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Associations between quality of work features in primary health care and glycaemic control in people with Type 2 diabetes mellitus: A nationwide survey

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ABSTRACT

Aims: To describe and analyse the associations between primary health care centres' (PHCCs') quality of work (QOW) and individual HbA1c levels in people with Type 2 diabetes mellitus (T2DM).

Methods: This cross-sectional study invited all 1152 Swedish PHCCs to answer a questionnaire addressing QOW conditions. Clinical, socio-economic and comorbidity data for 230,958 people with T2DM were linked to data on QOW conditions for 846 (73.4%) PHCCs.

Results: Of the participants, 56% had controlled (≤52 mmol/mol), 31.9% intermediate (53–69 mmol/mol), and 12.1% uncontrolled (≥70 mmol/mol) HbA1c. An explanatory factor analysis identified seven QOW features. The features having a call-recall system, having individualized treatment plans, PHCCs' results always on the agenda, and having a

Abbreviations: CI, confidence interval; EFA, exploratory factor analysis; GEE, generalized estimating equations; GP, general practitioner; NDR, National Diabetes Register; OHA, oral hypoglycaemic agents; PHC, primary health care; PHCC, primary health care centre; RN, registered nurse; SALAR, Swedish Association of Local Authorities and Regions; QOW, quality of work; Swed–QOP, Swedish National Survey of the Quality and Organisation of Diabetes Care in Primary Healthcare; T2DM, Type 2 diabetes mellitus; WTE, whole time equivalent.

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follow-up strategy combined with taking responsibility of outcomes/results were associated with lower HbA1c levels in the controlled group (all $p < 0.05$). For people with intermediate or uncontrolled HbA1c, having individualized treatment plans was the only QOW feature that was significantly associated with a lower HbA1c level ($p < 0.05$).

Conclusions: This nationwide study adds important knowledge regarding associations between QOW in real life clinical practice and HbA1c levels. PHCCs' QOW may mainly only benefit people with controlled HbA1c and more effective QOW strategies are needed to support people with uncontrolled HbA1c.

1. Introduction

Type 2 diabetes mellitus (T2DM) is an important public health problem worldwide. In many countries, people with T2DM are treated in the primary health care (PHC) system. The PHC system is being outstripped by the increased burden of T2DM and its complications, resulting in a major public health issue [1]. The quality of work (QOW) in primary diabetes care for people with T2DM is essential for postponing the development of diabetes-related complications [2]. People with T2DM who has poor glycaemic control (HbA1c ≥53 mmol/mol) is at increased risk of complications [3]. Despite the presence of guidelines for diabetes care [2,4], the QOW is suboptimal and differs both within and between countries [5,6]. Improving the QOW requires efforts such as working with prevention strategies for reducing diabetes-related complications [7], using national registries for receiving tailored feedback on clinical outcomes [8], and providing individualized treatment [9,10].

Sweden is one of the leading countries in terms of primary diabetes care, and the Swedish National Diabetes Register (NDR) is the largest diabetes register globally [11]. A qualitative study by the Swedish Association of Local Authorities and Regions (SALAR) identified seven success factors in Swedish primary diabetes care, which were associated with county councils/regions having good performance regarding HbA1c level in people with T2DM: (i) focus on patients' targets; (ii) targeted initiatives for patients with poor outcomes; (iii) PHCCs' results are always on the agenda for management and healthcare professionals (HCPs); (iv) interpretation of new knowledge and clear expectations; (v) follow-up and feedback on results; (vi) long-term improvement initiatives for diabetes care; and (vii) ownership of results and focus on prevention [12]. This qualitative study examined HbA1c levels at an aggregated regional level, and it remains unclear whether these factors are important at an individual level. The study carried out by SALAR has had great impact on Swedish primary diabetes care and given that the organization of primary diabetes care is costly, there are reasons to study these effects of actions with different approaches. Further, although a meta-analysis by Tricco et al. [13] found that quality improvement (QI) strategies are essential for improving HbA1c levels and interventions targeting HCPs seems to be valuable for people with poor baseline HbA1c, the main challenge is to address the combination of strategies which people with T2DM will benefit the most from. More information on real life clinical practice is also needed to fully understand the benefits of QOW in PHC for people with T2DM. Thus, the aim of the present study was to describe and analyse the associations between PHCCs' QOW and individual HbA1c levels in people with T2DM.

2. Methods

This cross-sectional study was based on data collected by PHCCs in all 21 Swedish county councils/regions using the Swedish National Survey of the Quality and Organization of Diabetes Care in Primary Healthcare (Swed–QOP) questionnaire. Individual clinical data on people with T2DM were obtained from the NDR. Information on socio-economic conditions and comorbidities were retrieved by linkage to the Longitudinal Database for Health Insurance and Labor Market Studies (LISA) and the Swedish National Patient Register (NPR). The Uppsala Regional Ethical Review Board approved the study (Dnr: 2013/376).

2.1. *Setting*

In 2013, Sweden had a population of 9.6 million people, of whom >400,000 were estimated to have T2DM [14]. The Swedish PHC system is tax-funded and organized into 21 separate geographically based county councils/regions, which cooperate nationally through the SALAR [15].

2.2. *Study population*

All Swedish PHCCs in operation in 2013 were invited to participate in this study. In total, 880 (76.4%) of 1152 eligible PHCCs completed the Swed–QOP questionnaire. Individual-level data from 2013 were collected for 290,808 people with T2DM who attended these PHCCs and were registered in the NDR. To be eligible to participate, people were required to be ≥18 years. The final sample comprised 846 PHCCs with 230,958 people with T2DM. Supplementary Fig. S1 gives a detailed overview of the inclusion process.

2.3. *Data collection*

The Swed–QOP questionnaire was answered by each PHCC's manager. It contained questions about the PHCC's characteristics and was constructed based on items from previous studies conducted in Swedish asthma care [16] and diabetes

Table 1 – The questions from the Swedish National Survey of the Quality and Organization of Diabetes Care in Primary Healthcare (Swed–QOP) questionnaire and descriptive statistics of primary health care centres' (PHCCs') background characteristics and quality of work conditions ($n = 846$).

