expect changes in HRQoL among patients with chronic conditions which are measurable, is difficult to determine. Evidence in literature is inconsistent, e.g. Freund and colleagues [16] found a significant change in HRQoL within an additional care management intervention only after 24 months, whereas interventions that improved self-care behavior showed changes in HRQoL after 6 and 12 months [47]. Moreover, the measurement of changes in HRQoL over time is often linked with the phenomenon called 'response shift' [48]. The mean age within this study sample was 68 years, so most participants had already lived with their chronic conditions for several years, and all participants suffered from at least three chronic conditions. Persons with a higher age as well as persons affected by chronic conditions over a long period of time may become used to their health status and might downscale their expectations [49]. So, it is possible that they change their internal standards, values and/or conceptualizations of HRQoL ('response shift') and downscale their demands.

A further unexpected finding within this trial were the relatively good baseline values of important clinical outcome measures, like HbA1c or systolic blood pressure, within the study sample which have left little room for improvements. Tricco and colleagues [9] found that patients improved significantly on various important aspect of diabetes management through interventions targeting the system of chronic care and promoting self-care activities. But in contrast to our study sample most of these patients did not achieve satisfying targets of diabetes-relevant outcomes and presented HbA1c values greater than 8.0% or systolic blood pressure of more than 140 mmHg at baseline.

The already existing impact of German DMP on healthcare services might have led to high-quality diabetes care and left little room for improvements. Like previously described the implementation of DMP for certain chronic conditions in Germany has improved quality of care, especially in persons with diabetes [1,22,35]. In addition, all PCPs in this trial were enrolled in a regional network of healthcare professionals which might have led to further improvements in patient care and coordination. Current evidence suggest that healthcare professional networks facilitate coordination of care and contribute to improvements in quality of care [25,50].

4.1. *Strengths and limitations*

This trial was embedded within a regional network of PCPs. Already existing structures and shared resources of this network enabled even small PCPs to participate in this trial and offer their patients an additional care management. Structures and resources of existing networks of healthcare professionals seem to support implementation of new care concepts and thus improve quality of care [50]. So, findings of this trial may need to be translated with caution into settings outside a network of healthcare professionals.

The measurement of study data was based on reliable, valid instruments like the EQ-5D, which is a widely used tool to capture HRQoL. But the 3-level version of the EQ-5D, which was used to detect changes in HRQoL in this study, might has some limitations in measuring small changes especially in mild conditions [51]. However, severity of each chronic condition was not measured in this study, but the satisfying baseline parameters lead to the assumption that the majority of study participants suffered from mild conditions.

Moreover, the context of this trial might has increased the risk of selection bias. At the time of this study, German DMP was already well implemented in healthcare services. Patients have to be motivated to actively engage in reaching agreed treatment goals to be eligible for DMP enrollment. In addition, patients have to be actively enrolled in a DMP by their primary care physician. Therefore, it remains unclear whether DMP participants are happier and more motivated to adhere to treatment regimens than non-participants in general. Moreover, randomization of participants was done on patient level, thus increased the risk of contamination of intervention effects.

5. Conclusion

The findings of this study indicate that an additional care management for multimorbid patients with Type 2 diabetes did not influence HRQoL over and above standard care in disease management programs. Data on impact on self-care activities of this trial suggest a similar conclusion. Improvements in diabetes patients' self-care behavior, in the sense of making them proactive partners in their care and empower them to self-manage their conditions, in the context of structured disease management programs seem to possess a challenge. However, standard care in German DMP and enrollment of PCPs in a network might have led to high-quality diabetes care and left little room for improvement. Subsequent analyses of subgroups only highlighted that women might benefit from additional care management, but this finding needs to be confirmed in future research.

This research contributed to questions which are still in the need of further investigation to identify strategies to support chronic care which improves self-care competences and patient-preferred outcomes like quality of life within a structured care approach, like German DMP. The possibility to combine structured disease management approaches with

the promotion of self-care activities as well as the association between the number of chronic conditions and HRQoL need to be examined in future research.

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Conflict of interest

None.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.diabres.2019.03.008.

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