Type of variable	Variable from the Swed–QOP questionnaire	Value[a]	Missing[b] n (%)
Background characteristics	List size of the PHCCs, mean (SD)	8461 (4196)	2 (0.2)
	Number of listed people with T2DM, mean (SD)	354 (199)	1 (0.1)
	WTE GPs/500 people with T2DM, mean (SD)	7.1 (4.5)	3 (0.4)
	WTE RNs/500 people with T2DM assigned for diabetes care, mean (SD)	0.8 (0.4)	19 (2.2)
	Diabetes-responsible GPs	611 (72.2)	0 (0.0)
	Number of RNs with diabetes–specific education, mean (SD)	1.7 (0.9)	0 (0.0)
	Diabetes-specific education for RNs (ECTS credits), mean (SD)	15.0 (8.9)	0 (0.0)
	Pedagogical education for RNs (ECTS credits), mean (SD)	4.1 (6.5)	0 (0.0)
	Length of regular visits to GPs, mean (SD)	28 (8.3)	6 (0.7)
	Length of regular visits to RNs, mean (SD)	46 (9.0)	7 (0.8)
	Diabetes team, n (%)	473 (56.3)	6 (0.7)
	Group education program, n (%)	203 (24.0)	0 (0.0)
	Registration system for revisits to GP, n (%)	662 (80.2)	21 (2.5)
	Registration system for revisits to RN, n (%)	732 (89.1)	24 (2.8)
	RNs' participation in setting treatment targets for HbA1c, n (%)	595 (70.7)	4 (0.5)
	GPs' participation in setting treatment targets for HbA1c, n (%)	701 (83.3)	4 (0.5)
	People with T2DM' participation in setting treatment targets for HbA1c, n (%)	256 (30.4)	4 (0.5)
Quality of work[c]	Call-recall system to GPs based on patient's needs (Q1a), n (%)	269 (32.3)	14 (1.7)[d]
	Call-recall system to RNs based on patients' needs (Q1b), n (%)	428 (52.1)	25 (3.0)[d]
	Goal-oriented drug therapy based on clear treatment stages (Q2a), n (%)	573 (73.5)	66 (7.8)
	Clear strategy with interventions targeted people with poor outcomes (Q2b), n (%)	562 (71.3)	58 (6.8)
	Common meetings regarding diabetes guidelines for all HCPs (Q3a), n (%)	342 (41.0)	12 (1.4)
	Frequent dialogue between PHCC management and HCP about PHCC's results (Q3b), n (%)	475 (57.7)	23 (2.7)
	The HCP is informed about PHCC's results (Q3c), n (%)	446 (60.2)	105 (12.7)
	PHCCs report having regional guidelines for diabetes care, n (%)	831 (98.2)	15 (1.8)[e]
	Easy to access (Q4a), n (%)	665 (80.0)	0 (0.0)
	Easy to understand (Q4b), n (%)	559 (67.3)	0 (0.0)
	With clear recommendations (Q4c), n (%)	504 (60.6)	0 (0.0)
	Well-entrenched in the county council/region (Q4d), n (%)	442 (86.0)	332 (39.2)
	County council/region continuously reports results from NDR to PHCCs (Q5a), n (%)	590 (70.5)	9 (1.1)
	County council/region uses NDR-results for quality of dialogue (Q5b), n (%)	524 (62.9)	13 (1.5)
	County council/region internally reports NDR results concerning all PHCCs (Q5c), n (%)	472 (56.6)	12 (1.4)
	Culture of following guidelines (Q6a), n (%)	795 (98.5)	39 (4.6)
	Focusing on prevention of diabetes complications (Q6b), n (%)	761 (94.9)	44 (5.2)
	Follow-up strategy of outcomes/results (Q7a), n (%)	799 (96.5)	18 (2.1)
	Responsibility of quality and results for people with diabetes (Q7b), n (%)	769 (96.6)	50 (5.9)
	Having diabetes-responsible RNs (Q: excluded)	822 (97.2)	0 (0.0)
	Political priority of diabetes care (Q: excluded)	395 (48.6)	34 (4.0)
	Having conducted quality improvement work during several years (Q: excluded)	565 (73.6)	78 (9.2)

ECTS, European Credits Transfer Accumulation System; GP, general practitioner; HCP, health care professional; NDR, National Diabetes Register; RN, registered nurse; T2DM, Type 2 diabetes mellitus; WTE, whole-time equivalent.

[a] Percentages are based on PHCCs with valid values.

[b] Percentages are based on all PHCCs included in the study, i.e., $n = 846$.

[c] (Q#) refers to the question presented in Fig. 1 describing the result of quality of work features.

[d] Percentages are based on PHCCs reporting having a call–recall system ($n = 832$).

[e] Percentages are based on PHCCs reporting having regional guidelines ($n = 831$).

care in the United Kingdom [17,18]. For the present study, 21 questions addressing QOW conditions, which were based on components constituting SALAR's seven success factors [12], were added to the Swed–QOP questionnaire after having been validated using face validity. Details about the data collection of the Swed–QOP questionnaire [19] and reliability testing of the questionnaire [20] have been published elsewhere. Table 1 gives an overview of the Swed–QOP questions included in the present study.

Swed–QOP questionnaire data for each PHCC were linked to individual-level clinical data in the NDR using a unique identification number (the Swedish Health Care Address Register Identity Number). Individual-level data from other registers were linked using each individual's unique Swedish Personal Identification Number.

2.4. *Data sources*

The NDR includes >350,000 (90%) people who have been diagnosed with T2DM and are treated in the Swedish PHC system. The register is used in clinical practice to assist in the development of good diabetes care [21]. The NDR contains detailed

individual-level information regarding risk factors, medication, and complications. Clinical data are reported at least once a year from medical check-ups by general practitioners (GPs) or registered nurses (RNs). Individual clinical data are reported continuously either online or by electronic transmissions from medical charts [22]. Each patient provides informed consent [21]. The T2DM diagnosis was based on the clinical assessment by a physician. Clinical data from the NDR for people with T2DM aged ≥18 years reported to the registry during 2013 were obtained for all eligible PHCCs. HbA1c was defined in millimoles per mole (mmol/mol) according to the International Federation of Clinical Chemistry and Laboratory Medicine [23].

Additional individual-level data on socioeconomic status and comorbidities were retrieved to address potential biases. Socio-economic data were collected by linking the individual clinical level data from the NDR with the LISA maintained by Statistics Sweden. The LISA provided information on individual country of birth, marital status, income, highest educational level, and occupational status [24]. Also, individual-level data from the NDR were linked to data on comorbidities, obtained from the NPR maintained by the Swedish National Board of Health and Welfare. The NPR contains individual-level data on primary and secondary medical diagnoses from inpatient and outpatient visits at Swedish hospitals. The diagnoses are classified according to the International Statistical Classification of Diseases and Related Health Problems, 10th revision (ICD-10) [25]. Each participant's medical history was retrieved for the years 2012 and 2013, and was categorized into the main diagnostic groups of the ICD-10 classification system. Details about the coding procedure have been published elsewhere [19]. Table 2 gives details about the variables obtained from the NDR, LISA NPR. Comorbidities relevant to diabetes are presented in Table 2, while all ICD-10 diagnoses are given in Supplementary Table S1.

2.5. *Statistical analyses*

Categorical variables are presented as frequencies and percentages, *n* (%), while continuous variables are given as means and standard deviations (SDs). The answers to the 21 questions covering QOW conditions were dichotomized as 0 ("No") or 1 ("Yes"), with "Do not know" coded as missing. The 21 QOW questions are listed in Table 1.

To explore the underlying factor structure of the QOW questions, and thus explain the observed associations among the 21 questions measured at the PHCC level, an explanatory factor analysis (EFA) was performed for the 846 PHCCs included in the study. The factor extraction forming the basis of the EFA was performed using principal component analysis (PCA), with factors being above the threshold of eigenvalue = 1 deemed providing meaningful information for the interpretation of the EFA results. Based on this rule, seven factors were identified.

To obtain an easily interpretable factor solution, by minimizing the number of QOW questions that had high loadings for a factor, a varimax rotation with Kaiser normalization was performed for the factors extracted through the PCA method. Following this, QOW questions that still lacked high factor loadings, and thus were deemed to have ambiguous interpretations, were excluded using a step-wise procedure. In a first step, the question "political priority of diabetes care" was excluded, since the absolute value of its highest factor loading was <0.4. In a second step, the two questions "having diabetes-responsible RNs" and "having conducted quality improvement work during several years" were excluded, since the absolute values of their highest factor loading were <0.6 while they did not fit into the interpretation of the other questions with loadings >0.6 for the same factor. For these two steps, an iterative procedure was used whereby the extractions and rotations were re-estimated until a satisfactory result was obtained. This process led to the retention of 18 questions forming seven factors with 2–4 questions each, thus constituting the EFA solution used in the present study. The seven factors were interpreted as identifying the following seven QOW features: (1) call–recall system; (2) individualized treatment plans; (3) PHCCs' results always on the agenda; (4) characteristics of regional guidelines; (5) follow-up and feedback; (6) culture and prevention; and (7) strategies and responsibility (Fig. 1).

From the obtained EFA solution, seven EFA factor analysis scores were calculated for each PHCC, based on coefficients estimated using the Anderson–Rubin method (factor loadings varying between 0.681 and 0.867). In the present study, these EFA factor analysis scores are thus estimates of the degree of presence of each QOW feature at a PHCC.

To take account of the hierarchical dependence structure of the data, in which people with T2DM attend the same PHCC and PHCCs belong to the same county council/region, the associations between the degree of presence of PHCC-level QOW features and the individual-level HbA1c (mmol/mol) values were analysed using generalized estimating equations (GEE) linear regression models utilizing an independent structure working correlation matrix. In all analyses, the EFA factor analysis scores were used in the calculations as estimates of the QOW features. Two separate GEE linear regression models were used, with the seven QOW features being the explanatory variables of main interest: (i) an unadjusted model, including only the seven QOW features, and (ii) an adjusted model, which included, in addition to the seven QOW features, the individual-level demographic, socio-economic, lifestyle, clinical, and comorbidity variables described in Table 1 as well as the PHCC-level background characteristics described in Table 2 and Supplementary Table S1.

All regression analyses were performed stratified on three categories of HbA1c level: controlled (≤52 mmol/mol); intermediate (53–69 mmol/mol); and uncontrolled (≥70 mmol/mol). These data are presented using the slope coefficients β with accompanying 95% confidence intervals (CIs). Tests of difference between β values for the controlled and uncontrolled groups were performed using a normal approximation Z test procedure. Missing NDR data were imputed using the last observation carried forward method, utilizing valid values from the same year.

All statistical analyses were performed using IBM SPSS Statistics 24, except for tests of difference between β which were calculated manually using Microsoft Excel. For all statistical tests, two-sided p-value <0.05 were considered statistically significant.

Table 2 – Participant characteristics according to the three HbA1c level groups ($n = 230,958$).

Type of variable	Variable	Controlled ($n = 124,671$)	Intermediate ($n = 70,928$)	Uncontrolled ($n = 26,947$)	Missing[a] n (%)
Demographics	Age (years), mean (SD)	68.1 (11.5)	68.8 (11.6)	66.1 (12.9)	0 (0.0)
	Men, n (%)	69 430 (55.7)	40,699 (57.4)	15,844 (58.8)	0 (0.0)
	Duration of diabetes (years), mean (SD)	7.1 (6.6)	10.9 (8.0)	12.4 (8.5)	21,528 (9.3)
Clinical	Systolic blood pressure (mmHg), mean (SD)	134.2 (15.4)	135.5 (15.7)	136.0 (16.5)	11,979 (5.2)
	Diastolic blood pressure (mmHg), mean (SD)	76.1 (9.6)	76.0 (9.7)	76.9 (10.3)	12,130 (5.3)
	Body mass index (kg/m^2), mean (SD)	29.4 (5.2)	30.1 (5.3)	31.2 (5.8)	30,305 (13.1)
	Total cholesterol (mmol/l), mean (SD)	4.7 (1.1)	4.6 (1.1)	4.8 (1.2)	61,771 (26.7)
	Triglycerides (mmol/l), mean (SD)	1.7 (1.0)	1.9 (1.2)	2.3 (1.9)	83,328 (36.1)
	High-density lipoprotein (mmol/l), mean (SD)	1.3 (0.4)	1.2 (0.4)	1.2 (0.4)	78,019 (34.0)
	Low-density lipoprotein (mmol/l), mean (SD)[b]	2.6 (0.9)	2.5 (0.9)	2.6 (1.0)	77,102 (33.4)
	Estimated glomerular filtration rate (eGFR) <60 (ml/min), n (%)[c]	16,240 (15.0)	11,740 (19.1)	4569 (19.8)	35,680 (15.4)
	Risk/presence of foot complications, n (%)	19,619 (19.7)	14,303 (25.0)	6159 (29.8)	48,839 (21.1)
	Diabetes retinopathy, n (%)	18,772 (20.5)	18,697 (33.8)	8809 (43.9)	59,938 (15.4)
	Microalbuminuria, n (%)[e]	13,660 (16.1)	10,678 (22.6)	5247 (31.3)	80,468 (34.8)
	Macroalbuminuria, n (%)[f]	4593 (5.6)	4119 (9.1)	2305 (14.5)	87,075 (37.7)
	Antihypertensive drugs, n (%)	94,409 (79.0)	54,951 (80.7)	19,848 (76.9)	10,155 (4.1)
	Lipid-lowering drugs, n (%)	72,921 (61.2)	44,697 (65.8)	16,247 (63.2)	10,925 (4.7)
	Glucose-lowering treatment, n (%)				1457 (0.6)
	Diet	40,439 (32.6)	6460 (9.2)	1490 (5.6)	
	OHA	65,370 (52.7)	34,531 (48.9)	8294 (30.9)	
	Insulin	7264 (5.9)	10,977 (15.6)	6190 (23.1)	
	OHA + insulin	9716 (7.8)	17,057 (24.2)	9952 (37.1)	
	Other medications	1184 (1.0)	1527 (2.2)	880 (3.3)	
Lifestyle	Smoker, n (%)	14,946 (13.7)	8432 (13.7)	3925 (17.4)	33,591 (14.5)
	Physical activity, n (%)				50,352 (21.8)
	Never or less than once per week	23,960 (23.9)	17,596 (30.8)	8492 (40.9)	
	1–2 times/week	19,507 (19.5)	11,864 (20.7)	4406 (21.2)	
	3–5 times/week	24,319 (24.3)	12,279 (21.5)	3515 (16.9)	
	Daily	32,306 (32.3)	15,450 (27.0)	4357 (21.0)	

Socio-economics	Born in Sweden, *n* (%)	102,293 (82.1)	56,963 (80.4)	20,419 (75.9)	228 (0.0)
	Marital status, *n* (%)				228 (0.0)
	Single	18,120 (14.5)	10,412 (14.7)	5223 (19.4)	
	Married/registered partner	66,798 (53.6)	36,527 (51.5)	12,245 (45.5)	
	Divorced	21,389 (17.2)	12,316 (17.4)	5419 (20.1)	
	Widowed	18,279 (14.7)	11,607 (16.4)	4031 (15.0)	
	Income per year, *n* (%)				101 (0.0)
	<120,000 SEK	23,598 (18.9)	14,484 (20.4)	6264 (23.3)	
	120,000 ≤ SEK < 145 000	23,219 (18.6)	14,439 (20.4)	5812 (21.6)	
	145,000 ≤ SEK < 175 000	24,254 (19.5)	14,210 (20.0)	5042 (18.7)	
	175,000 ≤ SEK < 250 000	27,223 (21.8)	14,577 (20.6)	5332 (19.8)	
	≥250,000	26,348 (21.1)	13,193 (18.6)	4482 (16.6)	
	Educational level, *n* (%)				4397 (1.9)
	≤9 years (compulsory)	46,891 (38.2)	29,190 (42.0)	11,088 (42.3)	
	10–12 years	52,865 (43.1)	29,455 (42.4)	11,442 (43.6)	
	College/university	22,954 (18.7)	10,834 (15.6)	3691 (14.1)	
	Occupational status, *n* (%)				228 (0.0)
	Working	33,508 (26.9)	18,302 (25.8)	7441 (27.6)	
	Not working aged <65 years	15,466 (12.4)	9131 (12.9)	5518 (20.5)	
	Not working aged ≥65 years	75,612 (60.7)	43,429 (61.3)	13,959 (51.9)	
Comorbidity[d]	Neoplasms (ICD 10; C00–D48), *n* (%)	16,415 (13.2)	9224 (13.0)	3033 (11.3)	0 (0.0)
	Eye and adnexa, (ICD 10; H00–H59), *n* (%)	27,427 (22.0)	17,796 (25.1)	7223 (26.8)	0 (0.0)
	Circulatory system (ICD 10; I00–I99), *n* (%)	39,113 (31.4)	24,379 (34.4)	10,085 (37.4)	0 (0.0)

OHA, Oral hypoglycaemic agents; SEK, Swedish krona.

Note: Controlled, ≤52 mmol/mol; intermediate, 53–69 mmol/mol; uncontrolled, ≥70 mmol/mol.

[a] Percentages are based on all people included in the study, i.e., *n* = 230,958.

[b] Primarily based on low-density lipoprotein level (LDL) reported to the NDR and secondary if missing; the LDL was calculated based on the Friedewald formula.

[c] Calculated based on the Modification of Diet in Renal Disease form.

[d] Other comorbidities are reported as supplementary data (Table S1).

[e] Yes if two of three tests within 1 year were positive, i.e., albumin/creatinine ratio 3–30 mg/mmol or urinary albumin 20–200 μg/min or 20–300 mg/l.

[f] Yes if albumin/creatinine ratio >30 mg/mmol or urinary albumin 20–200 μg/min or 20–300 mg/l.

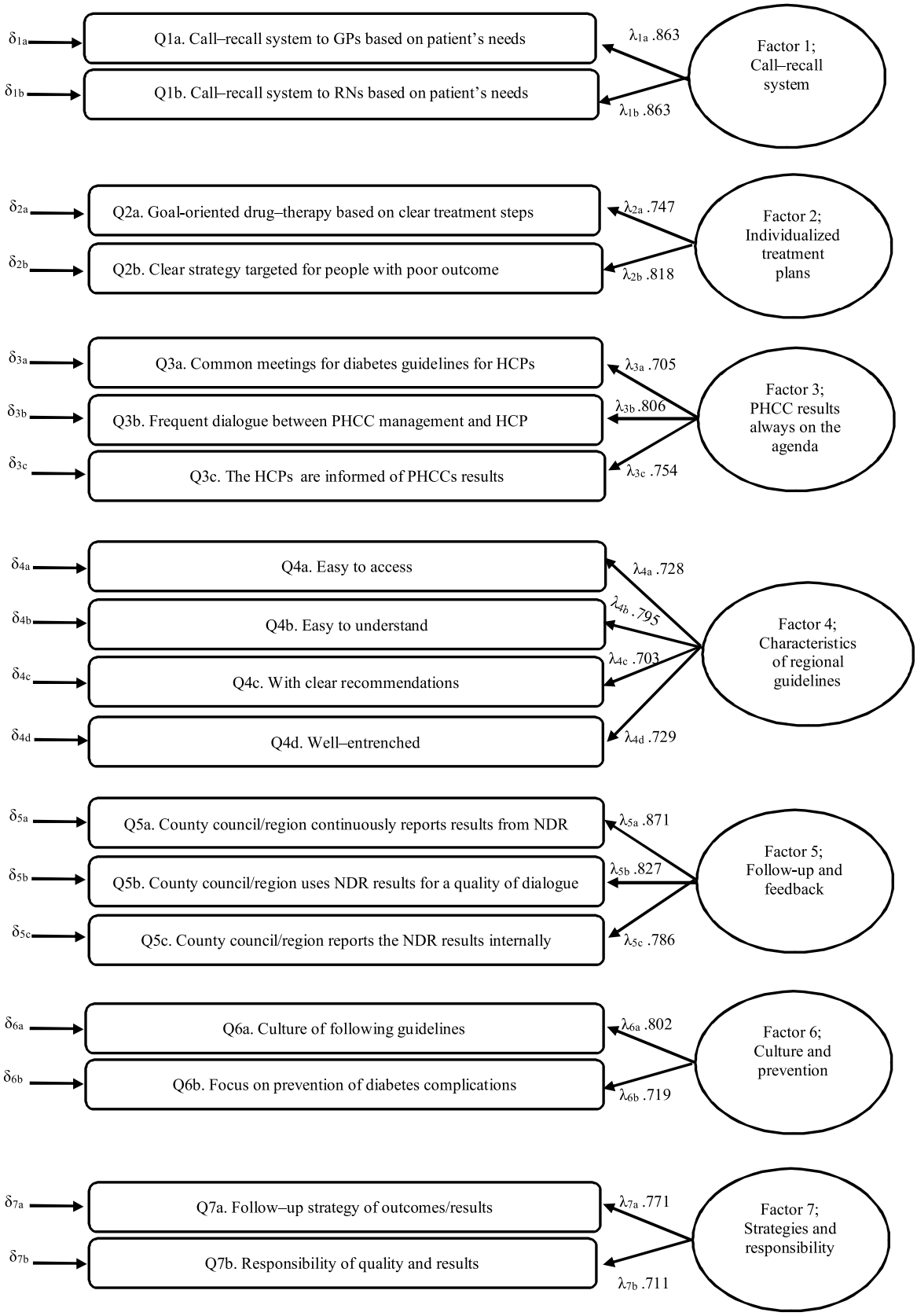

Fig. 1 – Results of the exploratory factor analysis (EFA), δ = residual/measurement error, λ = factor loading. GPs, general practitioners; HCPs, healthcare professionals; NDR, National Diabetes Register; PHCCs, primary health care centres; RNs, registered nurses.

3. Results

Background characteristics and QOW features of the 846 PHCCs are given in Table 1. The PHCCs reported a mean (SD) list size of 8461 (4196) patients, 354 (199) of whom had T2DM. Nursing personnel assigned for diabetes care at the PHCCs made up a mean (SD) of 0.8 (0.41) whole-time equivalent (WTE) RNs for every 500 people with T2DM.

Table 2 shows the characteristics of the 230,958 people with T2DM, grouped according to the three HbA1c categories. More than half (56.0%) of the participants had a controlled HbA1c level, about one-third (31.9%) an intermediate, and about one-tenth (12.1%) an uncontrolled HbA1c level. People with uncontrolled HbA1c were slightly younger, mean (SD) age 66 (12.9) years, were more often males (58.8%), and had a longer diabetes duration, mean (SD) 12.4 (8.5) years. Regardless of HbA1c level, most of the people were married/had a registered partner, and most had 10–12 years of schooling. Complications such as presence of microalbuminuria (31.3%) or macroalbuminuria (14.5%) were more common in the group with uncontrolled HbA1c.

3.1. QOW features at the PHCCs

As shown in Table 1, a low percentage of PHCCs reported having a call–recall system based on patients' needs to RNs (52.1%) and GPs (32.3%). However, more PHCCs recognized the importance of having a goal-oriented drug therapy treatment plan (73.5%) and a clear strategy for people with poor outcomes (71.3%). Incorporating the HCPs into the QOW process seemed to be less prioritized: only 342 (41.0%) PHCCs had common meetings about guidelines, 475 (57.7%) had a dialogue between PHCC management and HCPs, and 446 (60.2%) informed the HCPs about their PHCC's results. However, almost all reported taking responsibility for quality and results (96.6%) and having a culture of following guidelines (98.5%).

3.2. Association between QOW features and individual HbA1c levels

The associations between QOW features and individual HbA1c levels are shown in Table 3, separately for the controlled, intermediate, and uncontrolled groups. After adjusting for confounding variables, an increased presence of four of the seven QOW features was significantly associated with a lower HbA1c level for people with a controlled HbA1c level. These QOW features (expressed as the change in HbA1c per SD of the QOW feature) were: call–recall system (factor 1; −0.054 mmol/mol; $p < 0.001$); Individualized treatment (Factor 2; −0.053 mmol/mol; $p < 0.001$); PHCCs results always on the agenda (Factor 3; −0.088 mmol/mol; $p < 0.001$); and Strategies and responsibility (Factor 7; −0.046 mmol/mol; $p < 0.003$). The QOW feature Culture and prevention (factor 6) was not significantly associated with individual HbA1c levels in the unadjusted model. However, after adjusting for confounding variables, an increased presence of this feature was associated with increased HbA1c levels in people with a controlled HbA1c level (0.043 mmol/mol; $p = 0.005$).

For people with an intermediate or uncontrolled HbA1c level, the increased presence of Individualized treatment (Factor 2) was the only QOW feature that was significantly associated with a lower individual HbA1c level (−0.053 mmol/mol; $p = 0.001$ and −0.197 mmol/mol; $p = 0.014$, respectively). When testing for differences between the uncontrolled and controlled HbA1c level groups regarding associations between QOW features and individual HbA1c level, only the feature PHCCs' results always on the agenda (factor 3) differed significantly between the two groups; the slope coefficient β was lower for the controlled group than for the uncontrolled group ($\Delta\beta = 0.172$ mmol/mol; $p = 0.042$). Comparing PHCCs among the top 2.5% (i.e., having ≥2 SDs on all QOW features) with those among the bottom 2.5% (i.e., having ≤2 SDs on all QOW features) showed that the HbA1c level would be 1.136 mmol/mol lower in the controlled group, 0.212 mmol/mol lower in the intermediate group, and 0.788 mmol/mol lower in the uncontrolled group.

4. Discussion

The current study found a greater number of significant associations between QOW features and HbA1c level in people with controlled HbA1c than in people with intermediate or uncontrolled HbA1c. This contrasts with a previous systematic review and meta-analysis [13], where QOW strategies were reported to have the largest effect among people with intermediate/uncontrolled HbA1c. These conflicting results may be explained by limitations of the present cross-sectional study design and/or reflecting the need of more evidence-based QOW strategies to support people with uncontrolled HbA1c. Surprisingly, even though almost all PHCCs worked with the questions addressed in the QOW features Culture and prevention (Factor 6) and Strategies and responsibility (Factor 7), no significant associations were found for people in the intermediate or uncontrolled group. This may reflect that, even though PHCCs managers have an interest in pursuing these questions, their organization experiences challenges when translating this into clinical practice, especially for people with uncontrolled HbA1c [26].

The unexpected association between having more of the QOW feature Culture and prevention (Factor 6) and an increased HbA1c level in those with controlled HbA1c may reflect reverse causation. Notably, the QOW feature Follow up and feedback (Factor 5) was not significantly associated with lower HbA1c levels. Using the NDR provides the opportunity for PHCCs to get access to a systematic documentation, make comparisons, and come up with ideas for improvements [8]. Certainly, identifying associations could be challenging when the utilization of the NDR is unclear. The observed association between the QOW feature Individualized treatment plans (Factor 2) and lower HbA1c levels in people with intermediate/uncontrolled HbA1c confirms the importance of providing individualized care [9].

Systematic reviews [27–29] have found limited evidence for associations between the organisation of diabetes care and glycaemic control, which may be explained by poor methodological quality of the included studies. Moreover, these conclusions may be the result of heterogeneous stud-

Table 3 – Results of the generalized estimating equations linear regression models of the associations between quality of work (QOW) features and individual HbA1c level, separately for each HbA1c level. Significant differences are given in bold.

QOW feature	Controlled (n = 104,647 at 788 PHCCs)		Intermediate (n = 61,078 at 788 PHCCs)		Uncontrolled (n = 22,849 at 783 PHCCs)		Diff. uncontrolled vs controlled	
	β (95% CI)	p value	β (95% CI)	p value	β (95% CI)	p value	Diff β	p value
Unadjusted								
1. Call–recall system	−0.042 (−0.072; −0.013)	**0.005**	−0.005 (−0.042; 0.032)	0.805	0.025 (−0.130; 0.180)	0.754	0.067	0.238
2. Individualized treatment	−0.055 (−0.085; −0.025)	**<0.001**	−0.042 (−0.079; −0.005)	**0.027**	−0.107 (−0.260; 0.047)	0.174	−0.052	0.290
3. Results always on the agenda	−0.129 (−0.159; −0.099)	**<0.001**	−0.014 (−0.052; 0.024)	0.476	0.166 (0.007; 0.325)	**0.040**	0.295	**0.001**
4. Regional guidelines	−0.029 (−0.058; 0.001)	0.054	−0.014 (−0.051; 0.022)	0.439	−0.125 (−0.282; 0.032)	0.118	−0.096	0.155
5. Follow-up and feedback	−0.008 (−0.021; 0.038)	0.571	0.035 (−0.002; 0.072)	0.063	−0.043 (−0.194; 0.109)	0.582	−0.051	0.290
6. Culture and prevention	0.011 (−0.020; 0.041)	0.497	−0.017 (−0.055; 0.021)	0.374	−0.109 (−0.269; 0.052)	0.186	−0.119	0.111
7. Strategies and responsibility	−0.051 (−0.083; −0.019)	**0.002**	−0.012 (−0.051; 0.026)	0.529	0.111 (−0.050; 0.271)	0.177	0.162	0.050
Adjusted[a]								
1. Call–recall system	−0.054 (−0.083; −0.025)	**<0.001**	−0.009 (−0.046; 0.028)	0.641	−0.004 (−0.160; 0.152)	0.964	0.050	0.298
2. Individualized treatment	−0.053 (−0.083; −0.023)	**<0.001**	−0.053 (−0.091; −0.014)	**0.007**	−0.197 (−0.355; −0.040)	**0.014**	−0.144	0.065
3. Results always on the agenda	−0.088 (−0.119; −0.057)	**<0.001**	−0.017 (−0.057; 0.022)	0.391	0.085 (−0.080; 0.249)	0.312	0.172	**0.042**
4. Regional guidelines	−0.015 (−0.044; 0.014)	0.313	−0.009 (−0.046; 0.028)	0.640	−0.091 (−0.251; 0.068)	0.262	−0.077	0.213
5. Follow-up and feedback	−0.014 (−0.042; 0.014)	0.339	0.036 (0.000; 0.073)	0.052	−0.056 (−0.206; 0.095)	0.470	−0.042	0.323
6. Culture and prevention	0.043 (0.013; 0.073)	**0.005**	0.003 (−0.035; 0.041)	0.881	−0.098 (−0.258; 0.062)	0.231	−0.140	0.074
7. Strategies and responsibility	−0.046 (−0.077; −0.015)	**0.003**	0.007 (−0.032; 0.046)	0.724	0.109 (−0.054; 0.272)	0.190	0.156	0.058

Diff., Difference; HCP, healthcare professional; PHCC, primary health care centre; NDR, National Diabetes Register.

Note: Controlled, ≤52 mmol/mol; intermediate, 53–69 mmol/mol; uncontrolled, ≥70 mmol/mol. QOW features: 1. Call–recall system; 2. individualized treatment; 3. PHCCs' results always on the agenda; 4. characteristics of regional guidelines; 5. follow-up and feedback; 6. culture and prevention; 7. strategies and responsibility.

[a] Adjusted for all PHCC level personnel resources and organizational features as well as all individual-level demographics, clinical, lifestyle, socio-economic, and comorbidity variables.

ies with diverse participant characteristics, study settings, and reported outcomes [30]. The organization of primary diabetes care has no single universal pathway that can be applied in all settings [6]. However, this study adds important knowledge about the effects of QOW features within one of the most comprehensive PHC systems in Europe, which may be useful for benchmarking between countries.

To some extent, the findings of the present study are consistent with SALAR's seven success factors in terms of identifying organizational features as important to the ability of HCPs to provide a diabetes care of good quality for people with T2DM [12]. Caution must, however, be taken when comparing the present study and SALAR's qualitative study because of the different methodological approaches. Despite the limitations in the methodology and restricted generalizability of the results, SALAR's qualitative study has had a large-scale impact on Swedish primary diabetes care. The seven QOW features addressed in the current study should be seen as complementary information to SALAR's qualitative benchmarking study, making it possible for policy makers to better understand the meaning of success factors in primary diabetes care.

Limitations of the present study include the cross-sectional design, making it impossible to study causal relationships. Using self-reported questionnaires, although facilitating the collection of this large amount of data, increased the risk that respondents embellished answers or misinterpreted questions. To reduce this kind of bias, PHCC managers were encouraged to answer the questionnaire together with GPs and RNs having direct contact with the patients. There is also a risk of selection bias since well-functioning PHCCs may have been more inclined to complete the questionnaire. However, this is so far the first Swedish large-scale national survey to describe and analyse the associations between PHCCs' QOW and HbA1c level in people with T2DM. The large sample size of people with T2DM and PHCCs increases the ability to generalize the results in the Swedish PHC setting. Using well-administrated registers covering individual-level data on clinical risk factors, socio-economics, and comorbidities made it possible to adjust for all known important confounders.

In conclusion, having individualized treatment plans was the only QOW feature that was significantly associated with lower HbA1c levels in all groups. The greatest effect was found for people with uncontrolled HbA1c. In addition to previous research assessing the effectiveness on QOW improvements based on randomized controlled trials, this nationwide observational study points to the importance of examining associations between QOW in real life clinical practice and HbA1c levels in people with T2DM. To date, the QOW carried out at Swedish PHCCs may only benefit people with good glycaemic control (HbA1c $\leq$ 52 mmol/mol). More effective QOW strategies are thus needed to support people with uncontrolled HbA1c.

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Conflicts of interest

The authors state that they have no conflict of interest.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.pcd.2018.11.005.

REFERENCES

[1] World Health Organization [WHO], Global Report on Diabetes, WHO, 2016, pp. 1–88, Available at: http://apps.who.int/iris/bitstream/10665/204871/1/9789241565257_eng.pdf. (Last accessed 2 February 2018).
[2] American Diabetes Association, Standards of medical care in diabetes—2018 abridged for primary care providers, Clin. Diabet. 36 (1) (2018) 14–37.
[3] I.M. Stratton, A.I. Adler, H.A. Neil, et al., Association of glycaemia with macrovascular and microvascular complications of Type 2 diabetes (UKPDS 35): prospective observational study, BMJ 321 (7258) (2000) 405–412.
[4] The National Board of Health and Welfare, National Guidelines for Diabetes Care—Support for Governance and Management (in Swedish), The National Board of Health and Welfare, Stockholm, 2017, pp. 1–117, Available at http://www.socialstyrelsen.se/publikationer2017/2017-5-31. (Last accessed 31 August 2018).
[5] R. Husdal, A. Rosenblad, J. Leksell, et al., Resource allocation and organisational features in Swedish primary diabetes care: changes from 2006 to 2013, Prim. Care Diabet. 11 (1) (2017) 20–28.
[6] R.I. Holt, A. Nicolucci, K. Kovacs Burns, et al., Diabetes attitudes, wishes and needs second study (DAWN2): cross-national comparisons on barriers and resources for optimal care-healthcare professional perspective, Diabet. Med. 30 (7) (2013) 789–798.
[7] E.Y.F. Wan, C.S.C. Fung, F.F. Jiao, et al., Five-Year effectiveness of the multidisciplinary risk assessment and management programme—diabetes mellitus (RAMP-DM) on diabetes-related complications and health service uses—a population-based and propensity-matched cohort study, Diabet. Care 41 (1) (2018) 49–59.
[8] I.M. Hallgren Elfgren, E. Grodzinsky, E. Tornvall, Swedish Diabetes Register, a tool for quality development in primary health care, Prim. Health Care Res. Dev. 3 (3) (2013) 250–257.
[9] A. Coulter, V.A. Entwistle, A. Eccles, et al., Personalised care planning for adults with chronic or long-term health

conditions, Cochrane Database Syst. Rev. (3) (2015), Cd010523.
[10] M.J. Campmans-Kuijpers, L.C. Lemmens, C.A. Baan, et al., Patient-centeredness and quality management in Dutch diabetes care organizations after a 1-year intervention, Patient Prefer. Adherence 10 (2016) 1957–1966.
[11] European Coalition for Diabetes, Diabetes in Europe: Policy Puzzle, The State We Are In, European Coalition for Diabetes, 2014, pp. 1–164, Available at https://www.fend.org/sites/fend.org/files/ECD-PP4finalweb.pdf. (Last accessed 2 February 2018).
[12] Swedish Association of Local Authorities and Regions [SALAR], Success Factors in Swedish Diabetes Care: Inspiration for the Advancement of Diabetes Care (in Swedish), Swedish Association of Local Authorities and Regions, Stockholm, 2013, pp. 1–68, Available at https://webbutik.skl.se/bilder/artiklar/pdf/7164-983-6.pdf?issuusl=ignore. (Last accessed 2 February 2018).
[13] A.C. Tricco, N.M. Ivers, J.M. Grimshaw, et al., Effectiveness of quality improvement strategies on the management of diabetes: a systematic review and meta-analysis, Lancet 379 (9833) (2012) 2252–2261.
[14] S.P. Jansson, K. Fall, O. Brus, et al., Prevalence and incidence of diabetes mellitus: a nationwide population-based pharmaco-epidemiological study in Sweden, Diabet. Med. 32 (10) (2015) 1319–1328.
[15] A.G. Anell, A.H. Glenngård, S. Merkur, Sweden: Health Systems Review, Health Systems in Transition, 2012, pp. 1–159, Available at: http://www.euro.who.int/__data/assets/pdf_file/0008/164096/e96455.pdf. (Last accessed 2 February 2018).
[16] K. Lisspers, B. Stallberg, M. Hasselgren, et al., Organisation of asthma care in primary health care in Mid-Sweden, Prim. Care Respir. J. 14 (3) (2005) 147–153.
[17] M. Pierce, G. Agarwal, D. Ridout, A survey of diabetes care in general practice in England and Wales, Br. J. Gen. Pract. 50 (456) (2000) 542–545.
[18] J. Stewart, D. Kendrick, Setting and negotiating targets in people with Type 2 diabetes in primary care: a cross sectional survey, Diabet. Med. 22 (6) (2005) 683–687.
[19] R. Husdal, A. Rosenblad, J. Leksell, et al., Resources and organisation in primary health care are associated with HbA1c level: a nationwide study of 230,958 people with Type 2 diabetes mellitus, Prim. Care Diabetes 1 (2018) 23–33.
[20] E.T. Adolfsson, A. Rosenblad, K. Wikblad, The Swedish National Survey of the quality and organization of diabetes care in primary healthcare—Swed–QOP, Prim. Care Diabetes 4 (2) (2010) 91–97.
[21] B. Eliasson, S. Gudbjornsdottir, Diabetes care-improvement through measurement, Diabet. Res. Clin. Pract. 106 (Suppl 2) (2014) S291–S294.
[22] E.T. Adolfsson, A. Rosenblad, Reporting systems, reporting rates and completeness of data reported from primary healthcare to a Swedish quality register—the National Diabetes Register, Int. J. Med. Inform. 80 (9) (2011) 663–668.
[23] A. Geistanger, S. Arends, C. Berding, et al., Statistical methods for monitoring the relationship between the IFCC reference measurement procedure for hemoglobin A1c and the designated comparison methods in the United States, Japan, and Sweden, Clin. Chem. 54 (8) (2008) 1379–1385.
[24] Statistics Sweden, Background Facts: Integrated Database for Labour Market Research (in Swedish), Statistics Sweden, Örebro, 2016, pp. 1–386, Available at: https://www.scb.se/Statistik/AM/AM9901/_dokument/AM9901_1990I13_BR_AM76BR1601.pdf (Last accessed 2 February 2018).
[25] J.F. Ludvigsson, E. Andersson, A. Ekbom, et al., External review and validation of the Swedish national inpatient register, BMC Public Health 11 (2011) 450.
[26] R.E. Glasgow, Translating research to practice: lessons learned, areas for improvement and future directions, Diabet. Care 26 (8) (2003) 2451–2456.
[27] C.M. Renders, G.D. Valk, S.J. Griffin, et al., Interventions to improve the management of diabetes in primary care, outpatient, and community settings: a systematic review, Diabet. Care 24 (10) (2001) 1821–1833.
[28] G. Sidorenkov, F.M. Haaijer-Ruskamp, D. de Zeeuw, et al., Review: relation between quality-of-care indicators for diabetes and patient outcomes: a systematic literature review, Med. Care Res. Rev. 68 (3) (2011) 263–289.
[29] J. Worswick, S.C. Wayne, R. Bennett, et al., Improving quality of care for persons with diabetes: an overview of systematic reviews—what does the evidence tell us? Syst. Rev. 2 (2013) 26.
[30] H. Calsbeek, N.A. Ketelaar, M.J. Faber, et al., Performance measurements in diabetes care: the complex task of selecting quality indicators, Int. J. Qual. Health Care 25 (6) (2013) 704–709.